Federal Reserve Bank of Cleveland

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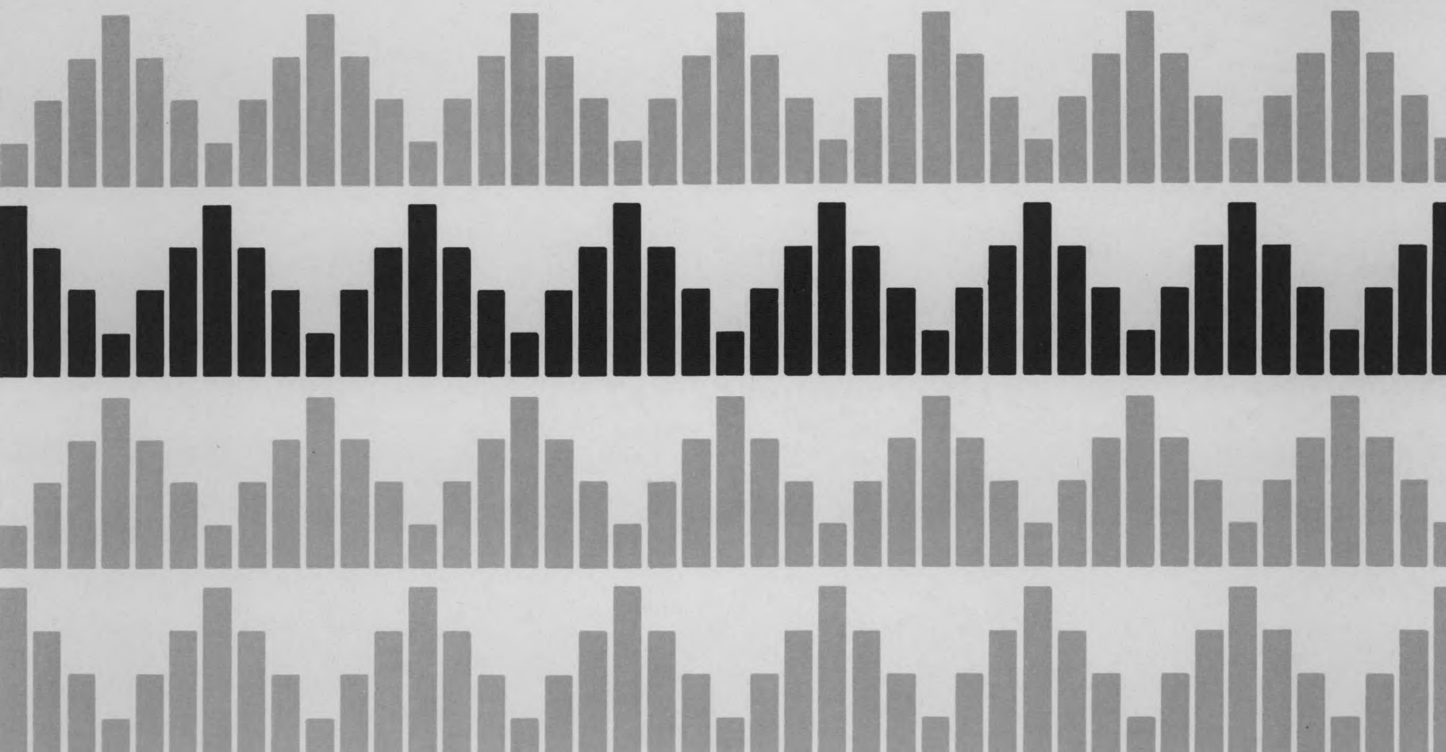

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Since policymakers need to evaluate money-growth rates between dates of different seasons, they must estimate what portion of money growth is seasonally transient and what portion is enduring. Unfortunately, the process of identifying the seasonal component of a time series is not a perfect one, and it may introduce errors into the interpretation of the raw data. Alternative seasonal adjustment methods are applied to recent money supply data to illustrate this interpretation problem. Particular attention is paid to the influence of the income tax season on money supply changes.

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Monitoring changes in regional manufacturing activity is one means of analyzing current business-cycle conditions. Since 1965, the Federal Reserve Bank of Cleveland has been surveying manufacturing firms within the Fourth Federal Reserve District on a monthly basis to ascertain basic conditions of production activity. This article describes the survey and the cyclical properties of the indexes derived from the survey and provides a statistical analysis of the performance of the index over the last ten years.

Interpreting Movements in Seasonally Adjusted Money-supply Data

by John B. Carlson, Paulette M. Maclin, and Mark S. Sniderman

Why Seasonal Adjustment?

Many economic time series commonly are adjusted for seasonal fluctuations. Seasonal adjustment is designed to eliminate movements in a time series that result only from seasonal events, such as holiday shopping and regularly occurring weather changes. Variations in the money supply are influenced strongly by income-tax filing and Treasury disbursement patterns. Tax refunds are held temporarily in checking accounts, while those who owe taxes usually fund their accounts just before the payment date. Both actions increase the narrowly defined money supply. All seasonal-adjustment techniques are designed essentially to "redistribute" the unadjusted (raw) data throughout a year in a pattern that differs from actual observance. The resulting seasonally adjusted data follow a pattern that should no longer be influenced by seasonal events. With seasonality thus neutralized, the basic movement in the data becomes more readily apparent.

If policymakers were interested only in comparing the current money-supply level with the level of the same season one year earlier, the raw figures frequently would be sufficient. Since policymakers need to evaluate money-growth rates between dates of different seasons, they must estimate the seasonal influences and take them into account when assessing the changes in the actual money-supply figures. The convenience of employing seasonally adjusted data is not necessarily costless, however. Often, the seasonal influences cannot be accurately estimated, for a variety of reasons. As a practical matter, the correct adjustment process for each data series can never be known with certainty in advance. An improper set of seasonal-adjustment factors introduces errors into the interpretation of the raw data, and the errors are likely to be inversely related to the length of the time interval being considered. For example, the seasonal component of weekly money-supply data is more difficult to ascertain than the seasonal component of quarterly money-supply data. In addition, the money supply is an aggregate of parts, such as currency and checking accounts, each of which has its own seasonal process. Failure to account adequately and separately for each process may introduce error.

If seasonal processes are considered to be basically stable, the seasonal pattern would be extracted from a raw-data series by a technique that treats each year of the series with equal weight. But, if seasonal processes are expected to change frequently and along a trend, the seasonal pattern would be extracted by a technique that gives more weight to the most recent years in the data series. Some analysts argue that changes in seasonal processes cannot be determined until several years after the fact; these analysts would claim that stable seasonality ought to be presumed when adjusting current data, unless overwhelming evidence to the contrary exists. Other analysts are confident that unequal weighting of the years in a data series can be justified, based on information about changes in the underlying determinants of the seasonal process.

One's interpretation of a raw-data series therefore is conditioned by the "prescription of the eyeglasses" that one wears. The raw data will appear differently when viewed through different seasonal-adjustment lenses. The analyst's problem stems from the fact that there is no single procedure known to be correct. Analysts who differ in the assumptions regarding the appropriate seasonal influences on the money supply consequently may differ in their interpretations of current money-supply growth. Moreover, the differences introduced by seasonal-adjustment techniques can be sizable. An examination of the seasonal factors used to adjust M-1A for the 1972-1979 period appears in table 1. The data indicate that the February-July factors have become more volatile over time, while the August-January factors have become less volatile. The intra-period means have been very stable, suggesting that changes in monthly factors within a period have been entirely offsetting. The consequence of these developments is that a constantly growing raw-money supply would appear, on a seasonally adjusted basis, to change first more sharply, then less sharply, in 1979 than in 1972.

Table 1 Means and Standard Deviations in M-1A Seasonals: 1972-1979

	February-July		August-January	
	Mean	Standard deviation	Mean	Standard deviation
1979	99.39	1.16	100.76	1.55
1978	99.38	1.07	100.80	1.64
1977	99.44	0.86	100.72	1.74
1976	99.43	0.85	100.71	1.75
1975	99.34	0.77	100.71	1.72
1974	99.35	0.79	100.70	1.71
1973	99.26	0.75	100.74	1.75
1972	99.23	0.73	100.78	1.84

Seasonal-adjustment Techniques

When approaching the problem of seasonality, the analyst should have some knowledge of the mechanism generating the data. This prior knowledge suggests the appropriate technique for adjustment. In some cases, it may not pay to attempt seasonal adjustment—for example, when seasonal variation is dwarfed by irregular movements or for a new series offering little or no historical experience. Economic theory may suggest reasons for relating changes in the seasonality of the money supply to readily measured variables, such as the timing of concentrated volumes of tax receipts or refunds. In principle, a regression model could be used to estimate these relationships to forecast changes in seasonality. Unfortunately, the science of economics has yet to produce a model that explains enough about seasonality to be useful at this level. In the absence of a more complete theoretical structure, most seasonal-adjustment techniques estimate and remove seasonal variations in the data by a weighted-average smoothing process that is based on the past history of the variable being adjusted. The most widely used technique is the X-11 seasonal-adjustment program of the Bureau of the Census. Because the X-11 program does not use information exogenous to the data series being adjusted, it is not likely to anticipate and capture abrupt changes in seasonality.[1]

The X-11 is the method employed in seasonally adjusting the money supply. It is applied to each of the basic aggregate components, such as currency and demand deposits in M-1A. The X-11 is an iterative procedure involving two fundamental steps designed to separate any monthly time series into three distinct series, identified as the trend-cycle, seasonal, and irregular components. The first step seeks to isolate the trend-cycle component from the seasonal and irregular components by dividing the original series by an estimate of the trend-cycle component. The second step is designed to separate the seasonal and irregular components. The X-11 procedure is iterative in two senses: (1) it repeats the second step, using a revised seasonal component in which extreme irregular values are eliminated or replaced with damp-

1. In recent years, a considerable amount of research has provided several alternatives to, and improvements in, X-11. A review of this material is found in David A. Pierce, "A Survey of Recent Developments in Seasonal Adjustment," *American Statistician,* vol. 34 (August 1980), pp. 125-34.

