Seasonal adjustment by the Census Method

Since January 1970 the Bundesbank has been using the so-called Census Method, developed after many years of research by the U.S. Bureau of the Census, for the seasonal adjustment of time series, in the place of the method previously employed. With the publication of the March issue of the Statistical Supplement "Seasonally adjusted economic data" the changeover will be complete. The following article outlines the reasons for abandoning the Bundesbank method employed up to now.

The use of seasonal adjustment methods in the Federal Republic of Germany

Apart from sporadic research in the early fifties, the method of seasonal adjustment developed by the Deutsche Bundesbank in 1956/57 was the first to be used in Germany on any appreciable scale in the analysis of economic time series. The results were originally published from time to time in the Monthly Reports of the Deutsche Bundesbank in the form of tables or charts, and from April 1963 onwards results covering a selection of important economic series appeared in the Monthly Reports regularly; since April 1968 they have been presented in the Statistical Supplement, Series 4, Seasonally adjusted economic data. Since mid-1966 the larger economic research institutes have also been publishing a sizable programme of seasonally adjusted figures. The method of seasonal adjustment devised by these institutes in a working party specially set up for the purpose (ASA) makes use of the same regression analysis model as the method hitherto employed by the Bundesbank, but embodies a number of modifications.

The computation and publication of seasonally adjusted series has long been the custom in other advanced industrial countries, which have a far greater continuity in their statistical series than Germany. It is a prerequisite for a higher degree of accuracy in economic analysis. With the increasing publication of such series the use of seasonally adjusted figures in economic analysis soon superseded the traditional approach of "growth rates on the previous year", which is a crude form of seasonal adjustment. Seasonal adjustment permits the elimination of variations that recur from year to year, thus revealing the latest changes in the movement of the business cycle, which can be elicited from mere annual growth rates only with difficulty, and sometimes in a positively misleading manner. With the aid of seasonally adjusted figures, turning points in the business cycle can reliably be detected after only a short time-lag, as also can the acceleration or deceleration of economic activity. The method employed up to now has foundations dating back to the period before the use of electronic data processing equipment, so that in some cases simplified assumptions were imperative – among other things to keep the amount of work involved within reasonable limits – but even this method enabled major cyclical

changes to be diagnosed by means of quarterly, two-monthly and in favourable cases monthly figures. These features have made seasonal adjustment an indispensable tool of economic analysis. Like all scientific processes, the methods of computing seasonal adjustments are subject to change and gradual improvement. The available "hardware" is a most important factor in this connection; the advent of more sophisticated computer systems opens up new possibilities.

Standards for comparing methods of seasonal adjustment

Every seasonal adjustment method is based on certain assumptions about the number and type of relation of the various components of a time series and about the dependence of the components on each other or on time. These assumptions are then converted into a mathematical model to estimate the components – seasonal adjustment in the narrower sense. In other words, seasonal fluctuations can be eliminated in a fairly wide variety of ways, and this raises the question of the relative usefulness of the various techniques. The decision to use one particular method is taken as a rule following a comparison of several methods, and the comparison must be based on standards clearly revealing the differing performances of the methods. These standards are determined in the first place by the purpose of the seasonal adjustment, that is by its function of facilitating economic analysis. Secondly, the value of a method is judged by formal, statistical and methodological criteria. From this point of view preference should be given to the method which best fulfils the following conditions:

1. Fluctuations that recur year by year should be eliminated completely, gradual changes in the seasonal pattern should be apparent. Besides the seasonal variations, as far as possible influences due to the varying composition of the months, such as the unequal number of working days in months of equal length, the movable feasts (Easter, Ascension Day, Whitsun) etc., should be eliminated.

2. The results should depend as little as possible on the duration and location in time of the period covered. In other words, the inclusion of, say, an additional year in the calculation must not result in drastic revisions of the previous figures; in particular, the position of the turning points in the cycle should not be changed by the recalculations that are periodically required.

