SOME FACTORS AFFECTING SHORT-RUN GROWTH RATES OF THE MONEY SUPPLY

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I.
Introduction

Public interest in the monthly and weekly movements of the money supply[1] has intensified since the early 1970's. One manifestation of this interest is the extensive coverage of week-to-week and month-to-month changes in the money supply in the financial press. A second indication is the intense scrutiny of each new weekly or monthly money supply statistic by financial market participants. Indeed, one of the major current rituals in the markets is played out late every Thursday afternoon as investors across the nation hover around news wire machines awaiting the release of the latest weekly money supply figures.

The increased attention to short-run money supply movements dates back to 1970 when the Federal Open Market Committee (FOMC), the Federal Reserve's principal monetary policymaking body, began to place greater weight on achieving specific longer-run growth rates for particular monetary aggregates.[2] Under the current strategy of monetary policy,[3] the FOMC periodically specifies desired longer-run growth rates (extending roughly a year ahead) for certain monetary aggregates. These growth objectives are publicly announced in quarterly testimony before one of the Congressional banking committees. At its monthly meetings the FOMC then reviews the state of the economy and compares the actual growth of the aggregates with their desired long-run paths. Based on this review the FOMC specifies short-run "tolerance ranges" for the growth rates of the aggregates over the two-month period covering the current and following months. The aim in setting these tolerance ranges is to define the near-term growth rates most likely to be consistent with achieving the existing long-run growth objectives. Consistency in this context, however, does not necessarily imply equality. The short-run ranges can and often do deviate numerically from the long-run objective either because the FOMC is attempting to offset some unintended deviation in earlier months or because some temporary but foreseeable factor is expected to affect short-run growth.

In any event, once the short-run tolerance ranges are set, the FOMC specifies a Federal funds rate range (normally from 50 to 100 basis points in width) believed to be consistent with short-run monetary growth within the bounds of the tolerance ranges. In this tactical framework, an emerging deviation of the actual two-month growth rates from the specified tolerance ranges might lead the Federal Reserve to alter the Federal funds rate (by increasing or decreasing the supply of nonborrowed reserves to member banks) in order to hold the growth rates within the tolerance ranges. Finally—a point of considerable importance—both the long-run monetary growth objectives and the two-month tolerance ranges are expressed in terms of *seasonally adjusted* annual rates of growth.

It should be evident from this description of the Federal Reserve's operating strategy that despite the longer-run time horizon in which basic monetary growth goals are cast, the procedure by its nature tends to focus day-to-day attention on short-run monetary movements. First, from the standpoint of the Federal Reserve, the key tactical operating specification is the two-month tolerance range. Setting an appropriate range requires close attention to the numerous factors affecting current weekly and monthly growth rates. Further, incoming weekly and monthly data must be continuously tracked and evaluated against the criteria established by the tolerance ranges. Second, the procedure naturally stimu-

[1] There are several concepts of the money supply, and statistical series corresponding to each of these "monetary aggregates" are published regularly in the *Federal Reserve Bulletin*. This article deals exclusively with the short-run behavior of M_1, the most narrowly inclusive aggregate, which is comprised of (1) currency outside the Treasury, Federal Reserve Banks, and vaults of commercial banks; (2) demand deposits at commercial banks other than domestic interbank and U. S. Government deposits, less cash items in process of collection and Federal Reserve float; and (3) foreign demand balances at Federal Reserve Banks. M_1 is the aggregate most closely watched by financial market participants and the general public. Also, much of the short-run variability of the more broadly defined aggregates (all of which include M_1) is due to the variability of M_1.

[2] This change in emphasis is evident in the evolving language of the FOMC's directives to the Trading Desk at the Federal Reserve Bank of New York. Prior to 1970, the directives generally instructed the Desk to seek a desired condition in the money markets as indexed by interest rates or free reserves. Since 1970, in contrast, most directives have instructed the Desk to foster money market and reserve supply conditions consistent with more rapid, slower, or unchanged *growth of the monetary aggregates*.

[3] See Lombra and Torto [4] for a detailed description of the current strategy of monetary policy.

lates financial market interest in the short-run behavior of the aggregates. Given this procedure, these movements strongly influence market expectations regarding the likelihood that the Federal Reserve will seek a change in the Federal funds rate that will in turn influence the prices and yields of other financial instruments.[4] As a result, considerable resources within the markets are now devoted to "watching" both the Federal Reserve and the money supply.

The major difficulty that arises in this institutional framework is that short-run monetary data, even after seasonal adjustment, are highly volatile. It is therefore difficult to project short-run movements, even for the immediate future, and equally difficult to evaluate incoming data. Chart 1 illustrates this volatility. It compares the originally published or "preliminary"[5] seasonally adjusted one- and two-month M_1 growth rates (at annual rates) in 1975 and 1976 with the full year growth rates during the surrounding 12-month period. Table I provides a further illustration. It shows the standard deviations of the annualized preliminary one- and two-month M_1 growth rates in each of the last ten years. The average standard deviation is 5.5 percentage points for the one-month growth rate and 3.8 percentage points for the two-month growth rate. Strikingly, the standard deviation of the one-month growth rates actually *exceeds* the average monthly growth rate in a number of years. This volatility of short-run growth rates relative to trend would not constitute a serious problem if it were possible to distinguish, on a *current* basis, between transitory changes in money growth and more permanent changes related to basic economic developments. Unfortunately, making such distinctions is an extremely difficult task. Consequently, the possibility always exists that the short-run behavior of the monetary aggregates might mislead either the Federal Reserve or market participants observing and trying to anticipate Federal Reserve actions.

The purpose of this article is to provide some insights into the difficulties inherent in interpreting the short-run behavior of the seasonally adjusted monetary aggregates and to provide a framework for analyzing certain kinds of short-run swings. The article will focus on variations caused by factors other than changes in basic underlying conditions in

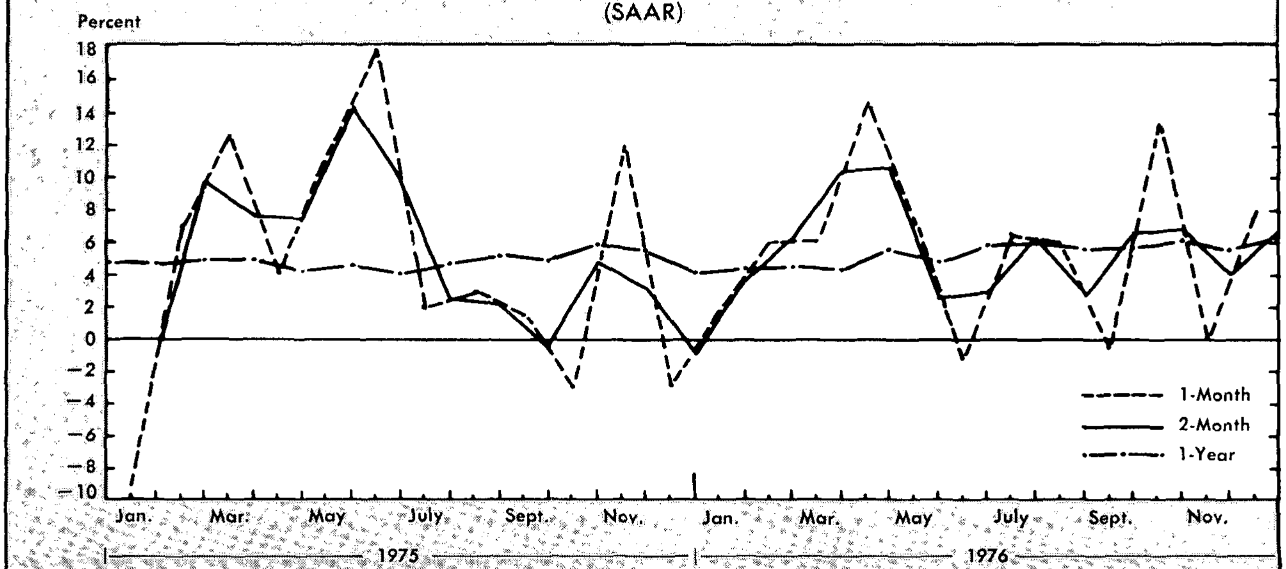
[4] As evidence of this expectational impact, the correlation coefficient between the change in M_1 announced Thursday and the change in the three-month Treasury bill rate the following day was .26 over the 52 weeks of 1976, which is statistically significant at the 5 percent level.

[5] Throughout this article, "preliminary" refers to the M_1 statistic first published covering a particular period. "Final" refers to the most recently revised statistic for a period. The emphasis will be on the preliminary data since it is the preliminary data to which both the Federal Reserve and the financial markets react.

Chart 1

PRELIMINARY SHORT-RUN M_1 GROWTH RATES COMPARED TO LONGER-RUN GROWTH RATES

(SAAR)



Note: All data are plotted in center of period to which they refer. One-year growth rates are based on latest revised data.

Source: Federal Reserve Bulletin.

Table I

STANDARD DEVIATIONS AND MEANS OF PRELIMINARY SHORT-RUN M_1 GROWTH RATES

(SAAR)

	One-Month Growth Rates		Two-Month Growth Rates	
	Standard Deviation	Mean	Standard Deviation	Mean
1967	6.7	6.6	4.0	6.6
1968	4.9	6.5	3.7	6.1
1969	3.6	1.9	2.1	2.1
1970	6.0	4.5	3.5	4.2
1971	6.5	6.1	5.5	6.3
1972	4.9	8.0	3.2	7.5
1973	5.1	5.6	4.1	5.4
1974	4.5	4.9	3.0	5.1
1975	7.7	4.7	5.4	4.7
1976	5.2	5.6	3.3	5.2
Average	5.5		3.8	

Source: Federal Reserve Bulletin.

the economy. As indicated in the sections that follow, these noneconomic factors are responsible for a substantial portion of the observed month-to-month and week-to-week variations in monetary growth rates. The next section of the article describes in general terms the various kinds of noneconomic factors that produce short-run movements in the preliminary M_1 data. Special attention is devoted to movements that result from the nature of the procedures currently used to seasonally adjust the data. The third section illustrates some of the points made in the second section with specific examples of factors affecting monthly M_1 growth rates in recent years. The fourth section provides further illustrations with reference to the weekly M_1 statistics. The final section contains a brief summary of the article and presents a few conclusions.

II.

Some Factors Affecting Short-Run Movements in Money Growth Rates: A General Description

This section will discuss in general terms some of the noneconomic factors that produce variations in seasonally adjusted short-run M_1 growth rates. Observed growth rates are no doubt related in some way to changes in economic conditions. But factors totally unrelated to current business conditions can cause significant variations in these growth rates. Special nonrecurring events can have an important effect on demand deposit balances in some cases over periods of several weeks. Moreover, seasonal adjustment techniques, despite notable improvements in recent years, are far from perfect. Over long periods, variations in the M_1 data related to both special events and seasonal adjustment problems should wash out. But factors such as these produce sharp fluctuations in short-run growth rates.

It will be useful in organizing the discussion to distinguish two classes of variations: (1) movements that result from shortcomings in the method currently used to seasonally adjust the data and (2) irregular variations due to special nonrecurring events. Each of these two categories of factors will be addressed in turn. The focus throughout this section is primarily on the monthly data.

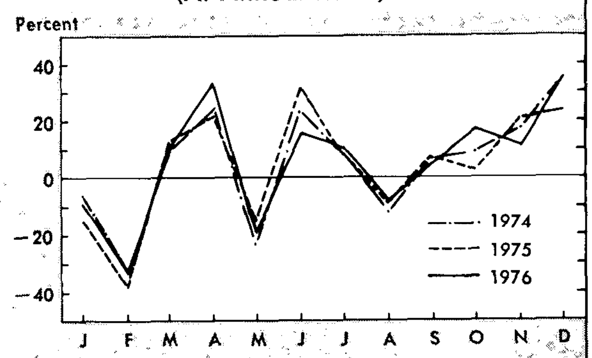
Variations Due to Deficiencies in the Seasonal Adjustment Procedures Chart 2 shows the annualized monthly growth rates of *not* seasonally adjusted M_1 in 1974, 1975, and 1976. It is evident from the chart that these growth rates are extremely variable, ranging from over 30% to under —30%, and that they are dominated by recurring seasonal movements. A glance at the chart suggests two of the major forces underlying this seasonal movement: tax dates—April, in particular, when individuals accumulate balances to pay income taxes—and the increased business activity during the Christmas season.

As described in Box I on p. 5, the M_1 data are seasonally adjusted with seasonal factors computed by the Bureau of the Census' X-11 Variant of the Census Method II Seasonal Adjustment Program (referred to below as X-11). Judgmental modifications are then made by the Federal Reserve staff in

Chart 2

NOT SEASONALLY ADJUSTED MONTHLY M_1 GROWTH RATES

(At Annual Rates)



Source: Federal Reserve Bulletin.

Box I

SEASONAL ADJUSTMENT OF THE MONEY SUPPLY: THE PROBLEM OF MOVING SEASONALS

As indicated in the text, money supply data are seasonally adjusted by the Federal Reserve staff using the Census Bureau's X-11 Variant of the Census Method II seasonal adjustment model, referred to below simply as X-11. Using unadjusted data for a period of years, this model generates a seasonal adjustment factor for each entry in the series: for example, for each individual month in a monthly series of money stock data. In determining the final seasonal adjustment factors actually employed in developing the published seasonally adjusted money supply series, the staff may alter the adjustment factors derived from the model where the staff's knowledge of special circumstances affecting the X-11 factors suggests such alterations are in order. What follows is a brief description of some of the problems encountered in applying X-11 to money supply data. (For a detailed description and analysis of Federal Reserve procedures used in seasonally adjusting the money supply, see the accompanying article by Lawler.)