For further information on the X-11 method, see Julius Shishkin, Allan H. Young, and John C. Musgrave, *The X-11 Variant of the Census Method II Seasonal Adjustment Program,* Technical Paper No. 15 (U.S. Department of Commerce, February 1967); *X-11: Information for the User,* Papers prepared for the Seminar on Seasonal Adjustments of the National Association of Business Economists, March 10, 1969 (U.S. Department of Commerce); and Thomas A. Lawler, "Seasonal Adjustment of the Money Stock: Problems and Policy Implications," *Federal Reserve Bank of Richmond Economic Review,* vol. 63 (November/December 1977), pp. 19-27.

ened ones; (2) it repeats both steps by reestimating the trend-cycle component, using alternative averaging methods employed on a preliminary seasonally adjusted series obtained in subsequent rounds.

Although the technique is considered mechanical, it permits the use of judgment to the extent that some parameters of the X-11 program can be varied. Until recently, however, the staff of the Board of Governors of the Federal Reserve System made additional judgmental modifications to the final estimates of the seasonal-adjustment factors obtained from the X-11 procedures and used in the forthcoming year. For example, the X-11 is not designed to handle abrupt changes in seasonal patterns that may result from a change in a tax-filing date or from the implementation of new tax-processing methods. Given prior knowledge, such events can be anticipated by modifying the seasonal factors estimated by the X-11. Although this practice is often necessary, it is difficult to perform consistently over time. In recent years, the Board staff has limited itself to making adjustments that are permitted within the structure of the X-11 procedure. The adjusted series that conforms most closely to prior expectations based on all available information is selected and used.

The discretion allowed by the X-11 program is best exemplified by the user's options for choosing both the length of the period and the weighting structure of the moving average. The moving average options are available when estimating both the trend-cycle and seasonal components of the series. Although the X-11 automatically selects default values for these options, the user has available alternatives that permit variations in the degrees of smoothing.[2] When estimating the final trend cycle, the degree of smoothing (length of moving average) desired would depend on the relative importance (average percent change) of the irregular variations to the trend-cycle movements. The greater the irregular movements relative to the trend cycle, the longer the moving average needed to smooth out the short-term movements and reveal the trend. Conversely, if cyclical movements dominate, then a short moving average would better reveal the systematic movements of the series.

Similarly, when estimating the seasonal components, the degree of smoothing desired would depend on the relative importance of the regular variation. If a seasonal for a given month is believed to be stationary, then all the movement in the seasonal-irregular component for the month must result from irregular variation. Thus, the user would choose to average as many years of that month as possible in order to average out the noise. For this reason, the X-11 has an option that averages seasonal-irregular (S-I) values of the same month for all prior years available, giving equal weight to each year.

On the other hand, if the seasonal factor is believed to be changing, then movements in the S-I component reflect movements of both individual components, and the default option may be desirable. This option takes a five-year moving average that weights most heavily the S-I component in the year being estimated. The two years before and the two years after are weighted with lesser weights (declining away from the year). When the seasonal being estimated is for the most recently available year, only the two prior years are included. Although a short moving average may fail to average out irregular noise, it enhances the probability that a seasonal factor would correctly incorporate movements reflecting fundamental changes in the determinants of seasonality. It also enhances the probability of removing irregular variations under the guise of seasonal variations. The trade-off is clear. If a priori evidence exists that movements in the seasonal are large relative to irregular variation, then a short averaging period is desired.

Finally, if seasonal factors are believed to be changing, and the character and extent of the changes are thought to be known, then it may be desirable to estimate this change and project it into the forthcoming year. An option of the X-11 adds one-half the change from the previous year to the seasonals of the last available year to obtain the seasonals for the upcoming year. While such a formula may be rigid, it may be preferable to using the last available seasonals when there is strong evidence that seasonals in fact are changing.

2. Experience has shown that the seasonal component of many economic time series can be adequately estimated by the same choices of X-11 options. Consequently, the X-11 program is preset to these default options, which can be changed as circumstances warrant.

Impact of the Tax-filing Season on Money

The difficulties in estimating the seasonal factors during the personal tax-filing season (primarily February-May) perhaps best exemplify one of the shortcomings of the X-11 method. While it is quite predictable that the nonseasonally adjusted money supply increases greatly around the tax-filing deadline of April 15, a number of variables affect the exact time pattern of this phenomenon. If these factors all changed regularly along trends, then the X-11 probably would adequately capture the movement in the seasonal factors. Unfortunately, some clearly identifiable determinants of the timing of tax flows have been behaving in an unpredictable manner, causing abrupt changes in the time pattern of tax payments and refunds. Because the X-11 ignores economic structure, it offers no mechanism for prompt incorporation of such changes into the seasonal factors.

Table 2 Federal Income-tax Refunds of Individuals

As a percent of nonseasonally adjusted demand deposits of previous month

	1975	1976	1977	1978	1979	1980
February	2.0	1.9	1.8	1.3	1.1	1.9
March	4.0	4.1	4.3	5.0	4.5	4.6
April	3.1	3.5	3.4	3.3	3.4	4.1
May	6.1[a]	2.4	2.4	2.9	3.0	4.2

a. Includes income-tax rebate.

Table 3 Non-withheld Income-tax Receipts of Individuals

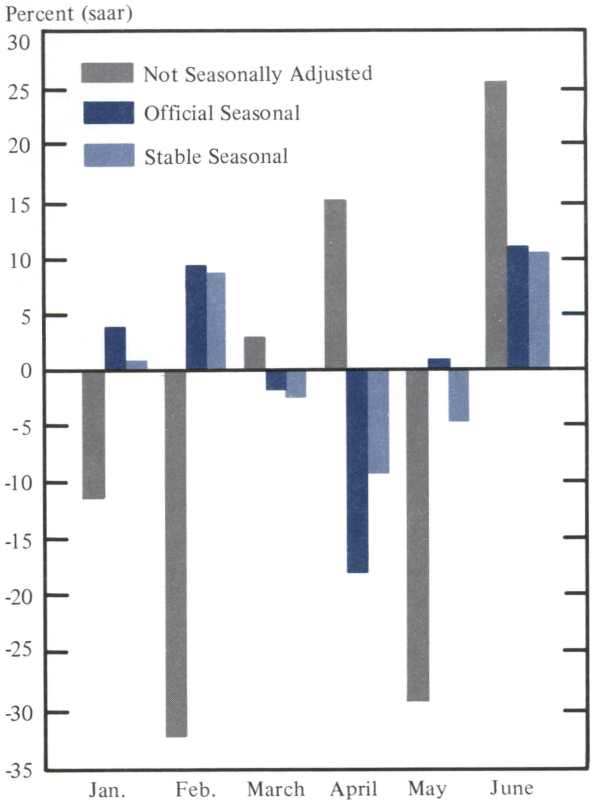
As a percent of nonseasonally adjusted demand deposits of previous month

	1975	1976	1977	1978	1979	1980
February	0.5	0.4	0.5	0.4	0.4	0.5
March	1.3	1.2	1.2	1.1	1.3	1.2
April	6.2	6.0	6.5	5.7	7.3	9.3
May	0.4	0.3	0.9	2.7	2.2	0.8

Tax processing affects the money supply in two particular ways. The typical tax refund (averaging roughly $250) is frequently deposited in checking accounts, if only temporarily. Refunds in the past two years totaled $31 billion, or 8 percent of M-1A. Almost 90 percent of this amount is paid out in the period of March to May. Thus, refunds can produce a sizable bulge in the money supply during this period. Second, and quite aside from refunds, persons owing taxes fund their checking accounts on or before the date the tax is paid. The time required for mail service and actual processing of the tax payments tends to increase the money supply until the Treasury cashes the checks. The monthly patterns of tax refunds and payments relative to the level of demand deposits for recent years are given in tables 2 and 3.

Variables that affect the timing of the tax-related impact on the money supply include the timing of tax filing, taxes and tax-withholding rates, the efficiency of the tax-processing equipment, the number of people employed to process returns, and the mail service. In the past two years, for example, individuals filed returns later than in previous years. As the April 15 deadline approached, the Treasury faced a larger than usual bottleneck in tax processing.

Chart 1 M-1A Monthly Growth Rates: 1980



Although new equipment was in operation, the Treasury's budget did not permit the overtime required to process the tax returns (particularly those with tax payments) at the rate achieved in the previous years. As a result, a greater percentage of the tax payments were not actually collected until May.

