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SEASONAL ADJUSTMENTS BY ELECTRONIC COMPUTER METHODS*

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I. INTRODUCTION AND SUMMARY

DURING the past few years, electronic computer programs for seasonally adjusting time series have been developed at the Bureau of the Census and improved and extended at the National Bureau of Economic Research. The electronic computer programs have been made available to other organizations and seasonal adjustments are now being made in several parts of the country on several different machines. More than 3,000 series had been adjusted for seasonal variations on electronic computers by mid-1957 and these series are being released in seasonally adjusted form by the responsible statistical agencies.

The electronic computer programs described in this paper have a limited objective—to eliminate the heavy burdens and high costs previously required for seasonal adjustments of time series and, consequently, to make seasonally adjusted data available for all important series. This paper does not try to resolve the many complex conceptual problems implicit in the decomposition

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The revised paper has been approved for publication, as a report of the National Bureau of Economic Research, by the Director of Research and the Board of Directors of the National Bureau in accordance with the resolution of the Board governing National Bureau reports (see Annual Report of the National Bureau of Economic Research). It is to be reprinted as No. 12 in the National Bureau's series of Technical Papers.

Many persons and organizations have made important contributions to our work on the use of electronic computers for seasonal adjustments of time series. Almost all the different groups utilizing the Census Univac service offered suggestions, and some of the strong points of the present method are their contribution. The staffs of the Bureau of the Census, the National Bureau of Economic Research, the Board of Governors of the Federal Reserve System, the Department of Agriculture, and the Department of Trade and Commerce in Canada should be specifically mentioned.

Thanks are also due to Howard C. Grieves and Morris H. Hansen of the Bureau of the Census for encouragement and practical assistance in the first stages of the project; to Arthur L. Broida of the Federal Reserve System and Maxwell R. Conklin of the Bureau of the Census for valuable suggestions and criticisms of the early work; to Geoffrey H. Moore of the National Bureau of Economic Research for similar contributions more recently; to Max A. Bershad of the Bureau of the Census for painstakingly reviewing and improving several early drafts of this paper; to a National Bureau of Economic Research staff committee consisting of Millard Hastay, Ruth P. Mack, and Victor Zarnowitz, and to W. Allen Wallis of the University of Chicago for helpful criticisms of a later draft; to Gladys F. Webbink for editorial suggestions; and to H. Irving Forman for drawing the charts. For assisting with the Univac programming, the writers are indebted to Lancelot W. Armstrong, George M. Heller, James L. McPherson, and the late Edward I. Lober, all of the Bureau of the Census.

During the 1956–57 academic year, while the writers were on leave of absence from the Bureau of the Census, working with the staff and records of the National Bureau of Economic Research, both Univac time and programming resources were provided by the Remington Rand Division of the Sperry-Rand Corporation. This project was supported by a grant from the National Science Foundation.

of economic time series and more specifically in the adjustment of series for seasonal variations, but only to show that the present electronic computer methods generally yield results of at least the same order of quality as the best clerical methods. There is little doubt, however, that the use of electronic computers, by forcing us to make explicit our assumptions at each stage of the work and enabling us to make comprehensive tests of the results, already has thrown considerable light on these problems and led to some improvements over the techniques previously used.

This paper describes the two methods developed at the Bureau of the Census and compares the results. The first method is a mechanical version of the familiar and widely used ratio-to-moving-average method and the second a refinement of the first. In the newer method the trend-cycle curve is traced out by a weighted fifteen-month moving average which provides a flexible yet smooth graduation. Smooth curves are also fitted to the seasonal-irregular ratios to provide seasonal adjustment factors, and follow the ratios for the full period of the data. Extreme values among the ratios are isolated automatically by a built-in system of control charts and are replaced by averages of the extreme ratio and surrounding ratios. Series as short as six years and as long as thirty years can be seasonally adjusted, and quarterly as well as monthly data can be handled.

Comparisons for a large number of different types of series show the second method to be superior. Comparisons with adjustments carefully made clerically by three different statistical organizations indicate that the results are at least as good as manual adjustments of the same series. These comparisons indicate that this electronic computer program has brought us fairly close to providing on a mass basis a fully mechanical method of making seasonal adjustments as good as those previously prepared for only a small number of series by a combination of laborious hand computations and professional judgments. For the few series where this is not the case, the electronic computer program provides data which can be converted to satisfactory seasonal adjustments with only a small amount of additional hand manipulations. Some of the kinds of series for which Method II is likely to yield inadequate adjustments are described, also.

Continuing studies are being made to find ways of reducing the number of unsatisfactory adjustments, and the resulting refinements of the method will improve it still further. Nevertheless, professional review of the results, particularly for the initial and terminal years of series, still is, and probably always will be, necessary.

II. SEASONAL ADJUSTMENTS BY METHODS I AND II

The first seasonal method programmed for the Census Bureau work, Method I, is an adaptation and elaboration of the familiar ratio-to-moving-average method at its most advanced stage of development.[1] A series reflecting the

[1] See, for example, F. C. Mills, *Statistical Methods* (New York, 1955), pp. 360–375; F. E. Croxton and D. J. Cowden, *Applied General Statistics* (New York, 1955), pp. 320–363; W. A. Wallis and H. V. Roberts, *Statistics: A New Approach* (Glencoe, Illinois, 1956), pp. 580–586; A. F. Burns and W. C. Mitchell, *Measuring Business Cycles* (New York, 1946), pp. 43–55; H. C. Barton, Jr., "Adjustment for Seasonal Variation," *Federal Reserve Bulletin*, v. 27 (1941), pp. 518–528.