Like most conventional seasonal adjustment procedures, X-11 assumes that the level of an unadjusted data series (call it M_{unad} in the case of monthly money supply data) at any point in time reflects the combined influence of four underlying determinants: long-term trend movements (T), cyclical movements (C), regularly recurring seasonal movements (S), and irregular movements (I). The version of X-11 used by the Federal Reserve assumes these four determinants are related to one another in a multiplicative, i.e., proportional, fashion:

$$M_{unad} = T \times C \times S \times I.$$

Within this general framework one can postulate two alternative conditions under which seasonal influences might affect the unadjusted money supply data: (1) a condition where the pattern of seasonal influences is constant from year to year and (2) a condition where the pattern changes from one year to the next. In the first case, the multiplicative or proportionate impact of seasonal influences on the unadjusted data is the same for any particular calendar month (say, January) over all of the years covered by the series. Under these conditions, any computed set of seasonal adjustment factors, S, for January, February, etc., respectively, should be constant over the full span of years covered by the series. In the second case, the proportionate impact of seasonal influences during a given calendar month changes over time. To reflect these changes computed seasonal adjustment factors for each calendar month should, in general, change from one year to the next.

X-11 has alternative operating modes designed to deal with each of these two sets of circumstances. As applied to any set of monthly data, the X-11 model is essentially a ratio-to-moving average seasonal adjustment procedure. This means that the seasonal adjustment factors are derived by developing ratios of (1) the unadjusted data for individual months (for example, June 1975) in the series to (2) an average of several months data centered on that month. Such a ratio is calculated for each individual month in the series. The seasonal adjustment factor for each individual month is then computed by averaging the ratio for that month with the ratios for several corresponding calendar months in other years. The two operating modes mentioned above enter the picture as follows. If the pattern of seasonal influences in the data is believed to be stable over time, a single seasonal adjustment factor is derived for each of the 12 calendar months from an average of **all** of the ratios for that calendar month over the full series. If the pattern is believed to be changing over time, a moving average of such ratios, covering a more abbreviated time span, is used to compute a distinct adjustment factor for each individual month in the series.

For the reasons given in the text, it is clear that the seasonal pattern of the unadjusted monthly money supply series is not constant but changes over time. Therefore the version of X-11 used to adjust the money supply data derives seasonal adjustment factors for each individual month in the series from a weighted 7-term moving average of the ratios in the corresponding calendar months of surrounding years. Where a month is in one of the terminal years of the series, the span of the moving average is reduced since data for a full centered 7-term moving average are not available. For example, the presently published adjustment factor for January 1973 (an example of what is called "final" data in the text) is derived from a weighted average of the January ratios for the years 1970-1976, inclusive. The presently published factor for January 1976 is derived from the four year period 1973-1976, inclusive.

It is important to note that under this procedure, the factors used to seasonally adjust incoming data during the **current** year—the all important "preliminary" data to which both the Federal Reserve and the markets react—are derived from ratios of preceding years and do not directly reflect any changes in seasonal patterns in the current year.* For example, the seasonal factor used to adjust the January 1973 figure when the figure was initially released in early February 1973 was derived from the January ratios for the years 1969-1972, inclusive. Therefore, if the seasonal pattern is in fact changing in the current year, it is particularly likely that the procedure will distort the preliminary, i.e., current, data. Ironically, this is precisely the data of greatest importance to Fed policymakers and the markets. The discussion in the text describes some of the distortions that arise and shows that these distortions are a source of seasonal movement in the seasonally adjusted money supply data.

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* Strictly speaking the weights attached to these preceding year ratios might implicitly cause the procedure to anticipate current year changes to a small extent.

an effort to compensate for some of X-11's deficiencies.[6] As indicated in the Box, the purpose of seasonally adjusting M_1 is to eliminate the impact of seasonal forces, leaving only trend, cycle and irregular movements. In practice, however, the influence of seasonal forces is often not eliminated from the preliminary seasonally adjusted M_1 data. A major reason for this residual seasonality is that X-11 necessarily relies solely on past data in calculating preliminary seasonal adjustment factors and therefore cannot take full account of changes in seasonal behavior currently in progress, despite the program's allowance for "moving" seasonals described in the Box.

A variety of developments can change the relative impact of seasonal events on the money supply in a particular month. First, there are changes in the *timing of seasonal events*. For example, in 1955 the final day for the payment of nonwithheld individual Federal income taxes was permanently shifted from March 15 to April 15. A contrasting example is the continuously shifting calendar position of the Easter holiday. Second, the *relative magnitude of a seasonal force* can change. The aggregate amount of individual or corporate taxes paid in a given month relative to the level of the money supply, for instance, might deviate from the usual norm. This deviation might be due either to a change in the total tax liability relative to M_1 or to a change in the distribution of payments over the various periodic tax payment dates within the year. Third, the *manner in which households and business firms manage their money balances* during periods characterized by recurring seasonal events can change. For example, improved corporate cash management practices have probably compressed the necessary lead-time for the accumulation of cash balances prior to scheduled tax payments. Finally, *new seasonal events* appear from time to time. In late 1972, for instance, the Federal government initiated sizable revenue-sharing payments at the beginning of each quarter.

The impact of these several changing seasonal forces on short-run seasonally adjusted M_1 growth rates is likely to vary, depending particularly on (1) whether the change is permanent or temporary and (2) if permanent, whether the change occurs gradually over a period of years or abruptly. Moreover, the impact of these changes on the preliminary (i.e., first published) adjusted data for a particular month is likely to differ from their impact on the final revised data for the month. The following paragraphs will elaborate these points.

Consider first the final data. As indicated in the Box, X-11 uses a seven-year weighted moving average of data centered on a given year in deriving final seasonally adjusted data for that year.[7] For this reason, the program is especially well suited to accommodating, after the fact, *gradual* changes in underlying seasonal patterns since the centered, seven-year moving average by its very construction should capture such changes. On the other hand, the program is not particularly well suited to dealing with permanent changes that occur abruptly. As an example, assume that a lasting change in some seasonal event affecting M_1 occurred abruptly in 1973. Here, even the final adjusted monthly data for 1973 might not adequately capture the change since the final data, derived from the seven-year centered moving average, would be based partly on experience during the years 1970, 1971, and 1972—all years preceding the change.

Consider next the more significant preliminary data. Regardless of whether a permanent change in underlying seasonal forces occurs gradually or abruptly, the preliminary adjusted growth rates are likely to be distorted in the sense that they will probably differ systematically from revised data published later. The reason for these distortions is that X-11 derives preliminary adjustment factors from actual data for years preceding the year in question. (See Box.) Consequently, the preliminary factors fail to capture the full effects of changes in underlying seasonal behavior. Such distortions are obviously significant since it is the preliminary adjusted M_1 data that condition current monetary policy and the behavior of the financial markets.

A couple of hypothetical examples might help to clarify the nature of these distortions. Suppose that beginning in 1980, the unadjusted growth rates of M_1 in the month of October began to display a *gradual* but persistent decline due, perhaps, to a

[6] See the accompanying article by Lawler for a description of these judgmental modifications. In making these modifications the staff faces many of the same difficulties anticipating changes in seasonal patterns encountered by the X-11 program itself. For this reason it is not clear that the modifications significantly improve the preliminary data. In any case, this article does not attempt to evaluate these modifications.

[7] The term "final" may be slightly misleading in that money supply data is always subject to further revision. The term is used here to refer to revised adjusted data available beginning in the fourth year following the year to which it applies. Such data is seasonally adjusted using adjustment factors that are derived from actual data for the full seven-year period covered by the seven-term moving average in the X-11 program.

decline in the relative volume of business sales in that month. Suppose further that this trend persisted through the year 1990. Under these circumstances, the X-11 seasonal adjustment factor used to compute the preliminary seasonally adjusted growth rate in, say, October 1985 would reflect the movement in M_1 in the years 1981-1984. Consequently, this preliminary factor would be biased upward and the preliminary seasonally adjusted growth rate would be understated.[8] In subsequent years the October 1985 growth rate would be revised upward. The preliminary growth rates for October in ensuing years, however, would continue to differ systematically from revised growth rates as long as the trend continued.

Consider next an *abrupt* future change in a seasonal event such as, for instance, a hypothetical change in the deadline for individual Federal income tax payments from April 15 to May 15. Suppose that such a change went into effect in 1986. In that case, beginning in 1986 the unadjusted growth of M_1 in April would be low while not seasonally adjusted growth in May would be high relative to the pattern in earlier years. Here, the preliminary seasonal adjustment factors for April and May 1986 would be based on M_1 behavior over the 1982-1985 period. Consequently, the preliminary adjusted growth rate for April 1986 would probably be unusually low, while the May 1986 growth rate would be significantly inflated. In the absence of further changes, however, the problem would tend to disappear by 1990 since by that year all of the data used in deriving the preliminary April and May adjustment factors would reflect the 1986 tax date change.

Beyond the more durable seasonal developments discussed to this point, temporary changes can also affect short-run seasonally adjusted monetary growth rates. As a final example, suppose that Federal tax payments by individuals were unusually large relative to the level of M_1 in April 1983, but that in 1984 and subsequent years, the payments fell back to more normal levels. In this case the preliminary seasonal adjustment factor for April 1983, which would be based on 1979-1982 experience, would be low relative to the level of the tax payments. Hence, in the absence of some other unusual event tending to depress growth, the preliminary seasonally adjusted M_1 growth rate for April 1983 would be relatively high. Further, the final revised data for this month would also show a relatively high growth rate under these circumstances.

It should be clear from this discussion that the procedure presently used to seasonally adjust monetary data is itself an important potential source of short-run variations in adjusted monetary growth rates.

Irregular Variations In addition to the effects of changing seasonal patterns working through the seasonal adjustment procedures, short-run M_1 growth rates are also strongly influenced at times by irregular, nonrecurring events. In contrast to seasonal movements no effort is made to remove such irregular movements from the adjusted M_1 data. While the events underlying these movements are not always fully understood, in many instances the explanation is straightforward. One of the best examples of a large irregular movement in recent years was the bulge in M_1 in May and June 1975 following the $9 billion disbursement of tax rebates and supplemental social security payments by the Treasury to the public.[9]

It should be noted parenthetically that the distinction between (1) irregular movements and (2) the movements discussed above reflecting temporary changes in seasonal forces is not always clear. In the preceding section the example used to illustrate temporary seasonal forces was unusually large individual tax payments in one year. Some analysts might prefer to regard such an occurrence as an irregular event. The criterion adopted in this article is that events that recur with some definite periodicity are seasonal in nature, while other events are irregular. Whatever the distinction in principle, in practice both categories of events are likely to produce short-run movements in the seasonally adjusted M_1 data. As indicated above, the X-11 program is unlikely to remove the effects of temporary changes in seasonal patterns from the seasonally adjusted data, and irregular movements are left in the adjusted series by design.[10]

The following section illustrates the foregoing discussion with specific empirical examples from recent experience.

[8] The X-11 program does contain an adjustment designed to correct partially for trend changes in seasonal behavior. See [7, p. 16]. As long as the changes continue at roughly the same pace, however, the correction will be only partial, and the bias discussed in the text will persist.

[9] See Breimyer and Wenninger [2] for empirical evidence on the impact of the rebates on seasonally adjusted monthly M_1 growth rates in 1975.

[10] It might be added that both irregular movements and movements due to temporary changes in seasonal forces can present additional problems if they are mistakenly treated as permanent changes in seasonal patterns by the X-11 program. In addition, computed seasonal adjustment factors might be distorted by cyclical developments. See Lawler [3, p. 24] and Poole and Lieberman [6, pp. 325-334].

III.

Factors Affecting Short-Run Money Growth Rates: Some Empirical Examples

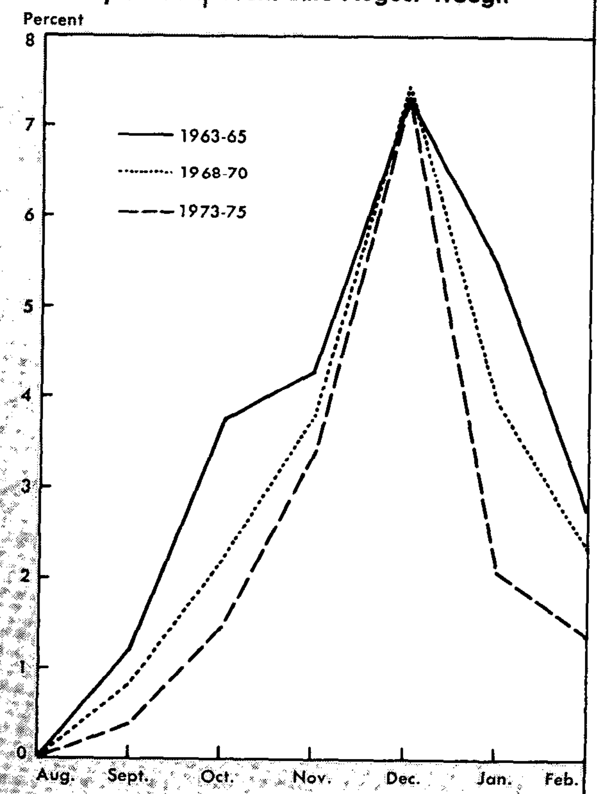
Gradual Changes in Seasonal Patterns: The Christmas Cycle As shown in Chart 2, the unadjusted growth rate of M_1 typically rises in the months prior to Christmas and falls in the months following Christmas. This pattern presumably reflects the rising demand for transactions balances associated with increased business activity prior to the holiday and the reduced need for such balances after the holiday. The behavior of unadjusted M_1 during this period forms a regular "Christmas cycle" that appears to begin as early as late August, peaks in the first week of January, and reaches a trough in late February.[11] The net increase from the late August trough to the late February trough generally is roughly equal to the trend rate of M_1 growth. Hence, the cycle is complete in the sense that the pre-Christmas seasonal rise has washed out by the end of February.