This series of events may explain some of the extraordinary M-1A growth in April of 1978 and 1979 (see table 4). Furthermore, because the X-11 *often is used* in a manner that weights the experience of recent years more heavily, the current year's seasonal factors probably overstate the tax-processing impact in April 1980. This seems all the more probable since a greater dollar volume of taxes was processed in April 1980 than in April 1978 and 1979. One consequence of increased processing could be that the seasonal adjustments in April are stronger than they should be, contributing to the negative growth of M-1A last April. In effect, tax-processing delays in 1978 and 1979 may have operated through the seasonal-adjustment procedure to contribute to the sharp drop in the money supply in April. Without a well-estimated model, however, a quantitative assessment of this impact is extremely hazardous.

Table 4 April Growth Rates for M-1A

Seasonally adjusted annual rates

	1980 seasonal factors	Stable seasonals	M-1A growth for year ending in April
1975	-3.0	-3.2	3.4
1976	6.6	9.4	6.2
1977	9.2	15.1	6.9
1978	12.6	20.7	7.3
1979	14.7	23.7	5.8
1980	-18.5	-9.6	3.7

While it is conceivable that the relationships between seasonal events and the money supply could be modeled and well estimated as a practical matter, the problems involved are enormous. The seasonal factors used to adjust current data are calculated at the beginning of the year. Consequently, optimal adjustment of the data would be required to forecast the exact time pattern of each seasonal event for the entire year ahead. It is not likely that any of these events could be forecast with the desired degree of accuracy. Thus, it may be of little consequence that the X-11 ignores this information.

Recent M-1A Growth

By looking at the raw data through somewhat different sets of eyeglasses, one can obtain a rough idea of the extent to which the 1978-1979 tax-processing problems may have contributed to the steep drop in M-1A this past April. As noted earlier, the official 1980 seasonal factors were constructed using the default option, in which greater weight was given to the data of the two most recent years. This method is consistent with the assumption that the M-1A seasonals are changing. Alternatively, however, one can assume that the seasonals are relatively stable and use a longer averaging process in which each year receives equal weight.

Charts 1 through 3 illustrate how this alternate weighing process can influence one's perception of money growth, not only for April but for the first six months of the year as well. When using the constant seasonals, M-1A still shows a considerable decline

Chart 2 Official M-1A Series

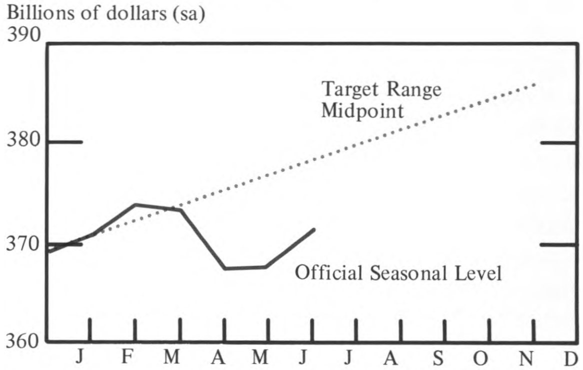
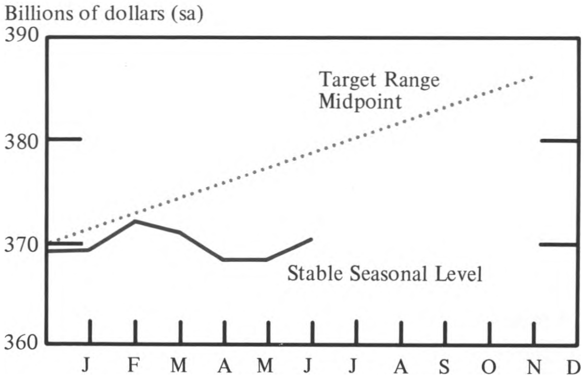


Chart 3 Equal Weight M-1A Series



in April but at only about half the rate obtained using the official factors. Thus, the April drop appears somewhat less alarming.

At the same time, however, by redistributing money growth somewhat differently throughout the entire tax-filing period, the equal-weight factors appear to signal some cause for concern about money growth earlier in the year. As charts 2 and 3 show, money growth, officially adjusted, was close to or above the midpoint of its long-run growth range throughout the first quarter. In February, M-1A actually moved above the top of its growth range, contributing to the adoption of more restrictive money and credit policies. By contrast, the February bulge in the stable seasonal money series merely carried M-1A to within the lower half of its long-run growth range. Otherwise, the equal-weight series has been below path throughout the period. This growth pattern would have been consistent with a less restrictive policy in the first quarter.

The two different policy prescriptions indicated by applying alternate sets of seasonal factors to the same raw data highlight the problem faced by policymakers in trying to separate seasonal from trend-cycle movements. Moreover, it is quite probable that neither of the two sets of seasonal factors used here is entirely correct. The equal-weight factors do not capture known changes in the determinants of the seasonal process. The official factors, which are influenced heavily by the extraordinary events of 1978 and 1979, may fail to average out enough of the irregular component of the data.

April Growth and Moving-average Options

The different growth patterns of M-1A implied by alternative smoothing assumptions are illustrated in table 4. In the years 1976 through 1979, seasonally adjusted growth rates for April (both official and those assuming stable seasonals) were greater than growth rates for the year ending in that month. Furthermore, the disparity increased over that period. In the absence of any explicit information, it seems unlikely that solely nonseasonal determinants could account for the four straight years of increasing disparity. It appears as if the seasonal relationship is changing. By comparison, it is evident that the official seasonals for March and April embody some change over time, which is verified in table 5. The trends that decrease the seasonal factors in March and increase them in April tend to dampen the growth of seasonally adjusted demand deposits in April. Thus, based on strictly empirical grounds, the official seasonal factors appear closer to the true seasonals than those that assume stability for this period.

Table 5 Seasonal Factors for Demand Deposits

	March		April	
	Actual[a]	Stable option	Actual[a]	Stable option
1975	0.985	0.984	1.009	1.010
1976	0.982	0.984	1.011	1.010
1977	0.981	0.984	1.013	1.010
1978	0.979	0.984	1.013	1.010
1979	0.978	0.984	1.014	1.010
1980[b]	0.978	0.984	1.014	1.010

a. Estimated in 1980.
b. The 1980 seasonal.

In 1980, however, the April growth trend was reversed, suggesting an abrupt change in seasonality. However, a number of cyclical factors (such as the declines in industrial production and business loans) also could have accounted for much of the sharp drop in M-1A in April. In the absence of a well-estimated model of seasonality, it is difficult to defend how much of this change, if any, should be embodied in the 1981 seasonals.

As noted earlier, some analysts would argue that the Treasury's expeditious performance in tax processing during 1980 explains a significant portion of the M-1A decline in April. If the Treasury continues to perform in such a manner consistently over the next few years, perhaps the true April seasonal would stabilize around a particular value. However, the April seasonal is probably related to other determinants that are changing both randomly and systematically. In either case, it could be argued that the five-year weighted-moving-average option is likely to be appropriate most of the time. In terms of time-series analysis, seasonality is not likely to be stationary, whereas the stable option assumes it is. Anyone who has applied time-series methods to economic variables appreciates the rare occurrence of stationarity in the original series.

Monitoring the Economy: Survey of Fourth District Manufacturers

by Robert H. Schnorbus

Monitoring changes in economic activity among manufacturing firms on a timely basis provides a valuable, but seldom possible, means of analyzing current business-cycle conditions. In fulfilling its responsibilities toward formulating monetary policy, the Federal Reserve Bank of Cleveland monitors the current performance of the regional economy, especially regional changes in economic activity that may signal national cyclical developments. In response to the need for regional information, in 1965 the bank developed a monthly survey of manufacturing firms within the Fourth Federal Reserve District (4D) to ascertain basic conditions of production activity. When converted into diffusion indexes that measure the direction of change in eight key indicators of economic activity, the 4D survey findings can be used to interpret the timing, amplitude, and duration of the current phase of the business cycle.

As with any analytical tool, the value of the indexes obtained from the 4D survey depends on an understanding of both the strengths and weaknesses of the survey. Major weaknesses in business-cycle analysis are the limitations imposed by the quality, timeliness, and availability of data. Often, key indicator series for the national economy either are not published on a monthly basis or are published with considerable time lags. Comparable regional data, where available, may involve even longer lags than national data. Although detailed monthly employment data for the United States, for example, are available within a week after the end of each month, state (payroll) employment data by industry are not released for another one to two months. Other monthly data, such as new orders, shipments, and inventories, take much longer to collect and process at the national level, and often are not available at the regional level. As a consequence, short-term economic forecasting and policymaking exclude key measures that may signal impending change in economic activity.

