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## Requirements for Short-Term Business Forecasting

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In the fall of 1957, Raymond J. Saulnier, President Eisenhower's Chairman of the Council of Economic Advisers, requested the Bureau of the Census to develop methods of appraising current business fluctuations in a monthly report that would take advantage of new findings about the relations of economic processes over time, the availability of a great many economic time series, and large-scale electronic computers. The experiment was conducted with the close cooperation of the National Bureau of Economic Research. The early-warning economic intelligence system developed under this program is the subject of this paper.

Dr. Saulnier's request arose from his responsibilities in assisting the President to appraise economic trends and the growing public interest in current business conditions, as well as from the developments listed above, which made such a report possible. These developments are explained in this first chapter. The second chapter describes and illustrates the monthly report on current business cycle developments as it stood after three years of evolution. This report provides a comprehensive body of current economic series, adjusted to bring out business cycle developments as clearly as possible, and summarized in measures which facilitate judgments on the over-all performance of the economy. The data are presented in such a way as to provide early-warning signals of cyclical changes and to place emerging cyclical trends in historical perspective. Chapter 2 also appraises the usefulness of the report by reviewing the behavior of the principal measures at strategic periods around the troughs and peaks since World War II. The third chapter offers suggestions for improving the monthly report.

Appendix A presents some technical notes on amplitude-adjusted general indexes, adjusted rates of change, and diffusion indexes. Appendix B shows various measures of the cyclical behavior of the individual

indicators—their leads and lags at the turns since World War II, their average leads and lags, the average month-to-month changes in the cyclical and irregular components, and related measures. Appendix C supplements Volume II of *Business Cycle Indicators* (which provides data through 1958) by giving the original and seasonally adjusted data and the seasonal factors for the principal indicators used for 1958 to June 1961. The amplitude-adjusted general indexes, adjusted rates of change, and diffusion indexes are also given in this appendix.<sup>1</sup>

#### NEED FOR EARLY WARNINGS OF RECESSION AND RECOVERY

The Employment Act of 1946 placed upon the federal government the responsibility for promoting "maximum employment, production, and purchasing power." Partly because of the government's responsibility under this Act and partly because of the growing public concern about economic fluctuations, it is now commonly accepted that the government will take definite action to moderate a recession and to reverse its course, and that it will also be alert to the possible excesses of a boom.

Although business fluctuations have long been a subject of study in many universities and private research organizations, our understanding of the causes of the business cycle and of the methods of dealing with it is still incomplete. While there has been considerable similarity among the twenty-six recessions and expansions recorded in the United States since 1854,<sup>2</sup> variation in amplitude, duration, and scope has also been a distinct feature. For this reason, policies for dealing with recessions must be adapted to the circumstances of the indi-

<sup>1</sup> Brief descriptions of earlier versions of the monthly report on current economic conditions appear in my "Experiment with New Measures of Recession and Recovery," *Proceedings of the Business and Economic Statistics Section, American Statistical Association*, December 1958, pp. 128-141; and "Statistics for Short-Term Economic Forecasting," *Business Cycle Indicators*, Princeton University Press for National Bureau of Economic Research, 1961, Volume I, Chapter 18.

The presentation has been simplified by removing most descriptions of statistical techniques and sources of data from the text and putting them instead in a series of explanatory notes to the more complex tables and charts. The notes are there for the reader who is interested in the details of the methods used; he who wishes only a broad view of the reporting system can read on.

<sup>2</sup> Various terms are used in popular writings to describe the different phases of the business cycle. Thus, the term "recovery," "expansion," or "prosperity" is often used to describe the rising phase, and "depression," "recession," or "contraction," the declining phase. In this paper "recovery" or "expansion" refers to the rising phase and "recession" or "contraction" to the declining phase. No difference in meaning is intended by the use of these different terms.

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## RECOVERY

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subject of study, our understanding of methods of dealing with considerable recessions recorded in duration, and policies for dealing with the indi-

current economic recession and Recovery, *American Economic Review*, for Short-Term Business, University Press for 1958.