As suggested by Chart 3, the shape of the Christmas cycle has undergone a substantial and fairly continuous change since the mid-1960's, despite the fact that the typical percentage rise from the August trough to the January peak has been fairly stable. In particular, the cycle has become narrower towards the base, so that a greater part of the pre-Christmas rise now occurs in the November-December period, and a greater part of the post-Christmas runoff occurs in January. This information is conveyed in a different way in Table II, which shows that the increase in the percentage of the post-Christmas runoff occurring in January has been remarkably persistent over the longer run. Similarly, except for 1976, the percentage of the pre-Christmas rise occurring in November and December has risen quite steadily.

Chart 3

THE CHRISTMAS CYCLE

Percentage Increase in Not Seasonally Adjusted M_1 From Late August Trough



Note: Percentage increases are derived from last-week-of-the-month data. Each of the lines in this chart is drawn on the basis of averages of monthly data for the indicated years.

Source: Federal Reserve Board Release, H.6.

[11] Of course, other seasonal forces affect the movement of unadjusted M_1 in this period. Christmas, however, appears to dominate the pattern of the unadjusted data over these months.

Table II

THE CHANGING SHAPE OF THE CHRISTMAS CYCLE

	% of Rise in NSA M_1 Occurring in Nov.-Dec.	% of Decline in NSA M_1 Occurring in Jan.
1961	50.5	51.7
1962	51.3	47.9
1963	47.5	40.8
1964	48.8	41.0
1965	50.1	40.5
1966	61.9	63.4
1967	62.9	62.7
1968	67.5	67.3
1969	73.1	60.7
1970	71.6	81.4
1971	70.5	81.9
1972	71.7	77.7
1973	75.2	90.2
1974	77.6	87.0
1975	90.8	86.5
1976	62.7	82.6

Source: Federal Reserve Board Release, H.6.

Table III

SUCCESSIVE REVISIONS OF JANUARY M_1 GROWTH RATES

(SAAR)

	Published Growth Rates for							
As of:	1970	1971	1972	1973	1974	1975	1976	1977
1970	9.0							
1971	9.4	1.1						
1972	9.2	2.8	3.7					
1973	10.3	2.7	1.0	0.0				
1974	10.4	3.3	1.5	4.7	−3.1			
1975	10.9	4.3	3.1	5.2	−2.7	−9.3		
1976	9.2	5.5	8.2	9.4	3.5	−5.1	1.2	
1977	9.2	5.5	9.2	10.3	4.4	−4.2	2.0	5.4
Cumulative Revision	+.2	+4.4	+5.5	+10.3	+7.5	+5.1	+.8	

Note: Diagonal shows preliminary growth rates for each year.

Source: **Federal Reserve Bulletin.**

The gradual change in the shape of the Christmas cycle since the mid-1960's has probably been due at least in part to the steady rise in interest rates during this period. As Table II indicates, the cycle began to change in 1966, the year interest rates began their strong upward trend. The underlying logic here is straightforward. Higher interest rates have made it progressively more costly for business firms and households to hold M_1 balances rather than alternative, interest-bearing assets. Hence, the buildup in M_1 balances prior to Christmas has been progressively delayed. Further, after Christmas the public has attempted to convert the M_1 balances acquired during the holiday period into interest-earning assets with greater speed. These efforts to economize on M_1 balances have probably been aided by the proliferation of credit cards and a variety of other financial instruments permitting improved cash balance management.

Whatever the cause, the gradually changing shape of the Christmas cycle has had a large impact on the seasonal adjustment factors for some of the Christmas cycle months. First, the final revised factors for these months have changed continuously from one year to the next since the mid-1960's. For example, the January factor has declined steadily since 1965. More importantly, the preliminary factors and the preliminary adjusted growth rates for these months in recent years have been substantially revised with the passage of time. Consequently, the preliminary reported growth rates for these months have been notably unreliable during the last several years. This is illustrated in Table III which compares the preliminary January seasonally adjusted growth rates with successive revisions. The cumulative revisions have been very large, frequently increasing the January growth rates by more than 5 percentage points and in one case by more than 10 percentage points. While a small part of these revisions might be unrelated to seasonal adjustment, it is clear that the preponderant share are due to revisions in the seasonal adjustment factors. The direction of the January revisions is consistent with the changing shape of the Christmas cycle. As data for succeeding years becomes available, the progressively more rapid decline in M_1 following the early January peak produces a lower January adjustment factor and a higher adjusted January growth rate.[12]

Abrupt Changes in Seasonal Patterns: The Rise in Federal Income Tax Refunds Due to heavy overwithholding of Federal income taxes, the Treasury typically pays out sizable tax refunds to individuals during the first half of the year, primarily in the period from March through May. Since a large portion of these funds are initially deposited in demand deposits, they affect the level and growth rate of not seasonally adjusted M_1. For several years prior to 1973, the time profile of these disbursements was relatively stable, as was the total amount relative to the outstanding money supply. Consequently, the seasonal impact of the refunds on M_1 was probably adequately captured by the X-11 seasonal adjustment factors.

[12] Another example of a long-run trend in a seasonal force that had a large impact on a monthly seasonal factor was the rapid growth in nonwithheld individual income taxes paid in April, relative to the money supply, between the mid-1950's and the mid-1960's. This growth in tax payments caused a steady rise in not seasonally adjusted April M_1, resulting in gradual progressive increases in the April adjustment factor. See Lawler [3, p. 25].

Table IV

INDIVIDUAL INCOME TAX REFUNDS

As a Percent of M_1

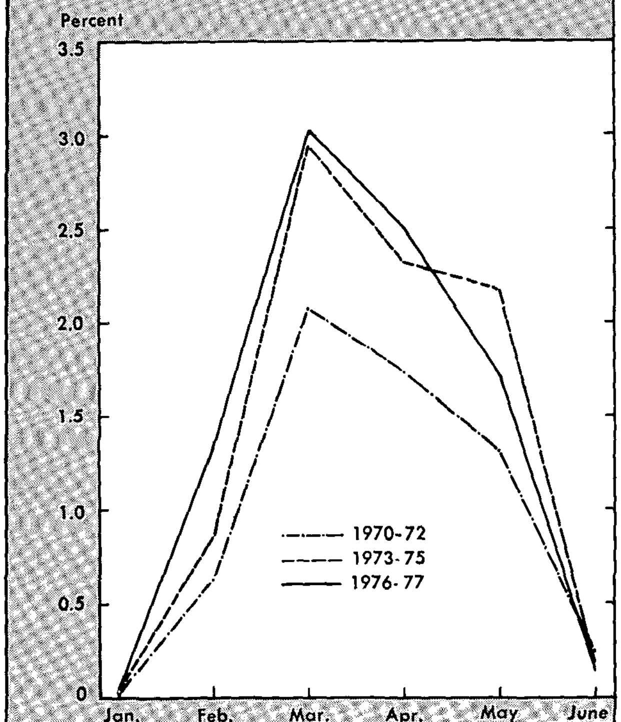
1968	4.9	1973	8.4
1969	4.9	1974	8.5
1970	6.2	1975	9.0
1971	6.4	1976	9.0
1972	5.9	1977	9.0

Note: Ratios are total tax refunds for the year divided by not seasonally adjusted level of M_1 in December of the preceding year. The figure for 1977 is an estimate.

Source: **Federal Reserve Bulletin.**

Chart 4

FEDERAL INCOME TAX REFUNDS RELATIVE TO NOT SEASONALLY ADJUSTED M_1



Note: Each point on the chart indicates the ratio of the level of refunds in the current month to the level of not seasonally adjusted M_1 in the preceding month.

Data for 1975 do not include the tax rebates disbursed in that year.

Source: Federal Reserve Bulletin and Federal Reserve Board Release, H.6.

In 1972, however, increased withholding for numerous individual taxpayers went into effect, causing a sharp increase in refunds from $14 billion in 1972 to $22 billion in 1973. As indicated in Table IV, the result was an abrupt jump in total refunds from about 6 percent of M_1 to roughly 8½ percent of M_1. Chart 4 shows the monthly profile of the tax refunds relative to M_1 in the years following 1972 compared to the pattern in the 1970-72 period. The monthly profile of the disbursements was very similar (1) in the years 1973, 1974, and 1975 and (2) in 1976 and 1977. Consequently, these two sets of years are grouped together in Chart 4.

Presumably, the abrupt increase in the level of refunds in 1973 altered seasonal patterns as between the 1970-1972 period on the one hand and the post-1972 period on the other. Specifically, the seasonal growth of not seasonally adjusted M_1 in the March-June period has probably been stronger in the latter years.[13] On the basis of the discussion of the X-11 model in the preceding section of this article, one might expect this shift to distort the preliminary seasonally adjusted M_1 growth rate over the March-June period in 1973, since this growth rate was calculated using seasonal adjustment factors based on data through 1972 only. More specifically, one would expect X-11 to produce an upward bias in the preliminary growth rate over this period in 1973, leading to downward revisions as additional high refund years were use to calculate the 1973 seasonal adjustment factors.[14] (As suggested in Section II, however, even the final adjusted 1973 data might reflect the abrupt surge in refunds to some extent since the final adjustment factors are based partly on pre-1973, low-refund year experience.) The same general process should affect the 1974 and 1975 data.

In fact, the preliminary growth rates over the March-June period in the years 1973, 1974, and 1975 have been significantly reduced by subsequent revisions. Annualized, seasonally adjusted M_1 growth from a base comprising the average of the January and February figures to a terminal value comprising the average of the four months March through June has been revised downward on average by 2.49 percentage points for these years, a fairly dramatic indication of the magnitude of M_1 revisions that can occur. It shows that the average revision of the M_1 growth rate over this period was in the neighborhood of the typical 2 to 2½ percentage point range between the upper and lower limits of the FOMC's longer-run M_1 growth targets.

The precise implications of these downward revisions, however, is clouded by the fact that they might have been influenced by benchmark revisions and by *ad hoc* judgmental adjustments made by the

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[13] June is included, even though the bulk of the refunds are paid before June, for two reasons. First, there is normally a lag between the receipt of refunds and their expenditure or conversion to other financial assets. Consequently, the daily average level of M_1 balances in June is likely to be affected by refund disbursements in May. Second, refund checks mailed in May (the refund data are reported on a mailing date basis) may not actually be cashed until June.

[14] Note that the increase in the level of refunds tends to increase the daily average level of not seasonally adjusted M_1 in each of the four months of the March-June period. Therefore, the impact of the refunds on any individual month's growth rate depends on the profile of the refund flow. The discussion in the text refers to growth over the entire March-June period: i.e., the increase in the daily average level of M_1 for the four-month March-June period over the average daily level for some base period.

staff of the Board of Governors as well as by changes in the underlying X-11 seasonal adjustment factors. In order to abstract from these other factors, comparable growth rates were calculated using the factors generated by the X-11 model without any modification. First, unmodified X-11 seasonal adjustment factors were calculated using data through 1972, and these factors were then used to develop a "preliminary" growth rate for the March-June 1973 period (over a January-February 1973 base). Preliminary March-June growth rates for 1974 and 1975 were derived in a similar manner. These preliminary growth rates were then compared to "final" growth rates for the same periods derived from unmodified X-11 factors computed using data through 1976. The implied revisions are —1.70 percentage points in 1973, —1.56 percentage points in 1974, and —1.06 percentage points in 1975—an average revision of —1.44 percentage points. This analysis suggests that successive changes in the underlying X-11 factors contributed heavily to the revision in the published M_1 data summarized in the preceding paragraph.[15]