The monthly survey of the 4D manufacturers collects a variety of reliable information about the district's production base with a minimal time lag. The shorter time lag of the 4D survey, compared with alternative sources of information, is its most valuable contribution. However, it is not simply availability and timeliness of data that are important. A data series should have a record for accuracy in identifying important characteristics, such as turning points in economic activity. Ideally, the 4D indexes should closely correspond to the timing, amplitude, and duration of comparable national series published by other sources, except where distinct regional characteristics are captured by the 4D survey. This article assesses the 4D survey indexes and their accuracy over the past ten years by statistically comparing them with rates of change in comparable aggregate series at the national level.[1]

1. Earlier evaluations of the 4D survey found the indexes to be consistent with behavior of their national counterparts. However, the survey sample has undergone changes in recent years, and the popularity of surveys, in general, has declined with the growth of econometric forecasting models. For earlier studies, see "Diffusion Indexes and Economic Activity," *Economic Review,* Federal Reserve Bank of Cleveland, January 1971, pp. 3-17; and Theodore S. Torda, "The Monthly Survey of Fourth District Manufacturers–An Early Warning Signal," *Economic Commentary,* Federal Reserve Bank of Cleveland, October 27, 1969.

Table 1 Survey Sample Distribution: 1978

Industry	Number of firms	Total employment of sample[a]	Survey employment, percent	Ohio employment, percent[b]	U.S. employment, percent[b]
Food	1	27,100	4.1	7.2	12.7
Furniture	3	16,300	2.5	1.7	3.6
Paper	2	37,000	5.6	3.8	5.2
Printing	2	13,698	2.1	6.3	8.8
Petroleum	1	12,927	1.9	1.5	1.5
Primary metals	6	227,505	34.3	14.9	8.9
Fabricated metals	4	16,105	2.4	16.5	12.4
Machinery	5	93,894	14.1	20.9	17.5
Electrical equipment	4	205,000	30.9	11.8	14.7
Transportation equipment	2	14,500	2.2	15.4	14.6
Sample total	32	664,029	100.0	100.0	100.0

a. Employment figures are based on a survey sample taken in July 1978.
b. Percentages are based on sum of employment for listed industries.

SOURCES: Bureau of Labor Statistics and Federal Reserve Bank of Cleveland.

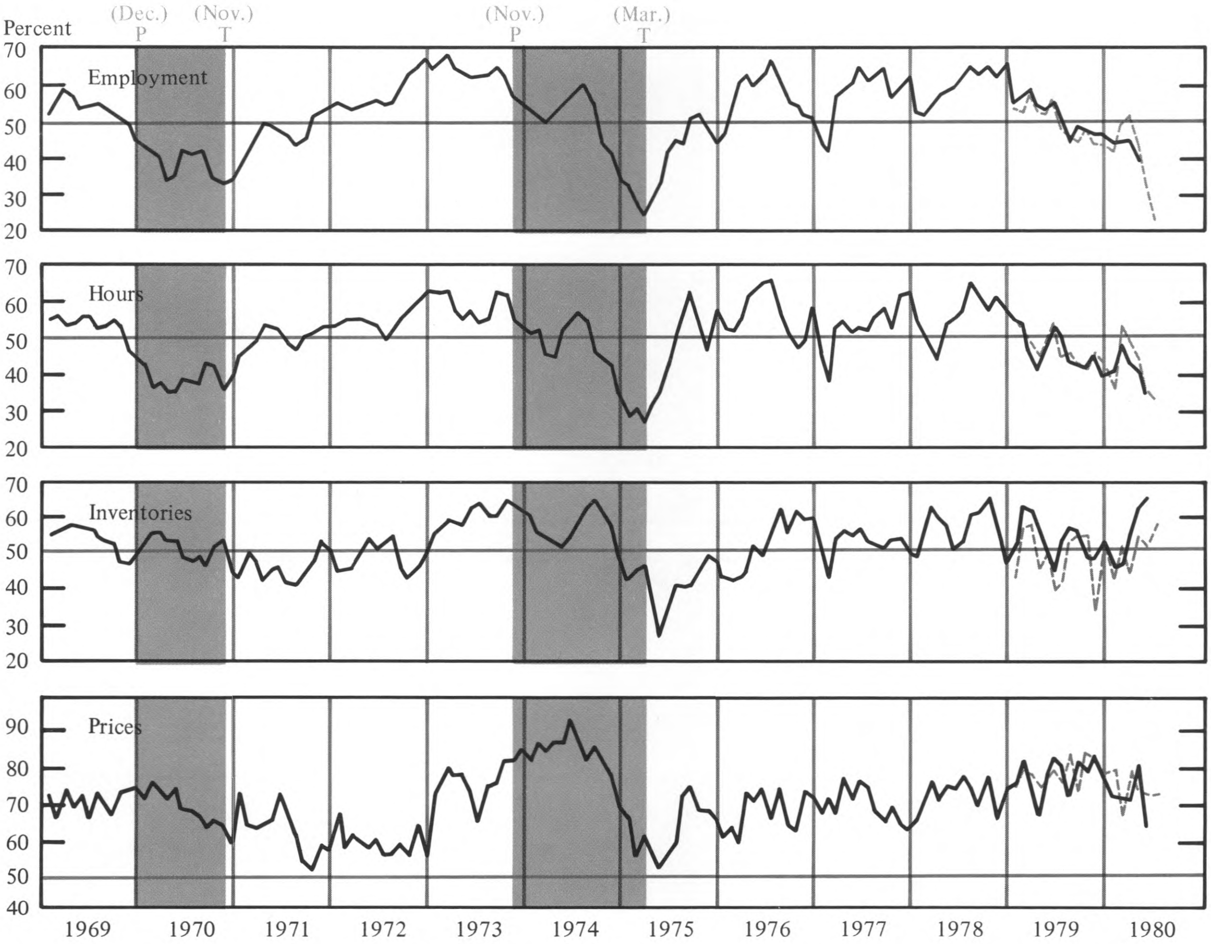
Description of the 4D Survey

The survey is derived from a sample of 4D manufacturing firms intended to reflect the regional manufacturing sector, especially the disproportionate share of durable-goods industries. To be sure, some of the participating firms in the current sample have only corporate headquarters remaining in the 4D, but most of the firms still have operating plant facilities within the district. To the extent that these firms also have nationwide operations, the sample captures national characteristics. (Table 1 compares a typical survey sample with the actual distribution of employment for Ohio and the nation among a limited set of ten industries.) Because of the predominance of durable-goods producers in the 4D, the sample has tended to overemphasize durable-goods industries, such as primary metals and electrical equipment. Other durable-goods industries, such as fabricated metals and transportation equipment, have been underestimated.[2] (Some important industries, such as rubber, are not represented.) While the sample size can vary from month to month, the number of active participants currently averages 30 to 35.

The monthly survey consists of eight indicators of economic activity and a composite index. One set of indicators tends to be production-oriented, including employment, hours worked per week, prices paid for materials, and inventories (see chart 1). Another set tends to be sales-oriented and includes new orders, backlog of orders, delivery times, and shipments (see chart 2). For each of these indicators, participants are asked whether manufacturing activity increased, decreased, or remained unchanged in the previous month and what is expected for the month in progress. By adding the percentage of responses that report in-

2. For example, 34.3 percent of the total employment represented by the survey sample was contained in primary metals, while only 14.9 percent in Ohio (a proxy for the 4D) and 8.9 percent in the nation would have been required for an unbiased sample. Likewise, 2.4 percent of the sample's employment was well below a required 16.5 percent in Ohio and 12.4 percent in the nation. In order to test the comparability of the sample employment distribution with the national distribution, a Spearman rank order correlation test was performed, using the percentage figures in table 1. The null hypothesis that the percentage distribution of employment is similar must be rejected on the basis of the computed correlation value ($\rho_s = 0.34$, with nine degrees of freedom).