Methods of statistical analysis instead in a series of notes are there; he who wishes

ent phases of the "expansion" is often followed by "contraction," which refers to the rising and falling. No difference in

vidual case. Clearly, a first step in checking a recession or in controlling a boom is a sound statistical basis for reporting current business conditions. In particular, the statistical program should emphasize early-warning signals of impending changes.<sup>3</sup>

The project described here may be viewed as one facet, sometimes taken for granted, of the more general task of increasing economic stability. Many delays usually occur between the onset of a recession and the measures taken to reverse it. There is, first, a delay in recognition: months sometimes pass before technicians become convinced that a business cycle turning point has occurred. Next may come an interval between the time that technicians recognize a turning point and the time they convince the executive or legislative authorities of its existence. A similar problem exists in private industry, as is clearly demonstrated by the tendency for series on businessmen's anticipations, as a rule, to miss cyclical turns. Third is the time that is required for government authorities to reach agreement on the need for action and on the appropriate action to take. Fourth is the time required to take the action. And fifth is the interval between the time the action is taken and the time its effects are felt, though occasionally results begin to appear before formal action is completed—as when intentions are announced.

It seems obvious that a reduction of these delays is desirable. Thus, Arthur F. Burns has observed that "... when the economy shows signs of faltering, prompt countermoves are required. Even mild measures on the part of government can be effective in the early stages of an economic decline. On the other hand, if action is withheld until a recession has gathered momentum, strong and costly measures may prove insufficient."<sup>4</sup> Similarly, delays in recognizing an upturn can result in the continuation of expensive measures beyond the point where they are needed, thus making it more difficult to promote sustainable growth. A prognostic system of economic intelligence is an essential part of any government program for promoting prosperity.

A statistical report which signals business cycle turns can also be helpful to private industry. Inventory adjustments can be made more promptly, action to adjust costs can be introduced earlier, speculation

<sup>3</sup> It is, of course, equally necessary to consider both economic and political developments that are not directly reflected in statistical series. For example, the dramatic shift in consumer credit terms in 1954 had a significant effect on the close balance between expansionary and contractive forces during that year, helping to stimulate expansion. Similarly, political events, new laws, and new appropriations may have significant effects upon economic trends, and must be taken into account in judging current and prospective business trends. See Chapter 3.

<sup>4</sup> *Prosperity Without Inflation*, New York, 1957, p. 33.

can be held within narrower bounds, and an enlightened industrial leadership can schedule construction projects so as to minimize their costs.

### NEW FINDINGS IN BUSINESS CYCLE RESEARCH

Modern research on business cycles<sup>5</sup> has yielded an accumulation of evidence on the interplay of economic forces which generate sustained advances in total economic activity for periods ranging from eight or ten months to several years, followed by declines over periods that are usually shorter. In general, it appears that as expansion becomes dominant in the economy, factors that work in the opposite direction are brought into play and gradually spread and gain strength. Eventually, these contrary forces prevail, and there is a reversal of the trend. However, soon after this reversal has gotten under way, expansive forces once again begin to emerge and gain strength, so that the new trend of economic events is itself eventually reversed.

In the course of its attempt to identify and measure these forces, the National Bureau of Economic Research has not only built up a large record of monthly and quarterly time series to provide a statistical basis for the analysis, but has also developed several analytical tools helpful in diagnosing current business conditions. One of the most important is a classification of economic time series into leading, coincident, and lagging groups. The terms "leading," "coincident," and "lagging" are short-cut expressions summarizing important economic concepts and findings of many years of empirical research.

The National Bureau has recently released a new list of twenty-six indicators. Of these, twelve are classified as leading series, nine as roughly coincident, and five as lagging. These twenty-six series have been selected because of their good historical performance, but it is equally important to note that their classification also has a theoretical basis.

Thus, some of the leading series relate to future rather than to current output (new investment decisions, such as new orders, commercial and industrial construction contracts, housing starts, and new business formation) and others measure businessmen's profit expecta-

tions (such as prices). Also included in the initial response, particularly in the case of workweek hours, are similar conditions.