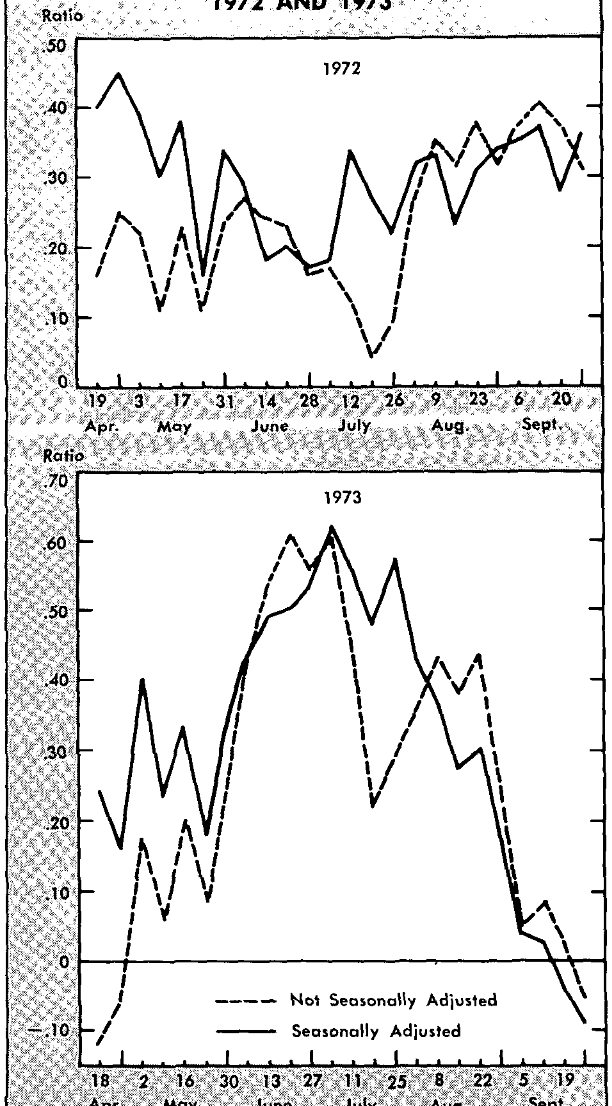
To this point the discussion has centered on the impact of the increased tax refunds on the preliminary seasonally adjusted M_1 data over the March-June period. More broadly, there is evidence that the increased refunds in conjunction with the X-11 model generally biased the preliminary seasonally adjusted growth rates upward in the second quarter and downward in the third quarter in 1973 and subsequent years. Chart 5 shows the week-to-week movements of a ratio of three-month M_1 growth to longer-run trend growth on both a (preliminary) seasonally adjusted basis and an unadjusted basis. The upper panel of the chart shows the movements in 1972, just prior to the abrupt increase in the refunds. The lower panel shows the movements in 1973, just after the increase in the refunds. If the increased refunds together with the X-11 model have in fact produced the biases mentioned above, one would expect a greater degree of (in this particular case positive) correlation between the unadjusted and adjusted movements of the ratio in 1973 than in 1972. The chart indicates rather clearly that the correlation is indeed considerably greater in 1973 than in 1972. Specifically, the correlation coefficient is .70 in 1973 compared to —.22 in 1972.

[15] It is possible that these results are influenced to some extent by the June 1975 tax rebate payments. Excluding June from the analysis, however, does not greatly alter the results.

Temporary Changes in Seasonal Patterns In addition to relatively durable changes in seasonal patterns, temporary changes in the timing and relative magnitude of seasonal forces can also affect

Chart 5

WEEKLY MOVEMENTS OF RATIO OF THREE-MONTH M_1 GROWTH TO TREND M_1 GROWTH NOT SEASONALLY ADJUSTED AND SEASONALLY ADJUSTED 1972 AND 1973



Note: Each point plotted is calculated as

$$\frac{W_t - W_{t-13}}{W_{t+26} - W_{t-26}}$$

where W_t is the level of M_1 in the current week.

Source: Federal Reserve Bulletin and Federal Reserve Board Release, H.6.

seasonally adjusted M_1 growth rates.[16] Although X-11 attempts to take account of lasting changes in the profile of seasonal forces influencing M_1 through the construction of moving adjustment factors, the model is simply not designed to deal effectively with temporary changes in these forces. Basically, the model treats such changes as though they were irregular movements in the not seasonally adjusted data. Consequently, most of their impact is probably passed on to the seasonally adjusted data. For example, since there is a positive relationship between the relative magnitude of April tax payments and the unadjusted M_1 growth rate in April, unusually large April tax payments in a given year probably tend to inflate the seasonally adjusted April M_1 growth rate in that year.

A somewhat more esoteric example involves the timing of April tax collections by the Treasury. Individuals generally pay nonwithheld income taxes by check. Many of these checks are mailed close to the April 15 deadline. Individuals typically accumulate the balances needed to cover these checks at the time they are mailed, but the Treasury often takes two or three weeks to process the checks. Because of the huge sums involved, even a small variation in processing time can significantly affect average daily M_1 balances in April and seasonally adjusted April M_1 growth rates.[17]

A final example is a recent change in the procedures surrounding monthly social security retirement and survivors benefit (SSA) disbursements. Prior to mid-1976 all of these disbursements were made by check. The checks were usually posted so that they would reach their recipients on the third of the month. When the third fell on a Saturday, payment was made on that day even though some financial institutions are closed on Saturdays. If the third fell on a Sunday, payment was made on the preceding Saturday. In mid-1976 this schedule was changed in conjunction with the introduction of facilities permitting the direct deposit of some of these disbursements through electronic media. Specifically, payments are now made on the preceding Friday when the third falls on either a Saturday or a Sunday.[18] Since a sizable portion of the disbursements are converted into M_1 balances, these changes in payment schedules have altered the seasonal behavior of not seasonally adjusted M_1 in these months for two reasons. First, the timing of the payments with respect to calendar dates has changed compared to earlier years. Second, since the payments are now made prior to rather than after a holiday or a weekend, the funds are likely to be held in the form of M_1 balances for a longer period (specifically the one or two days of the holiday or weekend) before being spent or converted into other financial assets, thereby raising average daily balances and growth rates. Again, to the extent that these changes are ignored by seasonal adjustment procedures, they are likely to affect seasonally adjusted M_1 growth rates.[19]

It is interesting to note that all of the conditions described in these examples were present in April 1977 when M_1 grew at a record annual rate of 19.7 percent. First, individual nonwithheld tax payments were larger relative to the level of M_1 than in any other year since the Treasury began publishing these data in 1954. Second, Treasury processing of these payments appears to have been considerably slower than in the three preceding years perhaps due to the magnitude of the payments.[20] Third, April 3 fell on a Sunday so that social security payments were made on Friday, April 1. Finally, April tax refunds were unusually high, as shown earlier in Chart 4. These observations are not intended to imply that these factors explain all or even most of the unusually large preliminary April 1977 M_1 growth rate. They do illustrate, however, how temporary changes in seasonal forces can cloud the meaning of a specific preliminary monthly M_1 growth rate.

Irregular Movements in M_1 The factors contributing to short-run variations in seasonally adjusted M_1 growth rates discussed thus far have all been related to changes in the underlying determinants of the seasonal behavior of M_1. Irregular movements in seasonally adjusted growth rates, in contrast, result from special or unusual events. Sometimes these events can be identified and anticipated. More often, unfortunately, they are neither identifi-

[16] As indicated in Section II of this article, the distinction between (1) temporary changes in seasonal patterns and (2) irregular movements in not seasonally adjusted data is not always clear. Consequently, the choice of examples in this and the following subsections is somewhat arbitrary.

[17] See Auerbach [1].

[18] These changes apply not only to direct deposits but also to payments by check, which continue to account for well over half of total payment volume.

[19] The third has fallen on a nonbusiness day three times since the schedule change went into effect: October 1976, April 1977, and July 1977. The preliminary seasonally adjusted M_1 growth rates (at annual rates) for these months were 13.7 percent, 19.7 percent, and 18.3 percent, respectively. These growth rates exceeded both trend growth and other monthly growth rates during the post-change period by wide margins. It is likely that the change contributed to these high growth rates, although the extent of the effect cannot be specified precisely.

[20] This statement is based on a comparison of tax collections in April and in early May, respectively, using data published in the *Treasury Bulletin*. (The collection date is the date on which the Treasury actually clears a check.) This comparison indicated that a significantly higher proportion of total collections in 1977 occurred in May as opposed to April than in the three preceding years, strongly suggesting slower processing in 1977.

able nor foreseeable. Consequently, movements in seasonally adjusted M_1 growth rates due to irregular events resemble variations resulting from changes in seasonal forces in that they complicate the conduct of monetary policy by making it difficult to distinguish fundamental changes in the trend or cyclical growth rate of M_1 from some transitory change.

As suggested above, the most obvious recent change in M_1 growth caused by an irregular event was the sharp acceleration in May and June 1975 due to the $9 billion of tax rebates and supplemental social security benefits paid during those months. In hindsight, it seems clear that while the FOMC expected these payments to enlarge growth rates over this period, the full magnitude of the impact was not anticipated. As a result, the FOMC appears to have concluded that the acceleration was attributable to a considerable extent to the expansion of business activity just beginning to gather steam at that time and put upward pressure on the Federal funds rate in order to restrain it. The M_1 growth rate dropped abruptly in July, however, and remained minimal for several months, prompting the Committee to reduce the funds rate to its pre-rebate level in October and November.[21]

A number of other recent swings in short-run seasonally adjusted M_1 growth rates can be linked to specific nonrecurring events. For example, the −3.2 percent rate of decline in December 1975 almost certainly resulted partly from the change in Federal Reserve Regulations Q and D permitting business firms to hold savings deposits. But while it is often possible to evaluate irregular variations in M_1 growth in terms of specific events such as these after the fact, it is extremely difficult in most cases to specify the probable impacts on short-run growth rates in advance with any degree of quantitative precision. Obviously the absence of such information makes the proper monetary policy response problematic even when the event is anticipated.

[21] The policy record for the FOMC meeting held May 20, 1975, refers explicitly to the Committee's recognition that short-run M_1 tolerance ranges in the May-June period should be relatively liberal to allow for the rebate effect. The range was set at 7 to 9½ percent. The actual (preliminary) growth rate for the two-month period was 14.4 percent. See Board of Governors of the Federal Reserve System, *Annual Report*, 1975, p. 197. This episode was later reviewed by Chairman Arthur Burns of the Federal Reserve in testimony before the Senate Budget Committee March, 1977:

"As events actually unfolded in May and June of 1975, the rise that took place in the money supply was much larger than the Federal Reserve staff had estimated would occur as a result of the rebate program. The inference we drew was that the demand for money was expanding rapidly quite apart from the rebate program. We therefore took mildly restrictive action toward the end of June to reassure the Nation that the Federal Reserve would not countenance monetary expansion on a scale that might release a new wave of inflation. Differences of judgment existed then—and still do—as to the appropriateness of that mild tightening action. Let me say only that if we erred, the mistake was technical in origin—that is, it grew out of the difficulty in making good estimates of the tax-rebate impact on deposit growth. In any event, monetary growth rates soon moderated, and we lost very little time in returning to an easier monetary stance."

IV.
The Weekly Data

Up to this point this article has focused on short-run movements in the *monthly* M_1 growth rates. The Federal Reserve also publishes seasonally adjusted *weekly* M_1 data. These data take the form of daily average balances over Federal Reserve "statement" weeks, which run from Thursday through Wednesday, inclusive. This section will extend the preceding discussion by describing some of the factors that influence the weekly behavior of M_1.

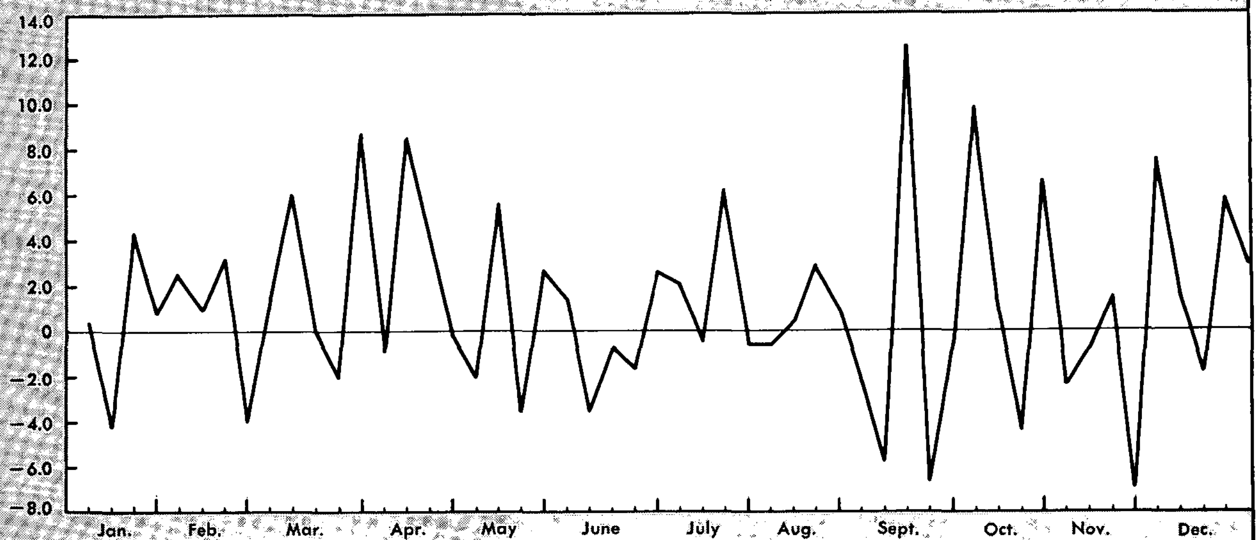
The first point that needs to be made about the weekly M_1 data is that they are exceedingly volatile: the change in M_1 this week—whether measured in dollars or as a percentage growth rate—is likely to be very different from the change next week. Chart 6 provides a visual demonstration of this point using preliminary 1976 data. Each point on the graph shows the ratio of the dollar change in seasonally adjusted M_1 during a given week to a moving 53-week average of weekly changes centered on that week. As the chart indicates, there are both wide variations in weekly growth over the year as a whole and, in many instances, sharp fluctuations from one week to the next.