Chart 1 Production-oriented Indexes



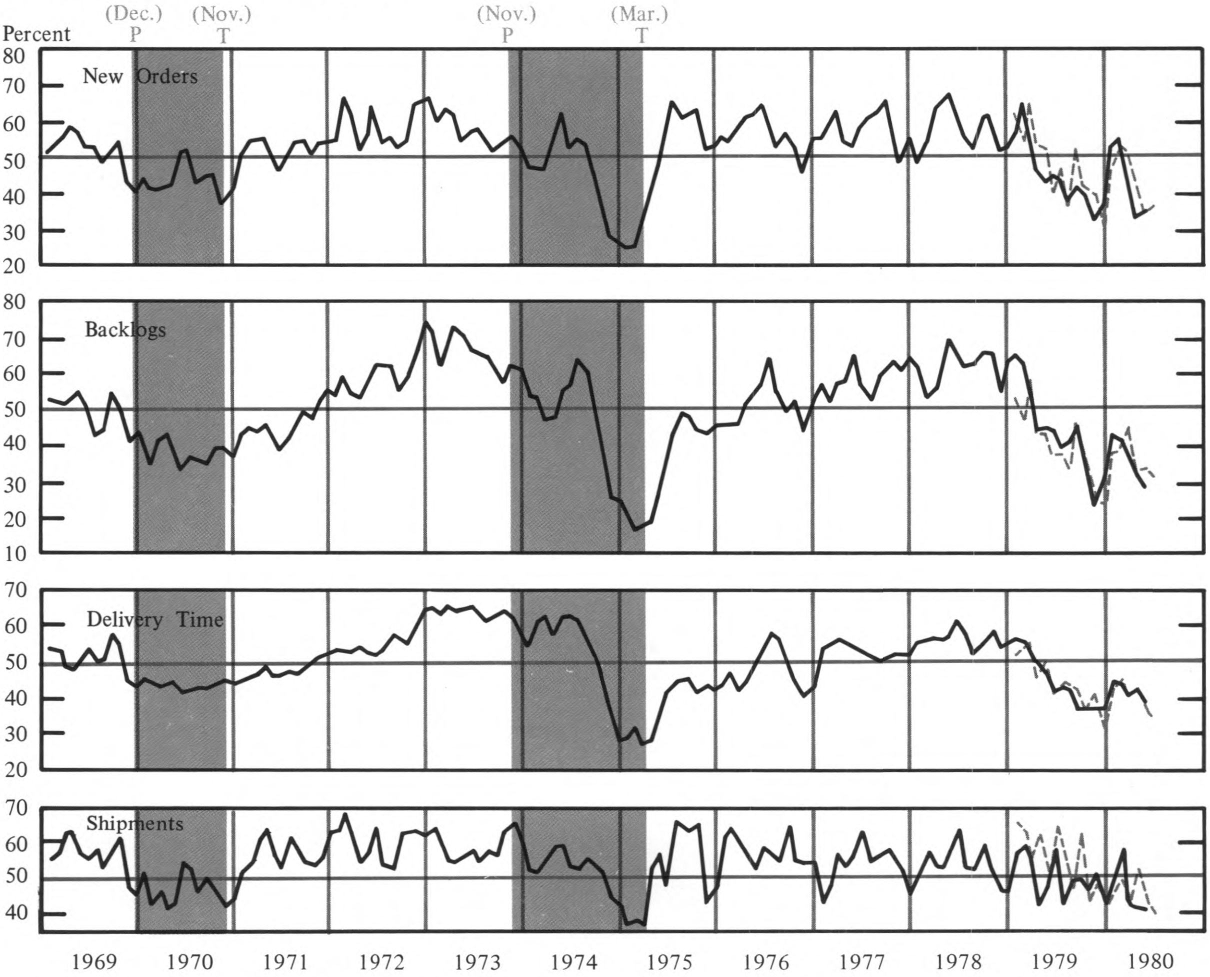
NOTES: Dotted lines indicate anticipated values for month in progress.
Shaded areas indicate periods of contraction.

creases and one-half the percentage of responses that report no change, a numerical score—called a diffusion index—is computed for each indicator.[3] The score for the month in progress is computed as a forecast value, although it may be based on partial information available at the time of the survey. By a simple averaging technique, the eight index values are then combined into a composite diffusion index that serves as a measure of overall manufacturing activity.

The 4D indexes suffer from statistical problems that are both inherent in the method of computing diffusion indexes and specific to the 4D sample. First, the sample distribution can be affected by the inclusion (or exclusion) of some of the largest firms in the 4D. For example, the overemphasis on primary

3. The index values are published after a seasonal-weight factor is applied to produce raw scores, which are then averaged with the raw scores of the previous month. The month-to-month fluctuations thus are smoothed out to reveal more clearly any underlying cyclical pattern. For alternative methods of constructing diffusion indexes, see Arthur F. Burns, "New Facts on Business Cycles," in Geoffrey H. Moore, Ed., *Business Cycle Indicators*, vol. 1 (National Bureau of Economic Research/Princeton University Press, 1961), pp. 13-44.

Chart 2 Sales-oriented Indexes



NOTES: Dotted lines indicate anticipated values for month in progress.
Shaded areas indicate periods of contraction.

metals was partly the result of including three of the largest steel-producing firms in the nation. The indexes are likely to show a bias toward events that are specific to a given industry, such as steel, and to the 4D economy, such as localized labor-management disputes. A second related source of bias results from the treatment of each participating firm on a "one firm-one vote" basis, regardless of the relative size of the firm's work force. Thus, a large firm is given as much weight in the computation of the indexes as a small firm, even though the magnitude of the change associated with the response of a large firm may represent a greater economic impact on the nation. Third, the eight individual indexes are not all independent. Delivery time, for example, is equivalent to backlogs divided by shipments, and the new-orders index is equivalent to the change in backlogs plus shipments. The problem of overlapping indexes is particularly relevant to the composite index, which, as a result, may overemphasize certain aspects of manufacturing activity. Finally, diffusion indexes, in general, are valuable in terms of indicating the direction of change in activity, but are more limited in terms of measuring amplitude of change.

Cyclical Properties of the 4D Indexes

The rationale for the 4D indexes is derived from the tendency for economic expansions and contractions to spread by a cumulative process among firms, industries, and regions. The relationship between cyclical spreading, or diffusion, of expansions or contractions and the timing, duration, and amplitude of business cycles reflects the interconnection among business activities of firms and the process by which adjustments to the cycle are made. A diffusion index can be related to the rate of change of a comparable aggregate series through the assumption that the deeper a contraction (and, therefore, the greater the rate of decline in the aggregate series), the more widespread the contraction becomes among firms and industries (see Properties of a Diffusion Index, p. 12). The expected behavior of the 4D survey indexes then is based on the performance of comparable aggregate series with which the indexes should have close historical relationships.

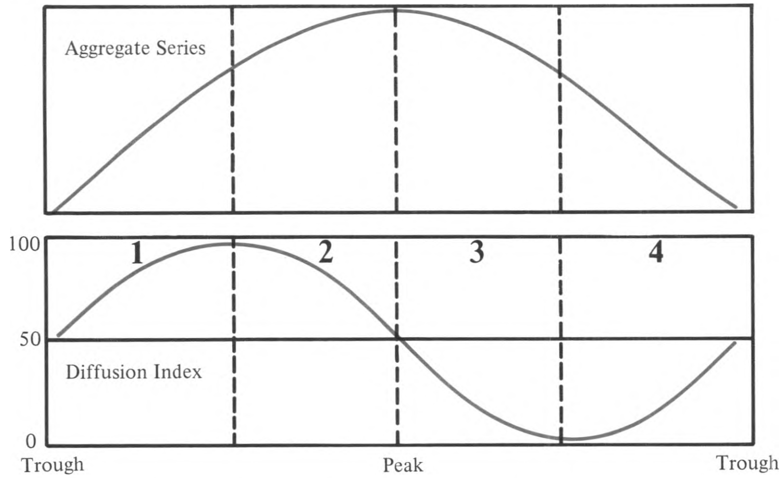
The mixture of production-oriented and sales-oriented indicators creates some unique properties for the behavior of the 4D composite index. Some of these properties tend to lead and others tend to lag the reference cycle as defined by the official dating of peaks and troughs by the National Bureau of Economic Research (NBER). The combination of cyclical properties causes the composite index to differ from a diffusion series based on other aggregate series, such as the FRB Index of Production, which tends to coincide with cyclical peaks and troughs. Although the construction of the composite diffusion index as an average of the eight individual indexes would suggest the likelihood of a coincident indicator, the expected behavior of the composite index depends on the predominance of the lead-lag relationships among the eight individual survey indexes.

Among the production-oriented indicators, only manufacturing employment qualifies as an aggregate series that is roughly coincident with the overall business cycle. The timing of the turning points of the employment series is expected to be coincident, because employment is a product of cyclical changes in demand. Thus, employment is at the center of cyclical movement, as it adjusts to changes in demand. The amplitude of employment swings may be mild, however, compared with changes in production, because employers often try to protect their skilled work force. Employers have the alternatives of not replacing workers who leave or retire and of slowing the rate of expansion of their work force. Production may experience wider fluctuations than other aggregate series, so that the relative adjustments of employment reflect the extent to which further adjustments in the other production-oriented aggregate series may be required.

The flexibility of hours worked and, to a degree, of prices of materials over the cycle makes them potentially leading indicators. Shortening of the work-week in response to an economic slowdown usually occurs before other employment adjustments. Changes in hours are easier to administer, easier to reverse when necessary, and just as likely to reduce costs per hour (for example, when overtime is reduced or when training costs for new employees are avoided). The prices of materials, too, generally change quickly as inventories of raw materials accumulate or contract over the business cycle. When demand for a firm's output is expanding, the firm's demand for input expands. If the rise in input demand cannot be accommodated by existing inventories, suppliers are tempted to raise prices. If inventories accumulate during a slowdown, suppliers may offer price discounts to manufacturers.