The coincidence of the current gross national product, unemployment, and personal income in rough correlation.

As a rule, the inverted series, but particularly in the lagging series, but particularly in the lagging series, but particularly in the lagging series. Two of the interest rates are slow to respond to influence subsequent investment decisions in the plant and equipment process, leading series. Theories and conditions that offer direction.<sup>6</sup>

Wesley Clair Mitchell's economic activity of firms. As a business unit costs often fall. Indeed, so-called reduplication. The

<sup>5</sup> Some of the principal publications in which this research is described are: Arthur F. Burns and Wesley Clair Mitchell, *Measuring Business Cycles*, New York, National Bureau of Economic Research, 1946, especially Chapter 1; Wesley C. Mitchell, *What Happens During Business Cycles*, New York, National Bureau of Economic Research, 1951; and *Business Cycle Indicators*, Volume I. This paper depends heavily upon the material presented in these publications. For reference to other studies of business cycles, see these sources.

<sup>6</sup> For fuller account see *Cycle Indicators*, pp. 318-322; and

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tions (such as stock prices, business failures, profits, and sensitive prices). Also included are three employment series, which measure the initial responses of employers to changing business prospects: the average workweek and the accession (hiring) and layoff rates in manufacturing. Similarly, inventory investment has moved promptly enough to be included in the leading group because it largely reflects an immediate response, particularly for purchased materials, to changing business conditions.

The coincident series provide more or less comprehensive measures of the current volume of aggregate economic activity. They include gross national product, industrial production, nonagricultural employment, unemployment rate, bank debits outside New York, retail sales, and personal income. The index of wholesale prices, which has moved in rough correspondence with these series, is also included.

As a rule, the lagging series move *after* the coincident series but, on an inverted basis, *before* the leading series. That is, the downturns in the lagging series usually follow the downturns in the coincident series, but precede the *upturns* in the leading series. Similarly, the upturns in the lagging series typically occur later than those in the coincident series, but earlier than the *downturns* in the leading series. Two of the lagging series—labor cost per unit of output and interest rates on bank loans—measure types of economic costs which are slow to respond to changing business conditions, but nevertheless influence subsequent changes in business expectations and new investment decisions. Another lagging series—expenditures for new plant and equipment—represents a fairly late stage in the investment process, in contrast to the early stages represented among the leading series. Two other lagging series—total manufacturers' inventories and consumer debt—reflect processes of accumulation or liquidation that often continue long after the curve of business has changed direction.<sup>6</sup>

Wesley C. Mitchell pointed out that the expansion of aggregate economic activity is not characterized by the success of all business firms. As a business upswing proceeds, competition often increases, unit costs often encroach on selling prices, and the profits of some firms fall. Indeed, some firms are forced into bankruptcy and more are compelled to reduce their output as the peak of a business cycle is approached. Thus, the proportion of firms expanding their output declines

<sup>6</sup> For fuller accounts of the concepts on which this classification is based, see *Business Cycle Indicators*, Volume I, especially Chapters 2 and 3, pp. 63-69; Chapter 10, pp. 318-322; and all of Part Two.

in advance of the decline in aggregate economic activity. This phenomenon is measured by the diffusion index, which shows what percentage of companies, industries, or geographic areas are experiencing rises during successive time intervals. Thus, it measures the scope or the breadth of a fluctuation in total activity. Empirical studies of many diffusion indexes have shown that they almost always lead their corresponding aggregates, frequently by six months or more. As Burns observed, there is an "unseen cycle" in the components of an economic aggregate that throws its shadow ahead of the "seen" cycle in the aggregate itself. A diffusion index for several hundred economic series over the period 1885-1939 is shown in Chart 1, where it is compared with the Cleveland Trust Co. index of business activity and with the National Bureau business cycle chronology. The diffusion index leads at every business cycle peak and at every trough, although the lead varies widely from one occasion to another.