Chart 6 suggests that there is little if any systematic relationship between weekly changes in the level of M_1—viewed either individually or over a period of several weeks—and longer-run trends in the rate of M_1 growth. Nonetheless, as pointed out in the introduction to this article, the FOMC's current procedures for implementing monetary policy tend to focus the attention of both policymakers and financial market participants on the weekly data. Apart from these procedures, though, the simple fact that the most recent weekly M_1 figure is usually the latest information available regarding monetary developments quite naturally stimulates interest. The remainder of this section attempts to provide some perspective for evaluating the informational content of the weekly statistics. In general, the same kinds of factors that produce variations in the seasonally adjusted monthly M_1 data also produce variations in the seasonally adjusted weekly M_1 data. Abstracting again from fundamental changes in underlying economic conditions, these factors are: (1) irregular events and (2) changes in the timing and magnitude of seasonal movements not captured by the seasonal adjustment factors used to adjust the data.

Chart 6

RATIO OF WEEKLY M_1 CHANGES TO MOVING AVERAGE OF WEEKLY CHANGES

1976



Note: Weekly changes in seasonally adjusted M_1 are divided by a centered 53-week moving average of weekly changes.

Source: Federal Reserve Board Release, H.6.

Box II

SEASONAL ADJUSTMENT OF THE WEEKLY M_1 DATA

The technique used to seasonally adjust the weekly M_1 data is essentially an extension of the procedure used to develop monthly seasonal adjustment factors. Indeed, the weekly adjustment factors are derived directly from the seasonally adjusted monthly data as follows. **First,** the adjusted monthly data are centered at mid-month, and a provisional seasonally adjusted level for each statement week* is derived by interpolation of the monthly series. **Second,** so-called "original" ratios of the unadjusted weekly data to the provisional adjusted weekly data are derived for each statement week, and, through interpolation of these statement week ratios, "offset" ratios are derived for weeks ending on days other than a Wednesday. Following these calculations, a ratio exists for each individual day in the entire data series, covering the calendar week ending on that day. **Third,** a weighted moving five-year average of these ratios is calculated for each statement week in the series. This calculation uses the ratio for the statement week in question along with the "original" or, where necessary, the "offset," ratios for corresponding calendar weeks in the four surrounding years, with truncation of the average for terminal years in the series. For example, the weighted average used in calculating the currently published factor for the statement week ending March 7, 1973, is based on the ratios for the calendar weeks ending March 7 in the years 1971-1975, inclusive. The average used in calculating the currently published factor for the statement week ending March 3, 1976, is based on the ratios for corresponding weeks in the years 1974-1976, inclusive.) This third step is designed to take account of moving weekly seasonality and resembles the procedure used to take account of moving seasonality in the derivation of the monthly factors. (See Box I on p. 5.) **Fourth,** the average of the weekly ratios for a given calendar month is adjusted to approximate closely the corresponding monthly seasonal adjustment factor. **Fifth,** these ratios are judgmentally adjusted by the Federal Reserve staff. It should be clear even from this brief summary that the weekly seasonal adjustment factors are subject to the same kinds of limitations as the monthly adjustment factors and for roughly the same reasons.

* Statement weeks are Federal Reserve reporting weeks running from Thursday through the following Wednesday.

Irregular Events As we have seen, irregular events can have a sizable effect on monthly M_1 growth rates. They can also have a marked impact on the weekly data, particularly if the event is of relatively short duration. Two illustrations from recent experience are relevant. In late January 1977, the eastern and midwestern portions of the United States experienced the most severe winter weather in several decades, disrupting production and sales activity in these areas. Seasonally adjusted M_1 fell a total of $3.0 billion over the two statement weeks ending January 26, compared to declines of only $100 million and $700 million in the corresponding periods in 1976 and 1975, respectively. It is likely that the unusual weather was partly responsible. More recently, there was a precipitous $5.0 billion increase during the statement week ending July 20, 1977. The magnitude of the rise contrasted sharply with the moderate growth typical of mid-July. While the full explanation for this increase is unclear, the July 13 power failure in New York City, which disrupted interbank settlements there, may have been a contributing factor. While it is sometimes possible to anticipate irregular events such as these, they are more often not anticipated, leading in some instances to substantial market reactions.

Changes in the Magnitude and Timing of Seasonal Gains As in the case of the monthly data, short-run swings in the adjusted weekly data are also caused by changes in the magnitude and timing of seasonal movements not captured by the seasonal adjustment factors. "Distortions" of the adjusted weekly data of this sort result from inherent deficiencies in the procedures used to derive weekly seasonal adjustment factors similar to those discussed in Section II of this article with respect to the derivation of the monthly adjustment factors. (The procedure for seasonally adjusting the weekly M_1 data is outlined briefly in Box II on p. 14.) There is evidence that the distortion of the preliminary adjusted weekly data due to these deficiencies is sizable. The results of one recent study suggest that the mean absolute revision of the preliminary adjusted data, expressed in terms of annualized growth rates, is on the order of 13 percentage points.[22] Two specific cases are discussed below.

Easter Week Since the week containing the Easter holiday varies from year to year over an approximately four calendar week span, the timing of this seasonal influence on the unadjusted weekly M_1 data also shifts. The weekly seasonal adjustment procedure described in the Box makes no allowance for these shifts.[23] Consequently, one would expect that the seasonal adjustment factor for the week containing Easter would typically be too small, and, correspondingly, the reported seasonally adjusted M_1 level in that week would be too large. The data in Table V tend to support this assertion. Each entry in the table is the ratio of the seasonally adjusted M_1 level for the indicated week to a five-week average of weekly levels centered on that week. Ratios are reported for the Easter week and the two surrounding weeks in each of the last ten years. In five of the years, the Easter week ratio is the largest of the five ratios. It is the second largest in four of the remaining five years, strongly suggesting a systematic upward bias affecting that week.

Table V

RATIO OF WEEKLY M_1 LEVEL TO CENTERED FIVE-WEEK AVERAGE IN WEEKS SURROUNDING EASTER

(Seasonally Adjusted Data)

	Week 1	Week 2	Week 3*	Week 4	Week 5	Date of Easter Sunday
1968	0.999	0.998	1.009	0.997	0.995	April 14
1969	0.997	0.998	1.011	1.005	0.996	April 6
1970	0.992	0.990	1.018	1.005	0.999	March 29
1971	1.001	1.008	1.006	0.997	0.990	April 11
1972	1.000	0.997	1.003	1.001	0.998	April 2
1973	1.000	1.003	0.994	1.001	1.000	April 22
1974	1.001	1.000	1.003	1.000	0.998	April 14
1975	0.999	0.999	1.000	1.001	1.000	March 30
1976	0.998	1.005	1.004	0.996	0.998	April 18
1977	0.991	1.005	1.004	0.999	1.004	April 10

* Includes Easter Sunday.

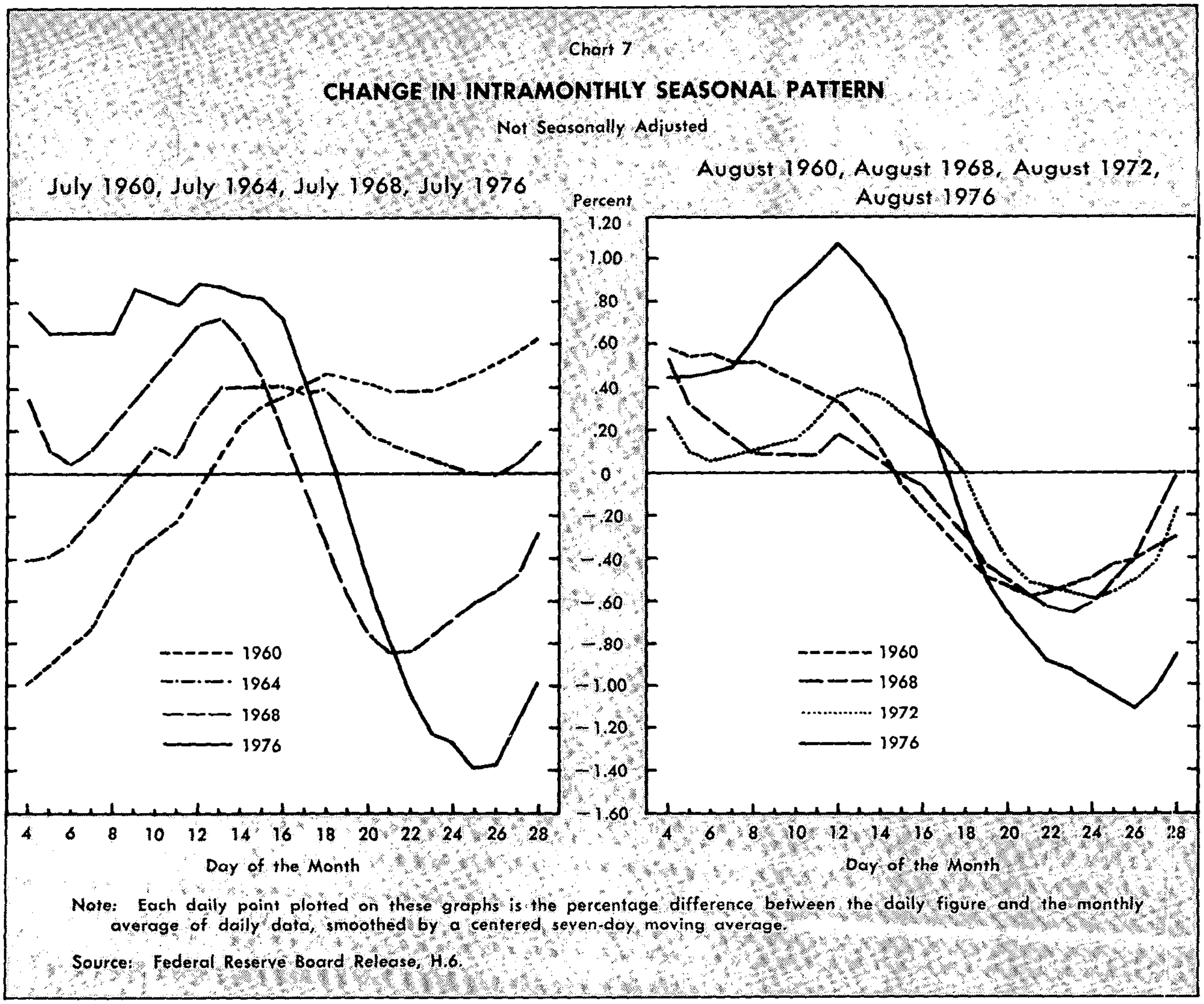
Note: Ratios are calculated using preliminary data.

Source: **Federal Reserve Bulletin.**

Changes in the Intramonthly Seasonal The second example involves the effect of a somewhat more general phenomenon on the behavior of the seasonally adjusted weekly data: namely gradual changes in the seasonal behavior of the unadjusted data *within* a calendar month. To the extent such change does in fact occur, it would tend to introduce an intra-

[22] See Wood [7], especially Table II.

[23] Since the week containing Easter is known well in advance, its seasonal effect on the weekly M_1 data could presumably be anticipated through judgmental adjustments to the preliminary seasonal adjustment factors. The evidence summarized in Table V, however, indicates that if judgmental adjustments have been made, they have not been adequate.



monthly seasonal movement into the preliminary adjusted weekly data in a manner analogous to the impact of the Christmas cycle on the adjusted monthly data.[24]

There is ample evidence that intramonthly seasonal patterns change. The two panels of Chart 7 depict the intramonthly pattern of the not seasonally adjusted M_1 data during four separate years spanning a 16-year period for the months of July and August. These months were selected since they are less influenced than other months by tax dates and other events that might obscure the evolution. While this evolution has by no means proceeded at a steady pace, a careful examination of both panels of this chart suggests that there is now relatively greater strength in the data during the first half of the month and a sharper decline during the second half. Comparable data for other months suggest that a similar change may be occurring in these months.[25] While this evolution is not as neat and persistent as the similar gradual change in the Christmas cycle affecting the monthly data, it does appear to be influencing the behavior of the adjusted weekly data. Chart 8 provides evidence supporting this contention. The chart shows the average change in preliminary seasonally adjusted M_1 for statement weeks ending on a given calendar day of the month over the 12 months of 1976, smoothed by a moving average. The chart clearly indicates an upward bias in the seasonally adjusted movement of M_1 in the first half of the month and a downward bias in the second half of the month, a pattern consistent with the evolution of the

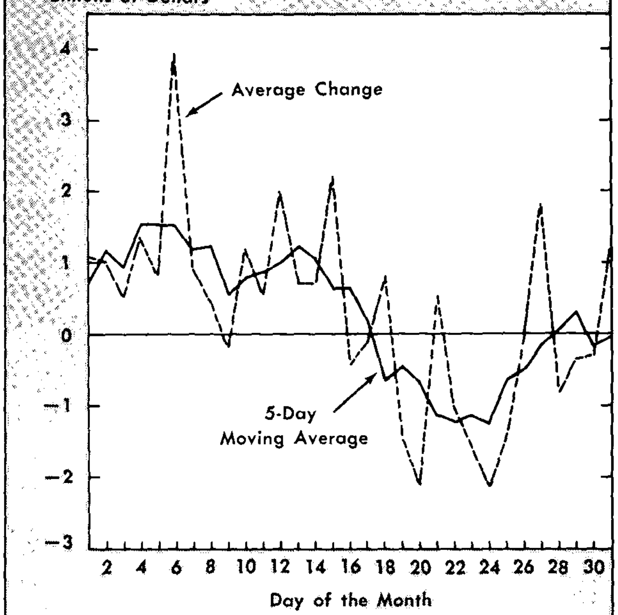
[24] See Section III, pp. 8-9.