Whether adjustments are made by altering hours worked or prices, the failure to keep production in line with demand has a spillover effect on inventory levels of finished products. Manufacturers produce either to stock, as in products such as nuts and bolts, or to order, as in products with special requirements. Production to order requires lower inventories of finished goods and greater control in managing inventory levels of materials. Production to stock depends on the accuracy of the firm's economic forecasts of demand for its product. As a rule, inventory levels begin to accumulate beyond the cyclical peak in economic activity because of the lags inherent in detecting and confirming a peak. Once inventories are high relative to desired levels, firms will attempt to liquidate their oversupply. The liquidation may continue beyond the cycle's trough, not only because of the problem of recognizing a trough, but also because orders should pick up before production will be expanded. Yet, even though inventory levels may lag the cycle, additions to or re-

Properties of a Diffusion Index



Stage	a diffusion index that	implies that the aggregate series
1	rises (50% – 100%)	increases at an increasing rate
2	falls (100% – 50%)	increases at a decreasing rate
3	falls (50% – 0)	declines at an increasing rate
4	rises (0 – 50%)	declines at a decreasing rate

In computing a numerical value for a given diffusion index, one-half of the percentage of the participants reporting no change is added to the percentage of participants reporting increases. Thus, if 30 percent of the participants report "increasing," 40 percent report "unchanged," and 30 percent report "decreasing," the value of the diffusion index would be 50 percent. While an aggregate series measures the actual level attained by a particular business-activity indicator, such as employment, the diffusion index measures the percentage of firms participating in the expansion (or contraction) in any given month. The proper interpretation, then, is not that employment is expanding, for example, but that one-half of the firms are experiencing expanding employment. The amplitude of the diffusion index above (or below) the 50 percent level measures the intensity of the expansion (or contraction), while the intersection of the 50 percent level signifies a peak (or trough). The distance between peaks measures the duration of the cycle. In the special case illustrated above, the diffusion index curve is equivalent to the rate of change in the aggregate series.[1]

1. A discussion of the diffusion process as it relates to aggregate series appears in Geoffrey H. Moore, "The Diffusion of Business Cycles," in Geoffrey H. Moore, Ed., *Business Cycle Indicators*, vol. 1 (National Bureau of Economic Research/Princeton University Press, 1961), pp. 261-81. Although a diffusion index is similar to a rate of change, there are fundamental differences. As indicated earlier, the diffusion index takes into account only the direction, not the magnitude, of change. Thus, if a general expansion is under way in a specific aggregate series, a diffusion index would show whether it has been spreading among firms. While the scope of an expansion in its early stages appears to be roughly correlated with the magnitude of the expansion, the same is not necessarily true for the rates of change in most economic aggregates during expansions. A diffusion index can do no more than measure the scope of period-to-period changes. For a discussion of the conditions required to make a diffusion index proportional to a rate of change of a comparable aggregate series, see Geoffrey H. Moore, "Diffusion Indexes, Rates of Change, and Forecasting," in Geoffrey H. Moore, Ed., *Business Cycle Indicators*, vol. 1 (National Bureau of Economic Research/Princeton University Press, 1961), pp. 282-93.

ductions in inventories (that is, the rate of change) may lead the cycle, especially near the peaks.[4]

The lead-lag relationship among the sales-oriented series depends upon its placement within the production process, beginning with the receipt of a new order through final shipment. New orders for durable goods particularly show a tendency to lead the business cycle in general (as well as to lead the output of the industry receiving the orders) because of the causal connection between commitment to buy and production.[5] The amplitude of fluctuations in new orders is augmented by two factors. First, firms tend to place orders with more than one manufacturer to assure delivery and an adequate supply around the peak of an expansion. Second, firms are able to cancel orders when they see the first signs of an economic slowdown, a problem further exacerbated by double ordering. Firms producing to stock have some advantage in using inventories to adjust to changes in new orders, while firms producing to order must rely on more complex adjustment mechanisms.

Shipments, especially for firms producing to order, are expected to run parallel with new orders, separated only by production time, which may vary from industry to industry. In addition to production time, however, the span between receipt and shipment of a new order can be altered by the supply constraints that result in backlogs and by changes in delivery time, which serve a role similar to inventories as a "buffer" to unexpected changes. Whether producing to stock or to order, firms may attempt to stabilize their production by allowing backlogs to accumulate before capacity is reached (especially if employment expansion is required) and only run them down after a slowdown begins. Backlogs, then, are generally designated as leading a cycle peak, but lagging a cycle trough.

Changes in backlogs and shipments also appear in the adjustments of delivery time. Indeed, the ratio of backlogs to shipments represents the number of months needed to dispose of existing backlogs at present rates of operation (average time interval between an order's receipt and delivery). Delivery time includes both the time spent in production and the time spent in backlogs. In a seller's market, where advanced orders are strong, manufacturing firms have a degree of discretion over delivery dates. (Even if firms cannot fill orders in excess of capacity constraints, they still can receive them.) When demand is rising, buyers seek early delivery dates; yet once a slowdown begins, buyers, too, are often willing to wait. In general, delivery time leads the cycle at both the peak and trough.

Behavior of the 4D Indexes

Over the past ten years, the 4D indexes have been effective in monitoring economic activity in the nation and in the district. In comparing the 4D indexes with the corresponding aggregate series (expressed as rates of change), the 4D indexes generally have proved to be statistically significant in explaining current and future levels of the aggregate series (see Appendix). Except for the inventory series, the 4D indexes are able to provide meaningful information on the behavior of the aggregate series beyond what is known from examining past rates of change in the aggregate series. Indeed, the shipments index has proved to be more successful than relying on past rates of change in the shipments series for indicating current rates of change.

The 4D indexes, however, are less successful in forecasting rates of change in the next month than an aggregate series. Only half of the indexes (employment prices, backlogs, and delivery time) exhibited statistical significance. In three of the remaining indexes (new orders, shipments, and the composite index), even knowledge of the past behavior of the series has proved to be unsatisfactory for forecasting rates of change in the subsequent month. Although confidence in the

4. Because of the uncertainty in supply and demand fluctuations and the time lags involved in the production process, inventories often serve as a buffer. Inventories, however, may accumulate for two different reasons. Businessmen may be building inventories voluntarily in anticipation of expanding sales, or businessmen involuntarily may be accumulating inventories from overestimating that expansion. In the first case, the change in inventories would be a leading indicator; in the second, a lagging indicator.

5. Many firms experience large cyclical fluctuations in demand and react to them strongly through output adjustments. Industries in which there are many such firms constitute an important part of durable-goods manufacturing, which, in turn, is a sector that carries much weight within the economy as a whole. See Victor Zarnowitz, "The Timing of Manufacturers' Orders During Business Cycles," in Geoffrey H. Moore, Ed., *Business Cycle Indicators,* vol. 1 (National Bureau of Economic Research/Princeton University Press, 1961), pp. 420-84.

Table 2 Comparison of Turning Points: 4D Index and Comparable Series

	1969-70 recession				1973-75 recession			
	Peak	Deviation[a]	Trough	Deviation[a]	Peak	Deviation[a]	Trough	Deviation[a]
NBER reference points	**Dec. 1969**		**Nov. 1970**		**Nov. 1973**		**Mar. 1975**	
Employment								
Index	Nov. 1969	-1	Oct. 1971	+11	Oct. 1974	+12	Oct. 1975	+7
Series	Oct. 1969	-2	Nov. 1971	+12	Aug. 1974	+10	June 1975	+3
Hours								
Index	Dec. 1969	0	Mar. 1971	+4	Oct. 1974	+12	July 1975	+4
Series	Oct. 1969	-2	Nov. 1970	0	Dec. 1973	+1	Mar. 1975	0
Inventory								
Index	May 1970	+6	Dec. 1972	+25	Dec. 1974	+14	May 1976	+15
Series	Dec. 1970	+12	Jan. 1972	+14	Mar. 1975	+18	June 1976	+10
New orders								
Index	Oct. 1969	-2	Jan. 1971	+2	Sept. 1974	+10	May 1975	+2
Series	Dec. 1969	0	Dec. 1970	+1	Sept. 1974	+10	Apr. 1975	+1
Shipments								
Index	Nov. 1969	-1	Jan. 1971	+2	Oct. 1974	+12	Apr. 1975	+1
Series	Dec. 1969	0	Dec. 1970	+1	Dec. 1974	+14	Apr. 1975	+1
Backlogs								
Index	Nov. 1969	-1	Oct. 1970	-1	Sept. 1974	+11	Mar. 1976	+13
Series	Dec. 1969	0	Dec. 1970	+1	Nov. 1974	+13	Mar. 1976	+13
Delivery time								
Index	Nov. 1969	-2	Oct. 1970	-1	Oct. 1974	+12	Apr. 1976	+14
Series	Oct. 1969	-3	Jan. 1971	+2	Mar. 1974	+5	Mar. 1975	0
Composite								
Index	Dec. 1969	0	Jan. 1971	+3	Oct. 1974	+12	May 1975	+3
Series	Dec. 1969	0	Dec. 1970	+2	Oct. 1974	+12	Mar. 1975	0

a. Numbers indicate difference in months between NBER reference cycle turning points and individual indicators. The specific NBER turning points are December 1969 (peak), November 1970 (trough), November 1973 (peak), and March 1975 (trough).

NOTE: Prices were excluded because no peaks were registered by the 4D index over the period studied.
SOURCES: Department of Commerce (Bureau of Economic Analysis) and Federal Reserve Bank of Cleveland.

forecasting ability of the 4D indexes may be limited, the survey generally provides information that is consistent with the expected cyclical behavior of the aggregate series, at least in terms of duration and amplitude.

The success of the 4D indexes in capturing the pattern of fluctuation in the comparable aggregate series does not guarantee that the timing of a 4D index peak or trough will closely correspond to the peak or trough of the aggregate series. In fact, almost one-third of the turning points among the 4D indexes followed their expected turning points (as determined by the rate of change in the comparable aggregate series) by more than a one-quarter time period (see table 2). Almost half of these deviations were concentrated in the inventory index, which has a weak correlation with the aggregate series. Of the remaining deviations, most were contained in the 1973-75 recession, which sharply contrasted with the more accurate signaling of turning points in the 1969-70 recession.