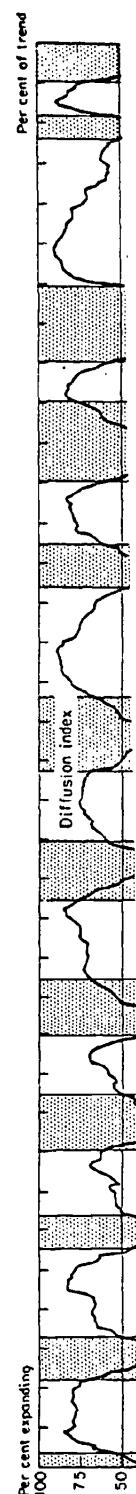
It should be noted that the very studies which showed that certain series led also showed that they did not lead all the time. Thus, one of the most useful leading series—average workweek—led at eleven turning points out of fifteen during the peacetime years 1921-58; spot market prices of industrial materials led at eleven turning points out of seventeen during 1919-58; stock prices led at twenty-two turning points out of twenty-six during 1899-1958; and so on. Moreover, the leads that occur are not uniform. Hence, earlier historical performance does not yield a mechanical clue to subsequent events. Similarly, the diffusion indexes constructed on the basis of current data are often highly irregular, and once again require judgment in their use and interpretation.

Still a third tool for analyzing a current recession has been suggested by Geoffrey H. Moore. He observed that there is a correlation between the severity of a recession in its early stages and its ultimate severity. Thus when, say, industrial production and nonagricultural employment dropped sharply during the first six months of a recession, the full decline during the recession was likely to be large; when the initial declines were small, the recession was apt to be mild. When "leading" series are analyzed in this way, similar results are obtained at earlier dates. The regularity of such historical relations, although far from perfect, suggested that a technique for keeping a current recession in perspective as it unfolds could be usefully developed.

Five other general findings of this research that are helpful in studies of current business conditions deserve mention:

First, over the period for which the National Bureau has compiled a chronology of business cycles (1854-1961), expansions of aggregate economic activity have lasted longer than contractions. Expansions have averaged about thirty months and contractions about twenty

CHART 1  
A Comprehensive Diffusion Index and an Index of  
Business Activity, 1885-1961