[25] The cause of this evolution is not entirely clear. Systematic changes in the intramonthly pattern of Treasury disbursements and receipts, however, are in all likelihood an important contributing factor.

Chart 8

WEEKLY CHANGES IN SEASONALLY ADJUSTED M_1 BY STATEMENT WEEK DATES

1976



Note: The dotted line is the average change in the seasonally adjusted money supply for all statement weeks in 1976 that ended on the day plotted. The solid line is a centered 5-day moving average of the points on the dotted line.

Source: Federal Reserve Board Release, H.6.

intramonthly pattern of the not seasonally adjusted data illustrated in Chart 7.

V.

Conclusion

This article has attempted to identify and explain some of the factors that produce the high degree of observed variability in short-run seasonally adjusted M_1 growth rates. Some of this variability undoubtedly results from fundamental changes in economic conditions that produce changes in the underlying demand for and supply of M_1 balances. A large part of the observed variation, however, appears to have little to do with economic conditions, and it is with these noneconomic determinants that this article has been concerned. In particular, the article has argued that many short-run swings in M_1 growth rates result from (1) special events that occur irregularly or (2) the inability of existing seasonal adjustment procedures to capture fully the impact of changes in the seasonal behavior of M_1, especially when such changes are actually in progress. Specifically, the discussion has indicated that the observed variation in short-run growth rates has been produced by forces as broad and persistent as the apparent longer-run change in the seasonal demand for M_1 balances during the Christmas season and the abrupt change in the level of Federal income tax refunds in 1973 to such seemingly innocuous developments as the recent change in the timing of monthly social security disbursements and year-to-year variations in the time required to process tax payments.

Monetary economists, both inside and outside the Federal Reserve, frequently point out that too much attention is paid to monthly and weekly M_1 growth rates. Short-run growth rates are important, however, because the Federal Reserve's current procedure for implementing monetary policy on a day-to-day basis makes them important. As pointed out in the introduction to this article, preliminary estimates of current two-month M_1 growth rates are one of the major factors determining policy actions under existing operating procedures.

Federal Reserve policymakers are well aware of the existence of short-run disturbances of the kind discussed in this article. The problem faced by policymakers—and by financial market participants attempting to anticipate Federal Reserve policy—is that the immediate causes of short-run M_1 growth rate variations are not usually apparent on a current basis. But the appropriate policy response to such movements depends critically on the conditions causing them. Suppose, for example, that M_1 growth over a two-month period exceeded the desired longer-run rate. If it were clear that this divergence reflected an increase in the demand for transactions balances due to excessive final demand for goods and services in the economy at large, policymakers would know that the acceleration should be resisted. Conversely, if the increase were obviously the result of some temporary disturbance likely to wash out in the near future, policymakers would presumably pursue a steady policy course. The principal implication of the analysis in this article is that making such determinations on a current basis with any degree of certainty is always difficult and often impossible. As the preceding sections have attempted to demonstrate, a wide variety of factors unrelated to basic economic trends can and do affect short-run M_1 growth rates, particularly the preliminary growth rates that actually determine policy actions.

Unfortunately, no simple, mechanical solution to this problem—either for policymakers or market observers—is likely to be forthcoming. Under these circumstances, close and eclectic analysis of each individual fluctuation in short-run growth rates appears to be the most promising approach. In particular, the analysis presented in this article suggests that a detailed familiarity (1) with seasonal patterns in the not seasonally adjusted M_1 data at certain times of the year and (2) with any ongoing or prospective changes in these patterns can assist in evaluating incoming short-run M_1 data.

Beyond the question of evaluating incoming data, however, lies the more fundamental issue of appropriate tactical procedures for implementing monetary policy. Any detailed analysis of this issue is well beyond the scope of this article. The preceding description of the difficulties inherent in evaluating current short-run M_1 data, however, is bound to raise doubts about the effectiveness of any operating procedure, such as the existing one, that focuses largely on annualized short-run growth rates without relating these short-run growth rates to desired longer-run growth in a very systematic fashion. Suggestions for improving these procedures have been made elsewhere.[26] It would appear that these suggestions deserve further attention.

[26] See, for example, Poole [5].

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SEASONAL ADJUSTMENT OF THE MONEY STOCK: Problems and Policy Implications

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The short-run behavior of the seasonally adjusted money stock has received increased attention from policymakers, economists, and financial analysts in recent years. Quarterly, monthly, and even weekly changes in the adjusted money stock are scrutinized carefully. Recently, however, some economists have questioned the adequacy of the method used to adjust the money stock for seasonality, and therefore the quality of the seasonally adjusted data itself.[1] Since the Federal Reserve considers short-run movements in the seasonally adjusted money stock in formulating monetary policy, seasonal adjustment problems may adversely affect the Fed's ability to achieve its policy goals.

The purpose of this article is to discuss some of the problems associated with adjusting the money stock for seasonality. The article begins with a brief discussion of the general principles of seasonal adjustment. Next, it examines the method currently used to adjust the monthly money stock (defined here as M_1, or currency plus demand deposits) for seasonality. Finally, it discusses the policy implications of inadequate seasonal adjustment.

Purpose of Seasonal Adjustment The purpose of seasonally adjusting a time series is to separate from that series any short-run variations that tend to recur at the same time each year. In this way longer-term movements as well as unusual short-term fluctuations can be distinguished from these systematic intrayear movements. The distinction between seasonal and nonseasonal movements is important, as the policy implications of the two types of movements may differ. For example, the reaction of the Federal Reserve to a change in short-run money growth will generally depend on whether that change is perceived as being consistent with some long-range money growth target. If a short-run change in money growth is due solely to seasonal forces, then it will be offset later in the year, with no effect on long-run money growth. Conversely, if the change in money growth is caused by nonseasonal influences, then it may not be offset within a year, and, in the absence of any policy action, may affect long-run money growth.

Seasonal Adjustment Methods There are various seasonal adjustment techniques available. Most of these assume that an original time series (O) can be broken down into separate components, namely the seasonal component, the trend-cycle component, and the irregular component. The seasonal component (S) embodies the intrayear pattern of variation that recurs regularly from year to year. The trend-cycle component (C) is made up of long-term trend and cyclical movements. The irregular component (I) reflects the influence of short-run erratic fluctuations. A seasonally adjusted series is composed of the trend-cycle and irregular components, the seasonal component having been filtered out. Experience indicates that for most economic time series, including the money stock [7, pp. 4-7], these components are related in a multiplicative fashion (i.e., $O = C \times S \times I$).[2]

Ratio-to-Moving Average Method The most widely used multiplicative method of seasonal adjustment is the ratio-to-moving average method.[3] For a monthly series the basic steps of this method are:

1. A 12-month centered moving average of the original series is constructed so that short-run intrayear movements are averaged out and the trend-cycle component can be estimated.[4] The average must be centered because a 12-month average falls between the sixth and seventh months, and therefore cannot be associated with either. For example, the midpoint of a 12-month average from January to December, inclusive, falls between June and July. Similarly, the midpoint of a 12-month average from February to January, inclusive, falls between July and August. However, the average of these two 12-month averages is centered on the month of July. Therefore, centering a 12-month moving average on a specific month is accomplished by taking the average of each two consecutive 12-month averages.

[1] E.g., see [8], [17], [18].

[2] This is in contrast to an additive relationship, where $O = C + S + I$.

[3] A good discussion of the ratio-to-moving average method, with a numerical example, is given in [2].

[4] A moving average is simply an average that moves forward one period at a time, dropping one term and adding another.

2. This centered average is then divided into the original series, and the resulting ratios are known as seasonal-irregular (S-I) ratios.

3. A moving average of these S-I ratios is computed separately for each month (i.e., a separate average of the S-I ratios for January, the S-I ratios for February, etc.) so that irregular movements are averaged out. This average estimates the seasonal component, or seasonal factor, for each month. The use of a moving average of the S-I ratios allows for a seasonal pattern that changes gradually over time. The time span over which these S-I ratios are averaged depends on how fast the seasonal pattern is assumed to change —the more stable the assumed seasonal pattern, the longer the span. If the seasonal pattern is believed to be constant over time, then the seasonal factor for each month is the average of all S-I ratios for that month.

4. These seasonal factors are divided into the original series to obtain a seasonally adjusted series.

Note that the seasonal factor in any time series is simply the ratio of the unadjusted value to the adjusted value of the series. Therefore, a seasonal factor (converted to an index number) greater than 100 indicates that seasonal influences are tending to push the series above the yearly average, while a factor below 100 indicates that the series is depressed by seasonal influences.

Seasonal Adjustment of the Money Stock Chart 1 plots the seasonally unadjusted and adjusted monthly money stock series (M_1) and its two components, demand deposits and currency, from 1970 to 1976. The chart indicates that the unadjusted money stock series is subject to significant seasonal variation, the greater part deriving from the demand deposit component. However, it is movement in the seasonally adjusted series that commands the attention of most analysts and policymakers. This section describes the method used by the Federal Reserve to adjust the monthly M_1 series for seasonality.

The Fed separately adjusts the currency and demand deposit components of M_1 for seasonal variation. Seasonal factors are first computed for each M_1 component using the Bureau of the Census' X-11 Variant of the Census Method II Seasonal Adjustment Program (hereafter simply X-11). The X-11 is based on the ratio-to-moving average method described above, although it is more complicated. The output of the X-11 is then reviewed by the Board of Governors' staff, and modifications are made when deemed appropriate. The modified seasonally adjusted currency and demand deposit series are added together to obtain the seasonally adjusted money stock. The two steps, the X-11 and judgmental modification, are discussed in more detail below.

The X-11 Program The basic steps of the X-11 program are described in the Box on page 23.[5] The X-11 program is an iterative process that can be broken down into three stages. In the first stage a preliminary seasonally adjusted series is obtained using a method similar to the ratio-to-moving average procedure described above, with an additional step limiting the influence of extreme irregular movements on computed seasonal factors. In the second stage a weighted average of this preliminary seasonally adjusted series is calculated to obtain a revised estimate of the trend-cycle component. This weighted average yields a smoother trend-cycle curve than does a simple 12-month centered moving average of the original series, and is generally thought to be a better representation of the true underlying trend-cycle component. In the third stage this revised estimate of the trend-cycle component is used to obtain revised calculations for the irregular component, the seasonal component, and the seasonally adjusted series.

Judgmental Modification Once the X-11 program has generated seasonal factors for each component of the money stock series, the Board of Governors' staff reviews the X-11's output, and any factor which in its judgment does not represent true seasonal influences is modified.[6] These final modified seasonal factors are divided into the original series to obtain the final seasonally adjusted series.

These judgmental modifications can either increase or decrease the smoothness of the X-11 adjusted series, and, depending on the circumstances, either type of modification may be justified. One justification for judgmental modifications that smooth the series stems from the X-11's use of 5- and 7-term moving averages to separate the seasonal from the irregular component [see Box, steps 3, 7, 11, and 13]. The use of these moving averages assumes a smooth, continuous change in seasonal patterns. If something occurs that would abruptly change the seasonal pattern of the series (such as the shift in the tax filing date from March 15 to April 15 in 1955), the X-11 would only reflect this change gradually. In such a case there seems to be good reason to modify the X-11 generated seasonal factor to reflect this change. This type of modification tends to smooth the series, since the change in the unadjusted series caused by the shift in seasonal patterns is reflected in the seasonal factor. On the other hand, a

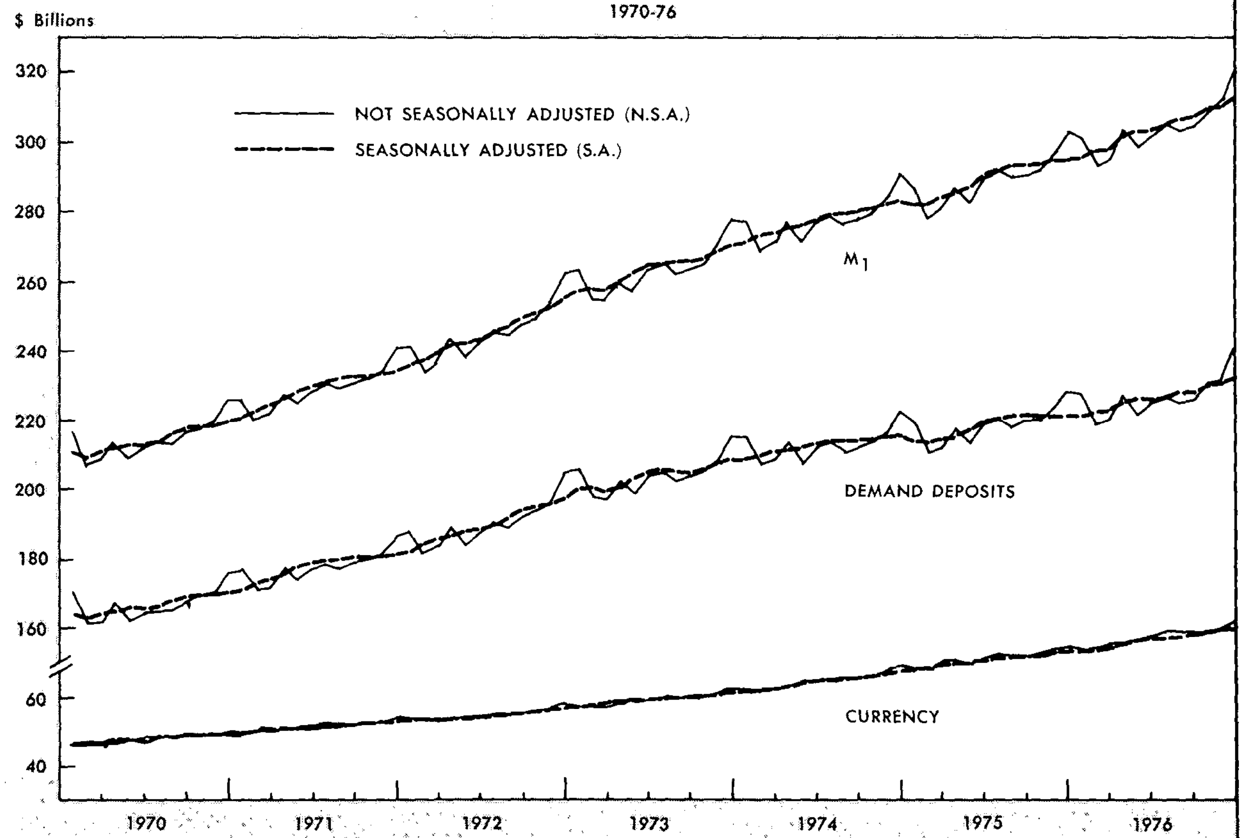
[5] For a more detailed description see [20], especially pp. 8-11.