3. The congruence of time series should not be impaired by seasonal adjustment. Seasonally adjusted subindices, when combined to an aggregate in accordance with their "weights", should yield the same figures as the overall index that has been seasonally adjusted separately. Moreover, the sum of seasonally adjusted values for separate components should not diverge from the seasonally adjusted whole series (e. g. the seasonally adjusted gross national product should be equivalent to the sum of its seasonally adjusted components).

4. In addition to these practical requirements a formal test is also applied. Each of the methods included in the comparison is tried out on a fairly large number of artificial time series (test series) constructed along as many different lines as possible. Sensitivity to revisions is quantified with the aid of statistical measures. More recently, techniques of spectral analysis to ascertain the structure and assess the effect of methods of computation on economic time series have been growing in importance.

Limitations of the Bundesbank's seasonal adjustment method

The method of seasonal adjustment employed by the Bundesbank was described in detail in the Monthly Reports of March 1957 and August 1961 and in an explanatory note in the April 1968 Statistical Supplement, Series 4, Seasonally adjusted economic data. Hence only those features of the Bundesbank method will be dealt with here which had a bearing on the change to the Census Method.

The Bundesbank method was developed at a time when the great majority of economic time series were characterised by strong growth with relatively minor fluctuations. An estimate of the seasonal components as a function of the trend/cycle component was tantamount to an estimate of the seasonal components as a function of time, owing to the almost continuously rising pattern of the series. In terms of the standards outlined in the preceding section, the regression model provided satisfactory results for almost a decade. But in the last four years the pattern of numerous series has undergone a sustained change. On the one hand the longer-term growth trend has slowed down and on the other cyclical fluctuations, such as the recession in 1966/67 followed by the rapid upswing, have been more pronounced than in all previous years included in the computation of the seasonal components. The absence of steady growth meant that one of the major premises of the Bundesbank method no longer existed, so that since then a number of important results of seasonal adjustment by the old method were subject to a wider margin of uncertainty. The limitations of the method resulting from the regression model employed are particularly marked in any of the following cases:

1. The method is difficult to apply to series exhibiting no or little trend variation. Such cases are not common, but they may be most important for economic analysis (e. g. unemployment figures between 1960 and 1965).

2. Erroneous estimates of the seasonal components for the entire length of the series occur if the seasonal pattern changes abruptly (which of course happens but rarely). The same applies to gradual changes in the seasonal pattern if they are not linear in relation to the trend/cycle component (e. g. expenditure on foreign travel).

3. In time series with a large proportion of irregular special factors the size of the seasonal components is substantially influenced by the length of the series selected; if a seven-year series is shifted by one year, e. g. from 1961–1967 to 1962–1968, the computed seasonal factors may change considerably.

These shortcomings have come to light only since about 1966, as a result of the changed pattern of time series referred to above. Non-recurring special influences, such as the Federal Government's measures to stimulate the economy, the introduction of value-added tax, the effects of the Law on Safeguards against External Influences, the various waves of speculation preceding revaluation and the revaluation itself, also led in most of the series to swings making it difficult reliably to eliminate the seasonal component with the Bundesbank method, which is fairly sensitive to extreme values.

Features of the Census Method

To counteract the difficulties arising from the use of the Bundesbank method, corroborative figures have been computed for the most important time series since 1967, first of all with a highly schematic version of the Census Method and for the last year with the latest version to date – the X-11 variant. These figures have been used where necessary to correct the estimate of the seasonal component by the Bundesbank method. The following paragraphs provide an outline of the principal features of the Census Method.[1]

1. Structure of the time series

   To begin with, the series are broken down in the conventional manner into a trend/cycle component, containing the longer-term trend and the cyclical influences, a seasonal component and finally an irregular or residual component which should contain neither the influences attributable to the trend/cycle component nor those attributable to the seasonal component. At this stage the irregular component, as in the Bundesbank method, still contains working-day variations, i. e. variations due to the composition of the calendar. In contrast to the Bundesbank method, however, these variations are eliminated from the irregular components as a separate component in a further step.