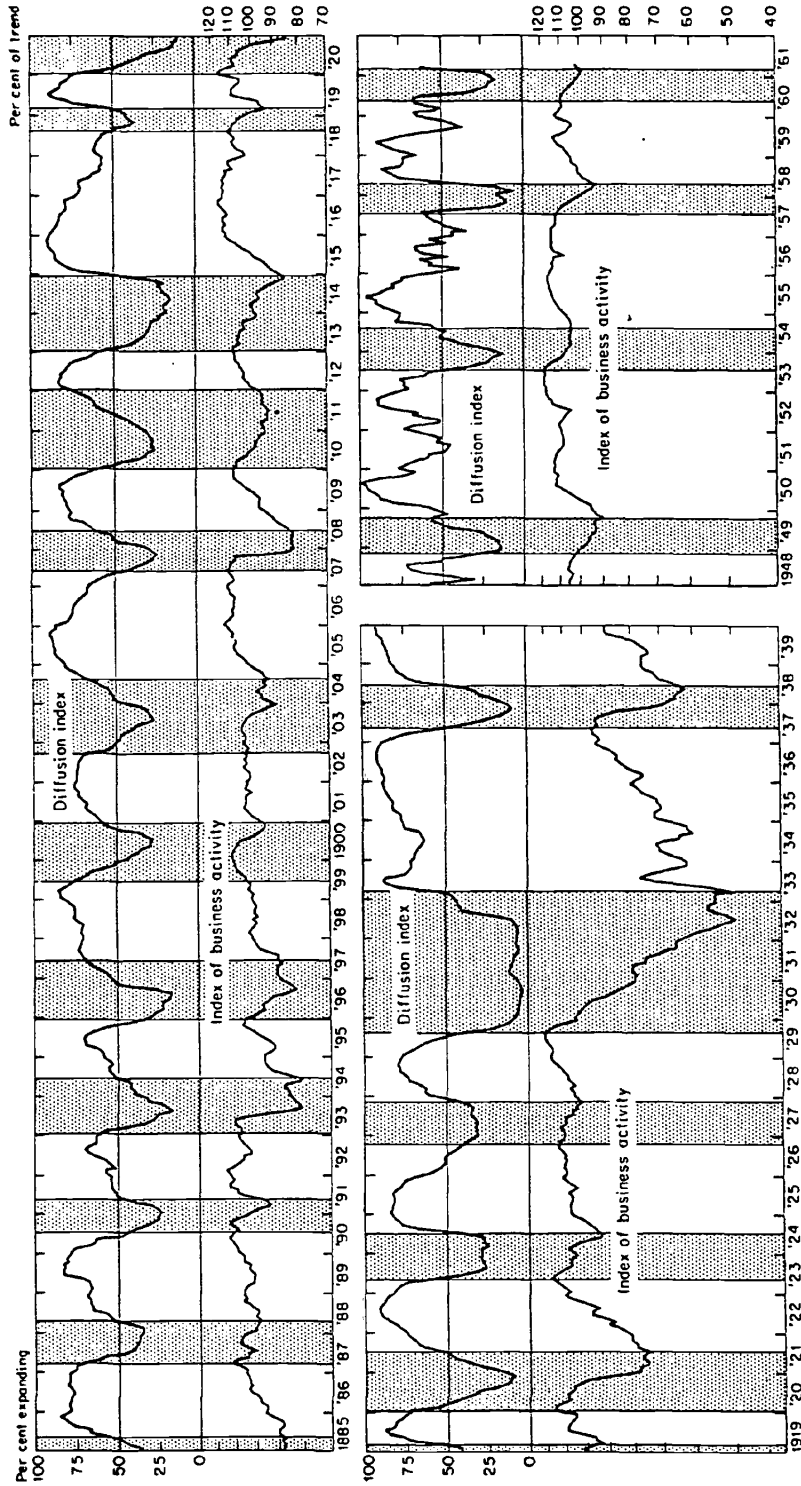
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**CHART 1**  
**A Comprehensive Diffusion Index and an Index of**  
**Business Activity, 1885-1961**



### Chart 1: Explanatory Notes

The index of business activity shown in this chart is published by the Cleveland Trust Company and is adjusted for trend. The comprehensive diffusion index consists of two different segments. The first one, 1885-1939, is a historical diffusion index based on 404 series, which is constructed by marking off the specific cycle peaks and troughs in each series. All movements between troughs and peaks in each series are assumed to be upward; all movements between peaks and troughs, downward. This results in a substantial amount of smoothing over the business cycle, and produces an index with virtually no trend. This index was taken from Business Cycle Indicators, Chapter 7.

A historical index cannot be computed for current periods because cyclical peaks and troughs can be identified only retrospectively. The second segment, 1948-61, is a current diffusion index based upon 57 series, including the 32 industrial components of the BLS series on total nonagricultural employment and the 25 major industry components of the Federal Reserve index of industrial production. In computing the current diffusion index, comparisons are made over 3-month spans, that is, the January figures are compared with April, February with May, etc. This technique eliminates some of the minor month-to-month irregularities and gives the cumulative cyclical components a better chance to register. The amount of smoothing involved is, however, substantially less than in a historical diffusion index and, therefore, the current diffusion index is more irregular.

The diffusion index is plotted on an arithmetic scale; the index of business activity, on a ratio scale.

Shaded areas represent contractions of business cycles according to NBER chronology; unshaded areas, expansions.

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months. There is, however, considerable variation around these averages, and contractions are sometimes longer than expansions. There are reasons for believing that, as a result of shifts in the structure of the economy, expansions are becoming longer relative to contractions.

Second, the rates of growth in aggregate economic activity during expansions have been more nearly uniform from one expansion to another than the rates of decline during different cyclical contractions. This historical generalization suggests that a more accurate estimate can be made of the rate of growth at the beginning of an expansion than of the rate of decline at the beginning of a contraction.

Third, the rate of expansion has been more rapid in the early stages of expansion, particularly during the first six months or so, than in the later stages.