[6] Of course, these modifications are constrained in that seasonal factors over any 12-month period must still sum to 12.000.

Chart 1

M₁ TOTAL AND COMPONENTS

1970-76



Source: Federal Reserve Bulletin.

possible justification for judgmental modifications that decrease the smoothness of the seasonally adjusted series is that the 5- and 7-term moving averages of the S-I ratios computed by X-11 may not be long enough to average out sufficiently the influence of relatively large nonseasonal movements (i.e., those nonseasonal movements that are large but not thrown out as extreme). If it appears that a large nonseasonal movement in the money stock series for a given month (such as the June 1975 jump in M_1 caused by the tax rebate) has unduly influenced the X-11 generated seasonal factor for that month, then it seems justifiable to alter that seasonal factor. This type of modification makes the series less smooth, as the nonseasonal movement in the series is no longer compensated for by the seasonal factor.

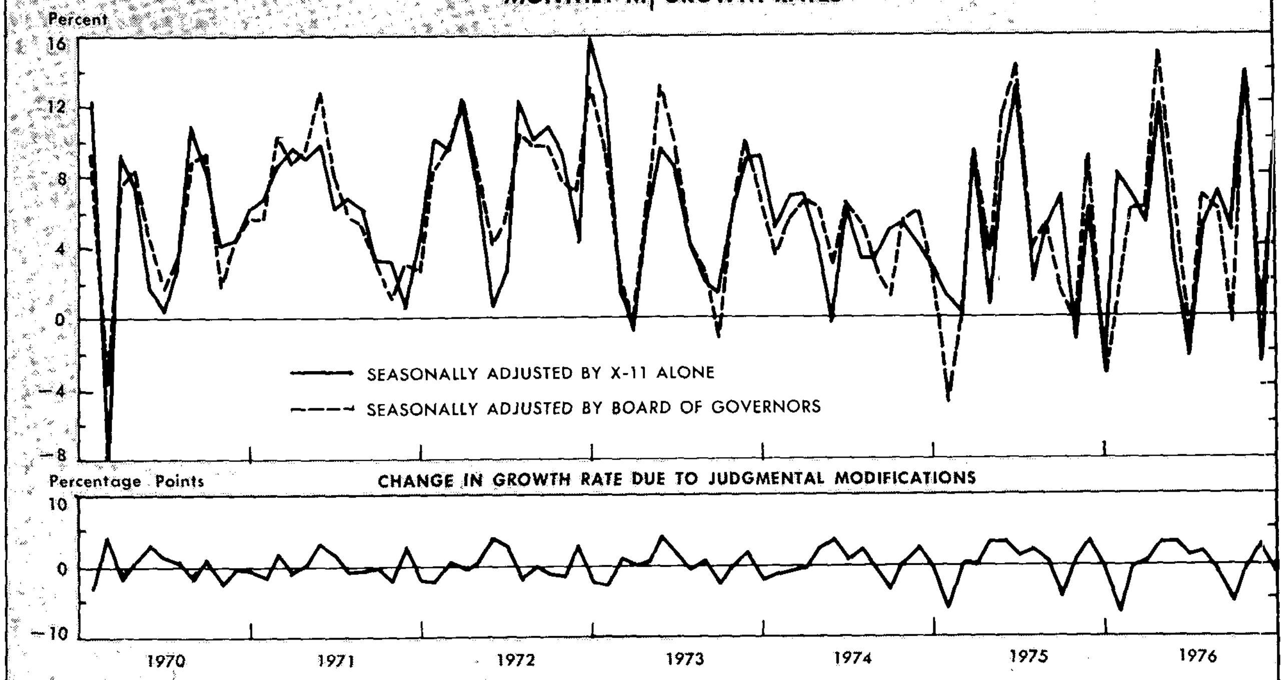
Impact of Judgmental Modifications Chart 2 plots the monthly annualized rates of growth of M_1 seasonally adjusted by the Board of Governors and M_1 seasonally adjusted by X-11 alone, from 1970 to 1976.[7] Also plotted is the difference between the two growth rates. The chart shows that while the two growth rates generally move together, judgmental changes have often significantly affected the published M_1 growth rates. The correlation coefficient of these two growth rates is only .867, which suggests that judgmental decisions play a significant role in determining the final published rates of growth.

To determine the net effect of these judgmental modifications on the smoothness of the M_1 series, the standard deviation of each of the two growth rate series was calculated. For the period 1970 to 1976, the two standard deviations are almost identical, suggesting that over the whole period judgmental changes did not alter the smoothness of the series (though as Chart 2 indicates, judgmental changes

[7] The X-11's default options were used to adjust the currency and demand deposit series using data from 1965 to 1976.

Chart 2

MONTHLY M_1 GROWTH RATES*



*CONTINUOUSLY COMPOUNDED ANNUAL RATES.

Source: *Federal Reserve Bulletin.*

have at certain times smoothed the series and at other times made the series less smooth).[8]

If just the 1975-76 subperiod is considered, however, the standard deviation of the published M_1 growth rates (5.5) is substantially greater than that of the X-11 generated growth rates (4.8), meaning that judgmental changes decreased the smoothness of the M_1 series in that subperiod. Chart 2 also shows that judgmental modifications have been larger in these two years. One possible reason for modifying the X-11's seasonal factors for 1975 and 1976 in this fashion involves the X-11's use of data before and, when available, after a given year in determining seasonal factors. Since 1975 and 1976 are the two end years for the series used in this article, sufficient year-ahead data are not available to compute 5- and 7-term moving averages of S-I ratios centered in these years. As noted in the description of the X-11 [see Box], relatively higher weights are assigned to end year data to compensate for this lack of future data. This procedure increases the chance of the X-11 incorporating nonseasonal movements into the seasonal factors for the end years. Apparently the staff at the Board of Governors thought that the large nonseasonal movements in the M_1 series in 1975 and 1976 (especially in January 1975 and April 1976) were at least partly incorporated into the X-11 seasonal factors, and they modified the seasonal factors to take account of this possibility.

Unfortunately, these judgmental decisions do not always perfectly compensate for deficiencies in the X-11. It is extremely difficult to determine precisely the effect a given occurrence will have on seasonal factors, or what portion of the X-11 seasonal factors represents the "true" seasonal pattern and what portion reflects nonseasonal influences.

Shortcomings of the Present Method There are a number of shortcomings of the present seasonal adjustment method. These shortcomings are inherent in almost all seasonal adjustment techniques. Therefore, in discussing the problems associated with the currently used seasonal adjustment process, this article does not mean to imply that the present process is a "bad" one, or that there exist other methods that are unambiguously better.

[8] The standard deviation of the M_1 growth rate for the period 1970 to 1976 seasonally adjusted by the Board of Governors is 4.27, while seasonally adjusted by X-11 it is 4.31. The standard deviation is a valid measure of the relative smoothness of the two series because by definition their trends are the same.

Box

BASIC STEPS OF THE X-11 SEASONAL ADJUSTMENT PROGRAM

1. A 12-month centered moving average of the original series is computed to obtain a first-round estimate of the trend-cycle component.

2. This trend-cycle estimate is divided into the original series to obtain preliminary seasonal-irregular (S-I) ratios.

3. A weighted 5-term moving average of these S-I ratios (with weights 1,2,3,2,1) is computed for each of the 12 calendar months separately to average out the influence of irregular movements and to obtain first-round estimates of the seasonal factors. The use of a moving average yields a distinct seasonal factor for each month of each year. Thus, the first-round seasonal factor for, say, January 1973 is derived from the five January S-I ratios for the years 1971 to 1975, inclusive.

Unfortunately, sufficient year-ahead data are not available for the 2 years at the end of a time series to calculate this 5-term average. For example, a 5-term average centered in 1976 requires S-I ratios for 1974 through 1978, inclusive, while for this article 1976 is the last year for which data are available. To compensate for the lack of future data, the X-11 weights the available S-I ratios (which for 1976 factors are the S-I ratios for 1974, 1975, and 1976) more heavily than if future data were available. For example, in calculating the first-round seasonal factor for January 1976 (with data through 1976), the January 1976 S-I ratio is given a weight of .407, while in computing the first-round seasonal factor for January 1973, the January 1973 S-I ratio is given a weight of only .333 [20, p. 61].

4. These factors are adjusted to sum to 12.000 in ratio form, or 1,200 in index number form, over any 12-month period so that year-to-year changes in the series are unaffected [20, p. 91].

5. These adjusted first-round seasonal factors are divided into the S-I ratios to get an estimate of the irregular component.

6. A moving 5-year (60-month) standard deviation (σ) of these irregular component estimates is calculated, and the irregulars in the central year of the 5-year period are tested against 2.5σ. Irregulars greater than 2.5σ are removed, and the moving 5-year standard deviation is again computed. If the irregular for a month in the central year is:

(a) greater than 2.5σ, it is considered an extreme value, and the corresponding S-I ratio is removed and replaced by an average of the two nearest preceding and two nearest following full weight (i.e., unmodified) S-I ratios for that month;

(b) less than 1.5σ, then the corresponding S-I ratio for that month is given full weight;

(c) between 2.5σ and 1.5σ, a linearly graduated weight between 0.0 and 1.0 is assigned to the irregular, and the corresponding S-I ratio is replaced with an average of the ratio times its assigned weight and the two nearest preceding and two nearest following full weight S-I ratios for that month.

This graduated treatment of extremes is designed to limit the influence of unusually large irregular movements on seasonal factors.

7. A weighted 5-term moving average of the S-I ratios is again calculated separately for each month—this time with extreme values replaced as described in step 6—to obtain modified first-round seasonal factors. Again, these seasonal factors are adjusted to sum to 12.000 over any 12-month period.

8. These modified first-round seasonal factors are divided into the original series to get a preliminary seasonally adjusted series.

9. A special weighted moving average (the so-called Henderson average) is applied to this preliminary seasonally adjusted series to obtain a revised estimate of the trend-cycle component.* The span of this moving average depends on the variability of the irregular component relative to that of the trend-cycle component, with the more irregular the series, the longer the span. A preliminary estimate of the variability of the irregular relative to the trend-cycle is obtained using a 13-month Henderson average [20, p. 34].

10. This revised trend-cycle estimate is divided into the original series to obtain revised S-I ratios.

11. A weighted 7-term moving average (with weights 1,2,3,3,3,2,1) of these S-I ratios is computed separately for each month to obtain revised seasonal factor estimates. Thus, the seasonal factor for, say, January 1973 is derived from the seven January S-I ratios for the years 1970 to 1976, inclusive.

Sufficient year-ahead data are not available for the 3 years at the end of the series to compute this 7-term average. For example, a 7-term average centered in 1976 needs data from 1973 to 1979, inclusive, and (as of the end of 1976) data from 1977 to 1979 are not available. To compensate for this lack of future data, the X-11 weights the available S-I ratios (for 1976 factors, the ratios for 1973 through 1976) more heavily than if future data were available. For example, in computing the revised January 1976 seasonal factor, the January S-I ratio for 1976 is given a weight of .283, while in computing the revised January 1973 seasonal factor the January 1973 S-I ratio is given a weight of only .200 [20, p. 61].

12. These revised seasonal factors are divided into the S-I ratios to get new estimates of the irregular component, and the S-I ratios are modified for extremes by the same method as described in step 6.

13. A weighted 7-term moving average of these modified S-I ratios is computed separately for each month to obtain the X-11's final seasonal factors. (Of course, these factors are adjusted to sum to 12.000 over any 12-month period.)

14. These final seasonal factors are divided into the original series to obtain the X-11's final seasonally adjusted series.