   The Census Method permits the components to be related either in multiplicative or in additive fashion (in the former case the seasonal component grows in proportion to the trend/cycle component, in the latter the seasonal component has a constant absolute value independent of the level of the trend/cycle component). The decision on which type of relation is to be used must be taken before the Method is applied. Previous experience has shown that in the majority of time series it is reasonable to assume a multiplicative relation; hence additive relation should only be selected if it is known from specific data that for the time series in question the extent of seasonal variation is independent of the level of the series measured by the trend/cycle component.

2. Estimating the components

   The *trend/cycle component* is ascertained in two stages, as in the Bundesbank method. First of all, a number of preliminary seasonally adjusted figures are computed with the aid of a moving twelve-month average. The disadvantage of a moving twelve-month average is that it blunts the pattern of a series at the turning points.[2] Hence the final values for the trend/cycle component are obtained by computing a weighted moving average of the preliminary seasonally adjusted figures. The weights of this moving average are selected in such a way that curved patterns, such as occur in economic time series, are correctly recorded.

   The *seasonal components* are estimated from the ratio of the original series to the trend/cycle component. The quotients of the original figures and the related figures of the trend/cycle component are defined as a time series for all months with the same name and are smoothed with a weighted moving average. The smoothed series yields the monthly seasonal indices required. This method of calculating seasonal components has two advantages over the Bundesbank method: the estimate of the seasonal components is independent of whether the series is rising, falling or flat; and the use of moving averages in the calculation of the seasonal indices ensures that gradual changes in the seasonal pattern are recorded with smaller distortions due to seasonal adjustment than by the Bundesbank method, where this estimate is made with a straight line.

   The *irregular component* is the difference between the original series and the sum of trend/cycle component and seasonal component. It contains a considerable measure of variations attributable to the composition of the calendar, unless these have previously been eliminated.

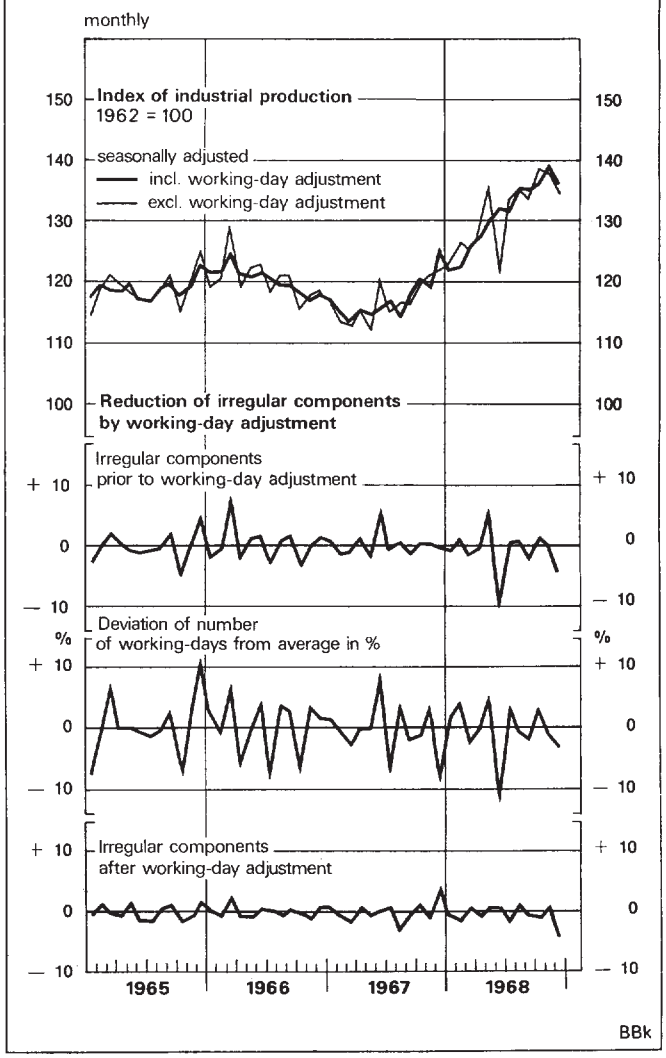
1 Readers interested in the precise mathematical procedure of the Method are recommended to read: "The X-11 Variant of the Census Method II Seasonal Adjustment Program", U.S. Bureau of the Census, Technical Paper No. 15, U.S. Government Printing Office, Washington, D.C., 1965.