Fourth, the rate of rise during the early stages of an expansion is related to the severity of the preceding contraction. In general, the rates of growth during the early stages of expansion have been more rapid after severe than after mild contractions.

Fifth, despite slower rates of expansion, recoveries attain and exceed previous peak levels much more quickly after mild contractions, because differences in the rates of recovery tend to be smaller than differences in the ground to be regained.

Thus, intensive research on business cycles over many years has yielded a variety of tools for studying current business: (1) a record of the typical sequence of changes in economic processes during a business cycle; more specifically, a list of significant series that usually lead, a second of those that usually move with, and a third of those that usually lag behind, cyclical movements in aggregate economic activity; (2) diffusion indexes, which provide a clue in making early judgments about shifts in the general course of business; (3) a technique that promises to be helpful in making an early judgment of the ultimate intensity of a current recession or expansion; and (4) various characteristics of the duration and patterns of the different phases of the business cycle. In addition, several promising new measures have been developed during the evolution of the reporting system described here, particularly amplitude-adjusted general indexes, adjusted rates of change, and timing distributions. More is said about these measures later. Like the data to which they must be applied, these analytical tools have limitations. Nevertheless, they represent a significant addition to other techniques for making short-term forecasts of business conditions.

## DATA AND COMPUTERS

A comprehensive system of statistical reporting that provides a basis for studying economic change has been built up over a long period of time by government and private statistical agencies. *Economic Indicators*, for instance, which is prepared once a month by the Council of Economic Advisers for the Joint Economic Committee, contains approximately 125 different current statistical series. These series cover virtually all aspects of economic activity. In addition, a great deal of the more detailed information on these processes (for example, employment in different industries and places) is published currently in the *Survey of Current Business*, the *Federal Reserve Bulletin*, and other magazines and daily newspapers. These sources now include well over 2,500 aggregate and component monthly or quarterly economic series.

Many of these series were developed after World War I. For instance, an entirely new body of useful data for short-term forecasting emerged in the late 1930's as a by-product of the unemployment compensation program. Three important series from this body of data are utilized in the report described here: insured unemployment, initial claims for unemployment insurance, and placements by Bureau of Employment Security field offices. In addition, forty-seven component initial claims series are used in preparing different analytical measures. These data are available weekly and are issued promptly, not only for the United States as a whole but also for states and labor market areas.

In recent years a variety of new types of data has become available. For example, a series on new capital appropriations was started by the National Industrial Conference Board, on accounts receivable by the Census Bureau, on overtime hours of work in industry by the Bureau of Labor Statistics, on businessmen's expectations by Dun and Bradstreet, Inc., on anticipated inventory changes by the Office of Business Economics, and on anticipated plant and equipment expenditures by the Office of Business Economics and the Securities and Exchange Commission. The frequency of the national income series has also increased significantly. The monthly series on personal income was started in 1933; quarterly estimates of national income were started in 1942, and the deflated quarterly figures in 1958. Each of these was carried back some years to provide a historical record. The release dates of some series have also been accelerated in recent years. Thus, since November 1953, a flash report on retail sales has been released by the Department of Commerce ten days after the end of the month covered. In February 1961 an advance report on manufacturers' new orders of durable goods began to appear shortly after the middle of each month. Equally important, though less obvious, are many improvements in quality. The Current Population Survey, from which the unemployment and labor force estimates are made, was improved

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in 1954 by an expansion of the sample and a revision of estimating techniques. The accuracy of series on new building permits and housing starts was considerably increased at the beginning of 1960. The size of the sample used in the manufacturers' sales, orders, and inventories survey has been substantially enlarged during the past few years, and improved aggregates and industry totals are now being issued.

This enrichment of the data available was not an unmitigated boon for the analyst. First, it was beyond the resources of any individual and most economic research organizations to carry out the calculations, such as seasonal adjustments, needed to make the series useful for current business cycle analysis. Second, the large number of series made it necessary to have various summary measures of their business cycle behavior.