During the 1969-70 recession, the actual deviation of the 4D index peak and trough from the NBER reference cycle peak and trough tended to be no more than one to two months. At the reference cycle peak (December 1969), for example, all of the 4D indexes except inventories closely corresponded to the reference cycle peak and to the specific aggregate series peak. At the reference cycle trough (November 1970), all of the indexes except employment, hours, and inventories closely tracked both the reference and the specific cycles. Both the index and the specific cycle for employment reached a trough about one year after the reference cycle, so that the index was still accurately representing the employment series. The hours index reached a trough four months after the reference cycle and the specific series in both the 1969-70 and the 1973-75 recessions.

The inability of the inventories index in the 1969-70 recession to coincide with the turning points of the aggregate series was perhaps expected from the relative weak correlation with the specific aggregate series. The index lagged the reference cycle peak by 6 months and the trough by 25 months, while the specific cycle of the aggregate series indicated a 12-month to 14-month lag at each turning point. Still, the index may indicate a pattern of behavior peculiar to the region. Inventory adjustments in the 4D may have lagged the reference cycle at the peak because of difficulties in making prompt production adjustments or hesitancy among 4D manufacturers to acknowledge that a recession was developing. At the trough, 4D manufacturers may have been cautious about building inventories until sales were increasing faster than production.

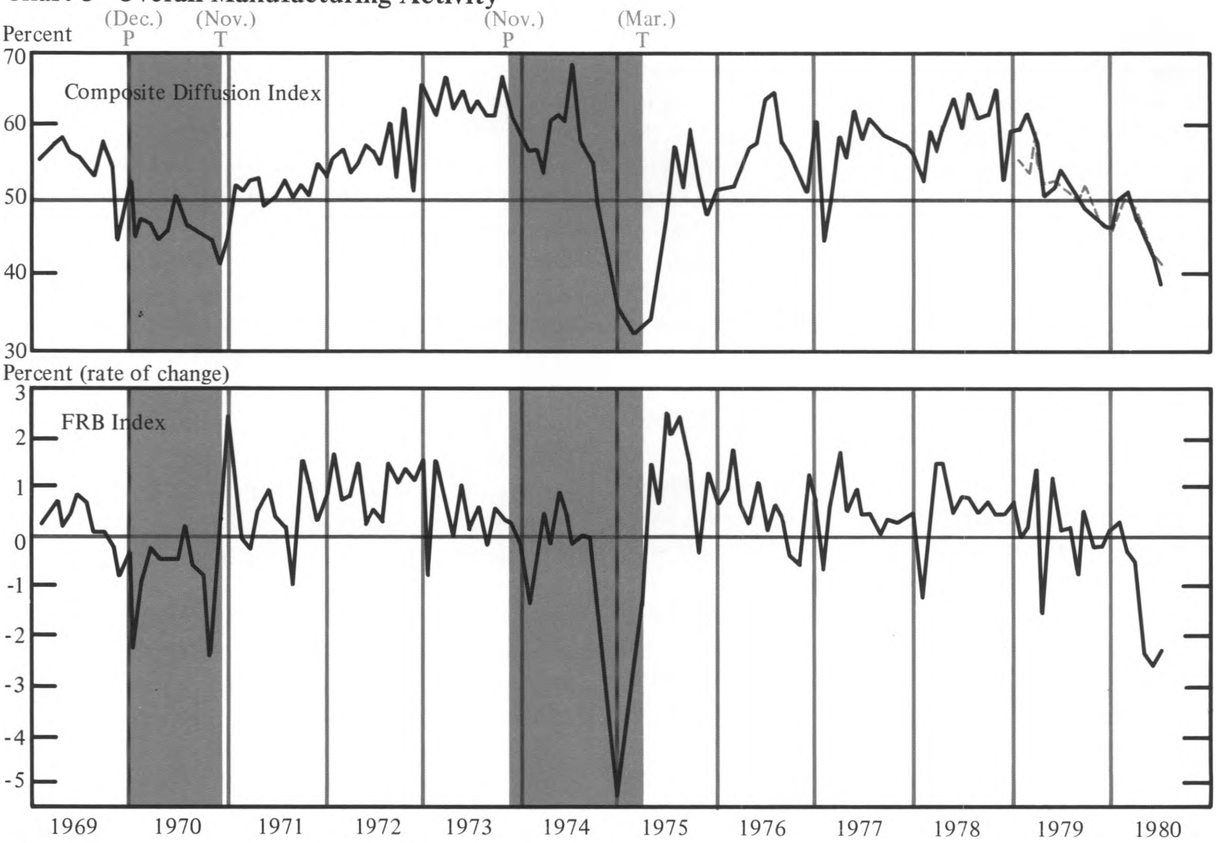
Although the number of 4D indexes that deviated substantially from the turning points of their counterparts increased during the 1973-75 recession, the aggregate series themselves tended to lag the reference cycle by roughly one year, especially at the peak (November 1973). However, the recession did not actually affect the 4D economy until late 1974, not the peak of late 1973 determined by the NBER. At the reference trough (March 1975), new orders, shipments, backlogs, and the composite index behaved satisfactorily with respect to specific turning points, but the other indicators signaled turning points much later than the specific aggregate series.

In addition to the inventories index, which repeated its earlier pattern of reaching a peak sooner and a trough later than its specific cycle, hours and delivery-time indexes had the largest deviation from their specific cycles. Because the 1973-75 recession was in many respects atypical, the discrepancies in the hours and delivery-time indexes may reflect regional characteristics of the recession. If much of the miscalculation that led to the overextension of inventories was concentrated among 4D manufacturers, the expansion of hours worked might have lasted longer, and the subsequent contraction may have led to a later trough in the 4D than elsewhere in the nation. With production expanding, delivery times may have continued to be extended in the 4D, while new orders and backlogs were tapering off in other regions. If so, the 4D indexes may be more indicative of the regional pattern of activity than the specific aggregate series.

Despite the shortcomings of individual 4D indexes, the 4D composite diffusion index has proved to be an effective indication of overall manufacturing activity. When compared with the FRB index, the composite index revealed a close correspondence with manufacturing activity, but its forecast was no better than could be obtained with past knowledge of the FRB index (see chart 3). The turning points and, thus, durations of the two cycles were almost perfectly coincident with the reference cycle. But the amplitude of the two cycles may have been exaggerated in the composite index, as the 4D economy was disproportionately affected during both the expansion and recession that followed.[6] Particularly, expansion that occurred during 1974 appears to be much more intense in the composite index than suggested by the rate of change in the FRB index. Expansion was strongest in inventory and business fixed investment, hence in primary metals and metal-working industries that held up well into the recession. Indeed, both indicators revealed a spurt of activity in the middle of 1974 that appeared to be largely concentrated in the 4D economy. However, the subsequent sharp contrac-

6. The regression residuals reflect the fact that most of the indexes overestimated the decline in November and December of 1974, presumably because of the intensity of the inventory liquidation and decline in goods-producing industries in the 4D. The plot of the two indicators also shows the effects of the automobile and expected steel strikes in 1970 on the FRB index, but not on the composite index (which was, of course, controlled for in the correlation tests with the dummy variable, Z). The residuals of the regression revealed other exogenous shocks experienced by individual series, but few were widespread among the indexes.

Chart 3 Overall Manufacturing Activity



NOTE: Dotted line indicates anticipated values for month in progress.

SOURCES: Board of Governors of the Federal Reserve System and Federal Reserve Bank of Cleveland.

tion in 1975 is captured by both indicators, even though the composite index is slower to recover, as might be expected in a widespread expansion.

Finally, the anticipated values for the composite index have proved to be about as accurate as the actual values. Although no test of significance could be used to check the accuracy of anticipated values, their performance between June 1978 and December 1979 has been reasonably consistent with the actual values. The anticipated values survey has a tendency to overstate amplitude, which is not unusual in forecasting. However, the apparent accuracy of the anticipated values suggests that the forecast could be greatly improved by including the anticipated value in the forecast model. By treating the month in progress as an actual value, knowledge of manufacturing activity is extended one full month, thereby improving the accuracy of the forecast. Since all of the indexes indicate reasonably accurate anticipated values, many of the problems with forecasting, especially with the composite index, may be overcome by the inclusion of anticipated values as a contemporary value in an analysis similar to confirming current levels.

1979 in Perspective

Turning points in peaks and troughs of business activity are difficult to identify and generally have eluded forecasters. Since early 1975, manufacturing activity was in an expansionary phase that has been characterized by spurts of growth between brief pauses, at least until late 1979. Each pause raised apprehension among manufacturers at the onset of another recession. Economic behavior is still sufficiently perplexing that forecasters who had expected a slowdown in early

1979 (based on available indicators) were required continually to revise those expectations. The credible performance of the 4D indexes over the past ten years provides a foundation for improving the month-to-month analysis of manufacturing activity.