2 This effect was described in detail in the studies on the Bundesbank method in the Monthly Reports of March 1957 and August 1961.

In addition to the seasonal adjustment proper, the influence of *working-day variations* can be estimated separately for each time series by the Census Method and eliminated. Seasonal adjustment is confined to the purely *formal* computation and elimination of annual fluctuations in time series, whereas adjustment for working-day variations involves an attempt to quantify the *causal* relationship between the size of the irregular component and the working hours available during the months in question. An important consideration here is that variations in the length of the months are already eliminated in principle by the seasonal adjustment, while variations in the number of working days due to the fluctuating distribution of week-days in months with the same name are not. For example, the number of working days (excluding Saturdays) in June varies between 18 and 22. The effect of these differences in the economically significant length of months is more or less pronounced from one time series to another. The Census Method makes it possible to examine the irregular components of seasonal adjustment with a view to discovering whether there is a statistically significant relationship between them and the composition of the months, measured by the frequency of the individual week-days. With the aid of a multiple regression model a weight is computed from the irregular components for each day of the week (Monday, Tuesday, . . ., Sunday). On the basis of the known frequency of the days of the week, for each month a factor can be derived from these weights that indicates whether and by how many per cent a monthly figure is affected by a week-day structure departing from the typical average of the calendar month in question. The influence of working-day variations quantified by means of these factors is eliminated from the original figures. The ensuing seasonal adjustment then yields the final seasonally adjusted values. As can be seen from the adjoining chart, these values are marked by a reduction of the irregular components and by a generally smoother curve. The advantage of this method is that no fixed assumption, such as the strict proportionality or uniformity of the influence on all kinds of economic series, is made about the closeness of the relationship between the number of working days in the particular month and the fluctuations in the time series. Each series is, rather, examined separately, and consequently allowance can be made in the adjustment for the fact that the influence of working-day variations presumably differs from series to series.

The basic framework of the Census Method which has been briefly outlined here can be modified in a variety of ways by the user, e. g. by selecting moving averages of different lengths for the trend/cycle component and the seasonal component or by changing the criteria for eliminating extremes. The adjustment of working-day variations, too, can be confined to parts of the series,

The effect of adjustment for working-day variations under the Census Method



so that, for instance, the fact that the reduction in working hours is bringing about a gradual change in the economic structure of the calendar months can be taken into account. These options enable external information on the structure of the time series to be applied profitably to seasonal adjustment. Unless they are used in a scientific manner, however, there is a certain danger of manipulation.

In its original version the Census Method is designed for the seasonal adjustment of monthly and quarterly figures. The Bundesbank is making efforts to develop a programme for the seasonal adjustment of two-monthly figures as well. This division of time series has proved quite satisfactory in the past, since two-monthly periods are very homogeneous as regards the number of working days and the movable feasts, so that the elimination of working-day variations, which is never wholly without problems from the theoretical viewpoint, can be dispensed with.

Results of the practical comparison between the Census Method and the Bundesbank method

The Census Method and the Bundesbank method were tried out jointly on a large number of series from widely differing fields of economic statistics over a lengthy period. The following similarities and differences emerged.

The basic pattern of the series seasonally adjusted by the two methods was identical in level, turning-points, and the extent of the acceleration or deceleration of cyclical movements observed over a substantial space of time.