15. Preliminary seasonal factors for the upcoming year are estimated from the formula

$$S_{n+1} = S_n + \tfrac{1}{2}(S_n - S_{n-1}),$$

where S_n = the seasonal factor for year n.

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* A Henderson average minimizes the sum of the squares of the third differences of a series. For a discussion of the merits of the Henderson average see [12], especially Chapter III.

Moving Seasonal Option One problem already alluded to involves the X-11's use of 5- and 7-term moving averages to separate the seasonal component from the irregular component. Some critics have argued that the seasonal pattern of the money stock has been quite stable over time, and therefore that the X-11's use of these relatively short moving averages only serves to smooth the money stock series excessively. Poole and Lieberman [17, p. 327] argue that the use of the X-11's moving seasonal option to adjust the money stock is justifiable only if the money stock's seasonal factors exhibit a recognizable trend. Chart 3 plots M_1 seasonal factors (unadjusted M_1/adjusted M_1) separately for each month over the period 1947 to 1976. The chart indicates that the factors for some months do display a clear trend. However, it also shows that for periods where no recognizable trend is present, seasonal factors for some months still vary significantly from year to year. Thus, the evidence suggests both that a moving seasonal model is warranted, and that the present method overly smooths the series. This behavior of the X-11 seasonal factors reflects the trade-off that exists between adequately allowing for moving seasonality and preventing nonseasonal movements from being incorporated into seasonal factors. The length of the moving average used reflects the adjuster's judgment on this trade-off.

Other evidence that suggests that the current method of seasonal adjustment is unduly smoothing the money stock series is given by Kaufman and Lombra [8]. Using spectral analysis, a statistical technique that decomposes a series into periodic (e.g., seasonal) movements, they find that the seasonal adjustment process flattens out the series at nonseasonal frequencies, "which indicates excessive smoothing of the series" [8, p. 1516].

Shifts in Seasonal Patterns Another problem occurs when the seasonal pattern of a time series changes abruptly. The X-11 is not designed to handle sharp, discontinuous shifts in the seasonal pattern, and judgmental changes are seldom able to correct the X-11 deficiencies perfectly. Failure to take such shifts into account can cause computed seasonally adjusted series to exhibit unexplained variability. The recent behavior of the M_1 series may be an example of a seasonal pattern shift. In April of both 1976 and 1977, the monthly seasonally adjusted M_1 growth rate jumped unexpectedly, with the annualized growth rate being almost 15 percent in April 1976 and 20 percent in April 1977. Suppose the seasonal pattern in the demand for M_1 shifted abruptly in 1976 in such a way that money demand rose in April relative to the other months. The X-11, with its 7-term moving average of S-I ratios, would not fully capture this shift until 1979, since the X-11 calculated seasonal factors for April in 1976 and 1977 are derived from data before this hypothetical seasonal pattern shift occurs in 1976. Therefore these factors will understate the true seasonal component for April in 1976 and 1977, causing the reported seasonally adjusted growth rate to overstate the true seasonally adjusted growth rate. Whether these unusually high April movements in M_1 are actually the result of a shift in the seasonal pattern of the demand for money, however, remains to be seen.[9]

Year-End Revisions Another shortcoming involves the year-end revisions of the money stock necessitated by the use of the X-11. The X-11 uses data several years before and, when available, after a given month to determine that month's seasonal factor. Unfortunately, sufficient future data are not available for end years in the series to calculate the 5- and 7-term moving averages of the S-I ratios used to compute seasonal factors [see Box, steps 3 and 11]. At the end of each year, the newly available data for that year are entered into the X-11, and revised seasonal factors are obtained for these end years. These revised factors frequently differ sig-

[9] See the accompanying article by Cook and Broaddus [1] for a discussion of some of the factors believed to have caused the April bulge in M_1 in 1976 and 1977.

PRELIMINARY VERSUS REVISED M_1 GROWTH RATES

1975

	(1) Preliminary M_1 Growth Rates	(2) Revised M_1 Growth Rates*	(2) − (1) Difference
January	−11.8	−5.1	6.7
February	3.4	0	−3.4
March	11.0	9.3	−1.7
April	3.4	3.4	0
May	11.3	11.3	0
June	18.7	14.1	−4.6
July	2.0	3.7	1.7
August	2.9	5.3	2.4
September	2.0	1.6	−.4
October	−2.4	−.8	1.6
November	12.2	9.0	−3.2
December	−2.8	−3.3	−.5

*Revisions made in January 1976.

Source: **Federal Reserve Bulletin.**

nificantly from the preliminary factors, and often affect the previously published M_1 growth rates. The accompanying table lists the 1975 seasonally adjusted annualized monthly rates of growth of M_1 published both before and after the January 1976 year-end revisions. Absolute differences in the before and after monthly growth rates vary from 0 to almost 6½ percentage points, with an average absolute deviation of about 2.2 percentage points. Most of this difference can be attributed to revisions in the seasonal factors (as opposed to revisions in the underlying data). Kaufman and Lombra believe that "the sizable difference between 'final' data (employed by the model-builders) and the 'preliminary' data (viewed by the policymakers) introduces a significant distortion into estimates of policy impacts" [8, p. 1525]

Seasonal Relationships Among Series Another problem with seasonal adjustment involves the way in which the money stock and other economic variables are seasonally adjusted on a variable-to-variable basis, without regard to the relationship between seasonal changes in one series and seasonal changes in other series. Marc Nerlove notes that:

> Seasonal variations have causes and insofar as these causes are measurable they should be used to explain changes that are normally regarded as seasonal. Indeed, seasonality does not occur in isolated economic series, but seasonal and other changes in one series are related to those in another [15, p. 263].

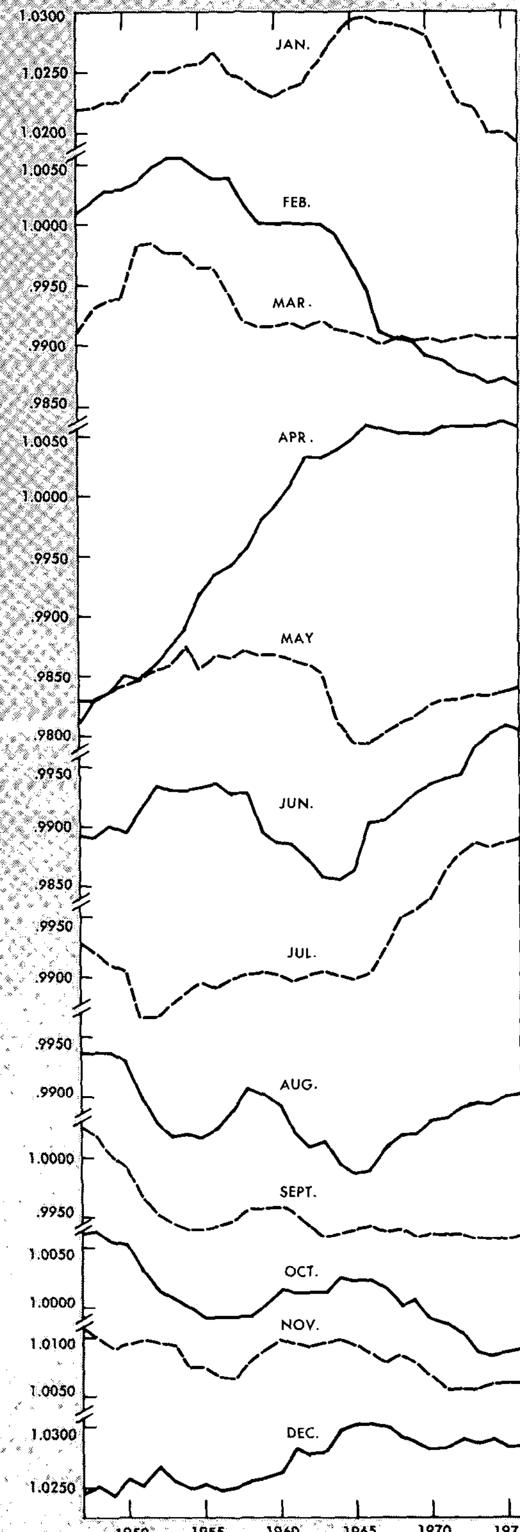
This is especially important because the money stock is a policy-controlled variable—i.e., the actions of the monetary authorities influence the seasonal pattern of the money stock. Therefore, if the policy objective of allowing the money stock to exhibit seasonality is to affect the seasonal pattern of some other economic variable, then knowledge of the structural relationship between seasonal movements in the two series would be desirable. "Unfortunately, the nature of ratio-to-moving average techniques and post-war monetary policy combine to obfuscate such information" [8, p. 1524].

For example, the implicit policy of the Fed since its inception has been to reduce or eliminate interest rate seasonality (arising from a natural seasonal in the demand for money) by allowing the money supply to vary seasonally. However, the method used to seasonally adjust the money stock does not take into account the structural relationships among seasonal movements in the money stock, interest rates, and factors affecting the seasonal in money demand. Indeed, one of the reasons that the present adjustment is inadequate in handling abrupt seasonal pattern shifts is that it fails to take into account the relation-

Chart 3

M_1 SEASONAL FACTORS FOR EACH MONTH

1947-76



Source: Federal Reserve Bulletin.

ship between abrupt changes in those factors affecting the money seasonal and the money seasonal itself.

Seasonality in Policy Actions One final shortcoming discussed here is that since the money stock is a policy-controlled variable, any seasonality in the Fed's policy actions may affect the seasonal factors calculated by the X-11. For example, if the Fed increases its money growth targets at the same time of the year in successive years, then the X-11, with its moving seasonal option, may incorporate these policy movements into its seasonal factors in subsequent revisions. Thus seasonality in policy actions, whether accidental or otherwise, may cause changes in computed money seasonal factors that are not due to any change in the underlying seasonal pattern of the demand for money and credit. Poole and Lieberman [17, p. 236] believe that the seasonal behavior of policy actions has been affecting money seasonal factors.

Seasonality and Monetary Policy As mentioned in the beginning of the article, the purpose of seasonal adjustment is to enable the user of a time series to differentiate between seasonal and nonseasonal movements. However, the above discussion suggests that the present method used to adjust the money stock sometimes has trouble separating seasonal from nonseasonal movements. For the Fed to be able to determine what portion of the current movement in the money stock is due to seasonal forces, the seasonal factors used to adjust the money data should reflect the true seasonal pattern in the demand for money and credit. In other words, nonseasonal movements should not influence the seasonal factors, while shifts in the seasonal pattern of money and credit demand should be fully reflected. However, the factors used to adjust current money stock data are probably the least likely to satisfy these criteria, since they are based solely on past money stock movements. These seasonal adjustment problems can affect Federal Reserve policy. To understand how, it is necessary to have some idea of the Fed's short-run strategy of monetary policy.[10]

Each month the Federal Open Market Committee sets a tolerance range for the two-month growth rate of the seasonally adjusted money stock and a tolerance range for the Federal funds rate.[11] The seasonally adjusted money growth rate is allowed to fluctuate within this tolerance range in order to limit interest rate variability. However, if the two-month money growth rate appears to be moving outside of the tolerance range, the Fed may react by changing its funds rate target so that longer-run control of the money stock can be achieved.

The Fed's money growth tolerance ranges are stated in seasonally adjusted terms, and the factors used to adjust the money stock are calculated by the method described above. Unfortunately, these computed factors may not reflect the true seasonal forces affecting the demand for money and credit in the current year. If they do not, then the seasonally adjusted money growth rate may exhibit fluctuations that are due solely to faulty seasonal adjustment.[12] These adjustment problems increase the difficulty of setting short-run money growth targets that are compatible both with some longer-run money target and with interest rate stability. Adjustment problems also complicate the Fed's task of deciding how to react to a given short-run change in money growth. For example, suppose that the seasonally adjusted M_1 growth rate in a given month is either very high or very low, causing the two-month money growth rate to move outside of its tolerance range. If the change in money growth is due to faulty seasonal adjustment, then any corrective action by the Fed will have to be reversed later in the year, producing unnecessary fluctuations in short-term interest rates. However, if the Fed does not react to this change in money growth by changing its funds rate target, and the change in money growth is really caused not by seasonal adjustment problems, but by, say, a cyclical shift in the demand for money, then deviations from target money growth rates may cumulate, and some longer-run target may be missed. Thus seasonal adjustment problems must be added to that long list of factors complicating monetary control.

Conclusion This article has shown that adjusting the money stock for seasonality is no trivial matter. Despite its high degree of sophistication, the X-11 program employed to seasonally adjust the money stock is far from flawless. The Board of Governors' staff recognizes that the X-11 is not perfect and attempts to correct for its deficiencies. Even the Board staff, however, cannot always distinguish between seasonal and nonseasonal movements in the money stock, especially in current money stock movements. If the estimated seasonal factors for the current year imperfectly reflect the influence of actual seasonal forces, then the seasonally adjusted

[10] The following description of the Fed's short-run strategy is oversimplified. For a fuller discussion see [3] and [11].

[11] The Federal funds rate is the rate at which commercial banks lend each other reserves.

[12] For specific examples of how seasonal adjustment problems have affected reported seasonally adjusted money growth rates, see Cook and Broaddus [1].

money data will exhibit some spurious volatility caused by the imperfections. Considering the Fed's dual policy goals of (a) long-run stability in money growth, and (b) short-run stability in money market interest rates, these seasonal adjustment problems can complicate the task of determining the proper policy response to any given short-run movement in the seasonally adjusted money stock.

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