A major breakthrough came in the early 1950's with the advent of the large-scale, general-purpose electronic computer. During the past few years electronic computer programs have been developed which make it possible to apply the new methods of business cycle analysis to current economic problems on a large scale. Such programs have proved especially helpful in carrying out the reporting system described here. The three most significant programs are described below.

First, a time series program computes seasonal factors for any monthly or quarterly series, producing a series free of seasonal variations as well as one that is free of both seasonal and erratic movements. It adjusts each series so that its month-to-month change, on the average, is equal to unity, thus facilitating comparisons among series that fluctuate widely or narrowly. The program calculates summary measures of the seasonal, cyclical, and erratic fluctuations in a series, and of the relations among them. It computes a new measure, *MCD* (months for cyclical dominance), which estimates the appropriate span over which to observe the cyclical movements in a monthly series. This span is usually longer than a single month because month-to-month changes are often dominated by erratic movements, but shorter than the frequently used twelve-month span (change from the same month a year ago), and is different for different series.

A special routine can be used to invert the original series about its trend line, a procedure that is useful when series such as unemployment and business failures, which are high when business is depressed, are to be shown or combined with series such as industrial production and retail sales, which move in the opposite fashion. All these measures and adjustments facilitate comparisons of the cyclical timing and pattern of different series, and provide powerful tools for experimenting with alternative ways of handling them.

Second, the National Bureau technique for measuring cyclical patterns and long-term trends has been programmed for the IBM 704 by the National Bureau staff. The technique is described in Burns' and

Mitchell's *Measuring Business Cycles*, and has for many years formed the basis for National Bureau studies in business cycles. For any monthly, quarterly, or annual series, the National Bureau technique produces a set of measures of secular trend, cyclical timing, amplitude, duration, pattern, and cyclical conformity. In the past, the NBER's cycle measures were computed by clerical methods for several hundred series, and to a considerable extent the timing classification of series shown below is based on these calculations. Since last year, however, all new series have been analyzed by the electronic computer program, and the measures for many other series have been brought up to date electronically.

Third, a time series dispersion program provides a method of analyzing groups of series in relation to one another. Thus it computes amplitude-adjusted general indexes, which are explained below, and diffusion indexes. The rates of change of each series in a group for any specified set of time intervals are computed and assembled into a series of frequency distributions. An adaptation of this program permits computation of percentage changes from a fixed month, say, a business cycle peak, to each of the following forty-eight months. Any peak or trough date, or series of dates, can be selected for this variation of the standard program. Other criteria for selecting a chronology, such as the dates of severe strikes, can also be used.<sup>7</sup>

Electronic computers and programs have substantially increased our ability to adjust and summarize, quickly and inexpensively, a large body of economic time series. They have similarly improved the powers of the professional to make analytical studies by freeing him from many of the burdens of routine work and providing him with more elaborate tabulations. They have thus paved the way for exploiting more fully current data and theories relating to business cycle fluctuations.

<sup>7</sup> A full description of the time series analysis and adjustment program appears in my *Electronic Computers and Business Indicators*, Occasional Paper 57, New York, National Bureau of Economic Research, 1957 (reprinted from *Journal of Business*, October 1957). This paper has also been reprinted, with a more up-to-date description of the program, as Chapter 17 of *Business Cycle Indicators*, Volume I. See also my "Decomposition of Economic Time Series," *Science*, December 19, 1958, pp. 1539-1546; *Seasonal Adjustments by Electronic Computer Methods*, Technical Paper 12, New York, NBER, 1958 (reprinted from *Journal of the American Statistical Association*, December 1957, pp. 415-449); and "Tests and Revisions of U.S. Census Methods of Seasonal Adjustment," Bureau of the Census, October 1960. The program for the National Bureau's cyclical measures is described by Gerhard Bry and Charlotte Boschan, in "Application of Electronic Computers to Business Cycle Research," *Proceedings of the Business and Economic Statistics Section, American Statistical Association*, 1960. A description of the time series dispersion program appears as Chapter 18 of *Business Cycle Indicators*, Volume I. Generalized moving average and trend adjustment routines were recently programmed for Sperry-Rand's 1105 by Allan H. Young of the Bureau of the Census.

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