While not designed specifically to determine turning points, the 4D indexes can be useful warning signals because of their currency and corroborative value. For example, both the composite index and the FRB index captured the spurts and pauses of the recent expansion. However, the composite index only once signaled a potential contraction (January 1977), compared with four by the FRB index (presumably related to strikes or other temporary disruptions) since 1975. In September 1979, the composite index clearly showed a peak and subsequent contraction in overall manufacturing activity. In contrast, the FRB index indicated only uncertainty, with alternating positive and negative rates of change each month throughout the year. Although one-half of the eight individual indexes in 1979 deviated from the pattern of their corresponding series, the remaining indexes conformed to their expected patterns. For example, hours, shipments, and backlogs also reached peaks by midyear and have continued to indicate decline into 1980, while their comparable series have fluctuated irregularly. The inventory index has indicated relative stability, while its comparable series has shown moderate accumulation. In each of these cases, the indexes have underestimated the strength of their corresponding series. Among the conforming indexes, most of the corresponding series were also in a contraction phase. Manufacturing employment, delivery time, and new-orders indexes indicated decline throughout the second half of 1979 and only temporarily showed signs of strengthening in early 1980. The price index, along with its corresponding series, again has been the exception in that the pace of inflation occasionally has slackened, but it has never declined.

The discrepancies between the indexes and their corresponding series can be attributed to inherent shortcomings in the survey. The 4D survey sample currently contains a disproportionate number of steel producers that, along with automotive producers, have been the leading edge of the recent economic slowdown. Steel inventories have been under extremely tight controls and appear to be preventing the inventory index from exhibiting the expected trend toward accumulation. Similarly, hours, backlogs, and shipments appear to be contracting in the 4D indexes rather than being stable as expected because of the steel industry's experience. However, the corresponding series may also be faulty because the length of the recent expansion and capacity constraints have produced sizable backlogs of orders. Until these backlogs are sufficiently reduced, production (and, as a result, hours and shipments) can be sustained at current levels, even though other areas of the economy are weakening. Therefore, the composite index, by being more broadly based than the FRB index and less dominated by capacity constraints, may in fact be a more accurate depiction of the current state of manufacturing activity.

Concluding Remarks

After nearly a year of unfulfilled recession forecasts, the outlook for manufacturing activity was uncertain. The need for current and reliable indicators of manufacturing activity is acute. The results of this investigation indicate that the 4D survey is a useful tool for monitoring the economy. To be sure, the indexes must be used with caution, incorporating knowledge of the 4D economy with experience in business-cycle analysis. Nevertheless, the information conveyed by the indexes is a valuable piece in the puzzle of where the district and national economy is and where it is likely to go.

Appendix Description of the Models and Empirical Results

Two basic models were constructed to determine whether the amount of information contained in the 4D index series constituted a significant improvement over the body of knowledge already available from the historical pattern of the aggregate series. Since the most inclusive measure of that body of knowledge can be presented by the past performance of the aggregate series itself, the models took the following form:

Coincident model

$$\dot{X}_t = a + b_1 Z + b_2 \dot{X}_{t-1} + b_3 \dot{X}_{t-2} + b_4 DI_t + b_5 DI_{t-1} + b_6 DI_{t-2} + u$$

Forecast model

$$\dot{X}_{t+1} = a + b_1 Z + b_2 \dot{X}_{t-1} + b_3 \dot{X}_{t-2} + b_4 DI_t + b_5 DI_{t-1} + b_6 DI_{t-2} + u$$

where

$\dot{X}$ = rate of change in aggregate series
Z = control variable for automobile and expected steel strikes in November-December 1970
DI = one of eight diffusion indexes for current time period, t, and for two previous time periods.

Tests were conducted on all the indexes, using a Cochrane-Orcutt iterative technique to minimize autocorrelation problems. The models test the ability of the indexes to conform to the rate of change of an aggregate series (coincident model) and to predict the rate of change of the aggregate series in the next period (forecast model). The null hypothesis that the coefficients of the diffusion indexes are zero and, therefore, contribute no useful information is rejected if the coefficients are statistically significant. (Although lags in data availability differ for each aggregate series, only one form of the model that gave the diffusion index a one-month availability advantage was tested for consistency.) The statistical results for the period between January 1970 and January 1979 appear in table A. The comparable series selected for the comparison were as follows:

Production-oriented

Employment: Employment (U. S.)–manufacturing
Hours: Weekly hours of product workers–manufacturing
Prices: Producer Price Index–durable-goods manufacturing
Inventory: Inventory stock–durable-goods manufacturing

Sales-oriented

New orders:[1] Diffusion index for new orders of durable-goods manufacturing
Backlogs: Unfilled orders–durable-goods manufacturing
Delivery time:[1] Vendor performance–percentage of companies reporting slower deliveries
Shipments: Shipments–durable-goods manufacturing

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1. New orders and delivery time are not based on the aggregate series. Because the series are themselves diffusion indexes, rates of change need not be computed.

Table A Coefficients of Regression Equations

Key: a = constant
R^2 = coefficient of determination
DW = Durbin-Watson statistic

	Production-oriented indexes				Sales-oriented indexes				
	Employment	Hours	Prices	Inventories	New orders	Backlogs	Delivery time	Shipments	Composite index
Coincident model ($\dot{X}_t$)									
$\dot{X}_{t-1}$	0.140	0.092	0.073	0.538	-0.367	0.773	0.562	0.053	0.291
	(1.87)	(0.96)	(0.81)	(5.72)	(-4.42)	(8.39)	(6.22)	(0.61)	(3.07)
$\dot{X}_{t-2}$	0.181	-0.268	0.230	0.189	-0.114	-0.079	-0.171	0.047	0.154
	(2.32)	(-2.78)	(2.77)	(2.14)	(-1.46)	(-0.88)	(-1.99)	(0.54)	(1.78)
DI_t	0.002	0.003	0.000	0.000	0.009	0.001	0.006	0.001	0.001
	(2.29)	(2.42)	(1.99)	(1.41)	(4.87)	(5.58)	(2.10)	(3.57)	(5.01)
DI_{t-1}	0.000	-0.002	0.000	-0.000	-0.002	-0.001	0.002	-0.001	-0.001
	(0.72)	(-0.94)	(4.97)	(-0.00)	(-0.80)	(-3.68)	(0.38)	(-2.34)	(-3.22)
DI_{t-2}	-0.000	-0.000	-0.000	0.000	-0.000	0.003	-0.008	0.001	-0.000
	(-1.53)	(-0.32)	(-0.08)	(1.10)	(-0.16)	(2.46)	(-2.90)	(1.93)	(-0.08)
Z	-0.024	-0.018	0.006	0.004	0.179	-0.008	-0.094	-0.069	-0.022
	(-9.24)	(-0.43)	(3.15)	(1.52)	(2.96)	(-1.96)	(-1.60)	(-5.47)	(-3.93)
a	-0.010	-0.004	-0.018	-0.010	0.453	-0.013	0.045	-0.037	-0.002
	(-2.36)	(-1.48)	(-3.97)	(-3.27)	(4.78)	(-4.03)	(1.13)	(-2.23)	(-0.39)
R^2	0.699	0.145	0.710	0.709	0.488	0.824	0.301	0.311	0.579
DW	2.020	2.001	1.991	2.028	2.019	2.028	2.150	1.993	1.969
Forecast model ($\dot{X}_{t+1}$)									
$\dot{X}_{t-1}$	0.101	-0.202	0.234	0.279	0.071	0.108	0.046	0.054	0.059
	(1.33)	(-2.02)	(2.56)	(3.27)	(0.80)	(1.08)	(0.51)	(0.57)	(0.58)
$\dot{X}_{t-2}$	-0.131	-0.104	0.030	0.262	0.067	0.110	0.000	0.008	0.089
	(-1.75)	(-1.05)	(0.36)	(3.07)	(0.78)	(1.06)	(0.01)	(0.08)	(0.94)
DI_t	0.003	0.000	0.000	0.000	0.004	0.000	0.008	-0.000	-0.000
	(2.83)	(1.45)	(5.41)	(1.78)	(1.72)	(1.94)	(2.48)	(-0.34)	(-0.16)
DI_{t-1}	-0.001	-0.000	0.000	0.000	-0.003	-0.000	-0.000	0.000	0.000
	(-0.86)	(-0.43)	(0.94)	(0.55)	(-0.94)	(-0.34)	(-0.13)	(1.10)	(0.33)
DI_{t-2}	0.000	-0.000	-0.000	0.000	0.002	0.000	-0.009	0.000	-0.000
	(0.31)	(-0.50)	(-0.63)	(1.23)	(0.90)	(2.35)	(-3.01)	(0.03)	(-1.01)
Z	-0.023	-0.002	0.006	0.003	-0.029	-0.004	-0.070	-0.071	-0.022
	(-9.88)	(-0.42)	(3.47)	(1.22)	(-2.71)	(-1.08)	(-1.05)	(-5.24)	(-4.06)
a	-0.012	-0.002	-0.017	-0.015	0.331	-0.021	0.127	-0.012	0.013
	(-2.09)	(-0.70)	(-3.31)	(-3.22)	(4.05)	(-2.65)	(2.05)	(-0.59)	(1.18)
R^2	0.688	0.102	0.701	0.704	0.374	0.768	0.269	0.222	0.481
DW	2.090	2.009	1.962	1.975	2.002	1.824	1.978	1.988	2.021

NOTE: Values in parentheses are t-statistics.

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