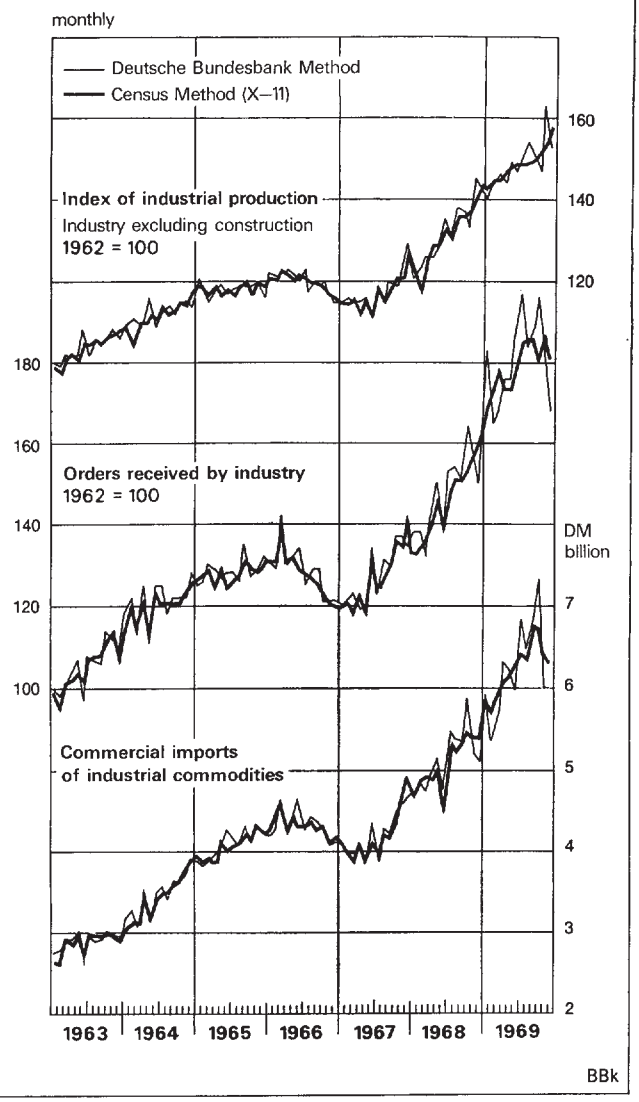
On the other hand, there were differences in the assessment of current trends. In almost all cases this assessment is made considerably easier by using the Census Method, as with this method the monthly seasonally adjusted figures exhibit fewer random fluctuations. With the Bundesbank method these fluctuations are fairly marked at the end of a series, that is, during the months that are of special interest for economic analysis. The greater smoothness of the curve (see the adjoining chart) is, as already mentioned, due to the fact that the Census Method eliminates working-day variations, and reliably identifies and adjusts for extreme values, and that the estimate of the seasonal component is not linear but flexible with regard to gradual seasonal changes. On recalculation, i. e. during the regular determination of new seasonal factors, the Census Method's results for the past usually require only minor revision. With the Bundesbank method, however, these revisions are on occasion considerable for monthly figures, though less so for two-monthly figures.

Thus, in terms of the standards for comparing methods set forth at the beginning of this article, the Census Method gives the more convincing results. It must, finally, be adjudged a practical advantage that the Census Method is used by numerous national bodies abroad and international institutions, so that methodological differences disappear when figures computed by this method are available for Germany as well.

Further developments in the field of seasonal adjustment

Although the Census Method is an efficient technique, well-tried and successful in practice, research in the field of seasonal adjustment goes on. In Germany a study group, of which the Bundesbank is a member, was set up in 1969 to examine problems of seasonal adjustment. The group has set itself the task of investigating the usefulness of various methods. In particular, a new technique is to be developed which, in contrast to traditional methods, which estimate the seasonal component in the dimension of time, makes use of elements of spectral analysis (dimension of frequency).[3] This approach, originating in the sphere of technology and the natural sciences, has the theoretical advantage over conventional methods, which were evolved on a more empirical basis, that the effects of the seasonal adjustment process can be checked precisely by means of mathematical and statistical test criteria. However, research is still proceeding and no great practical experience has been gained as yet. Hence it still remains to be seen whether a method can be developed from this theoretical approach that would be preferable to the Census Method.

Results of seasonal adjustment by Census Method in comparison with Bundesbank Method



3 See inter alia: Heiler, S.: Analyse der Struktur wirtschaftlicher Prozesse durch Zerlegung von Zeitreihen (Dissertation 1966, Tübingen). Nullau, B. et al.: Das "Berliner Verfahren", ein Beitrag zur Zeitreihenanalyse. DIW-Beiträge zur Strukturforschung, No. 7, Berlin 1969.