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

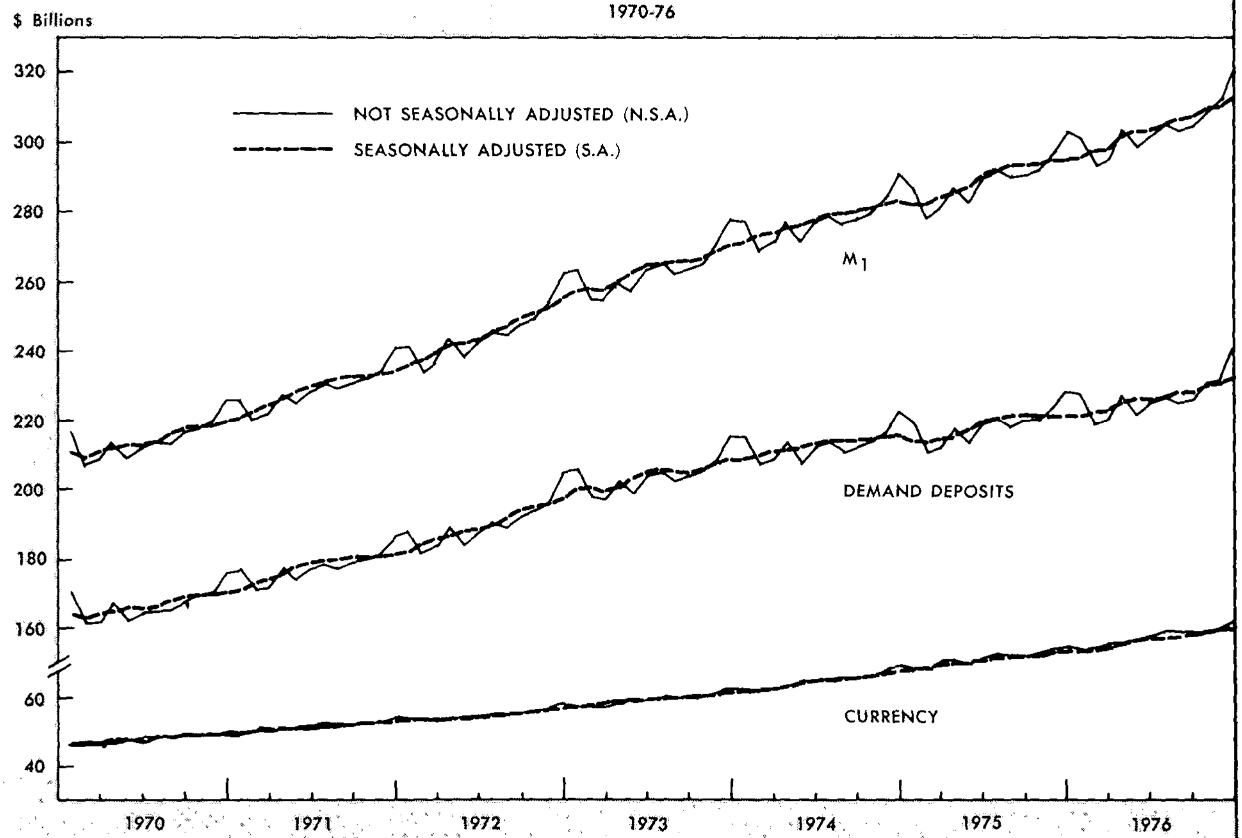
[5] For a more detailed description see [20], especially pp. 8-11.

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

Chart 1

M_1 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.

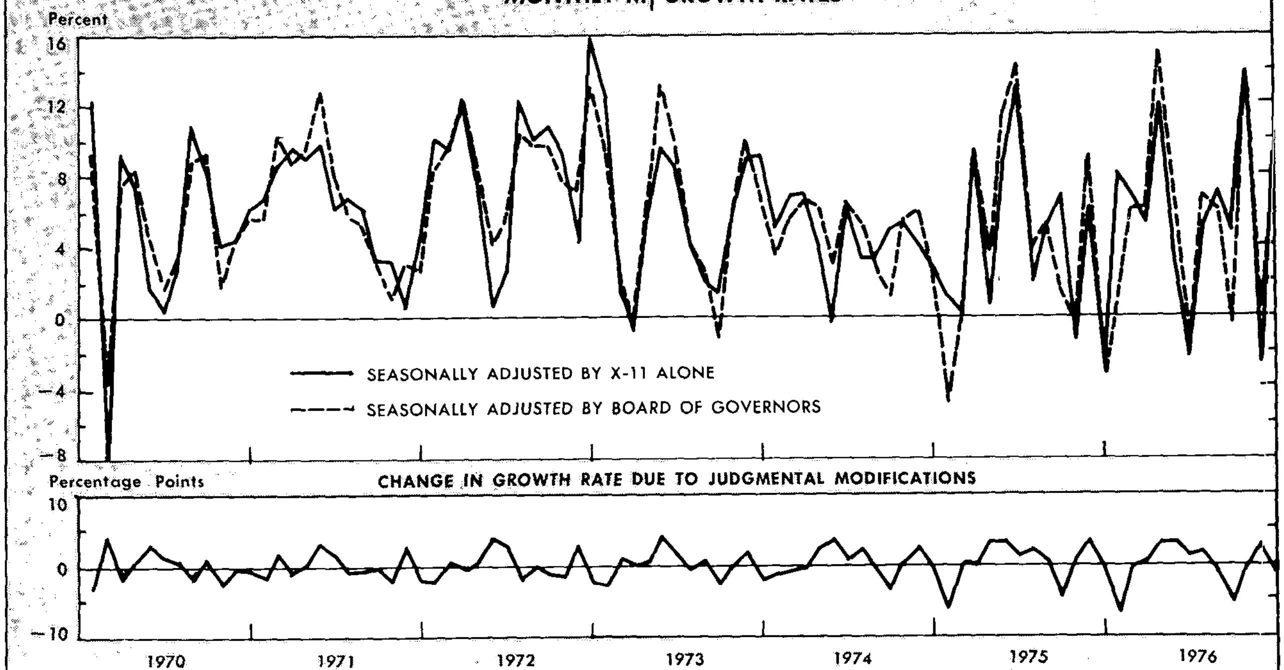
Impact of Judgmental Modifications Chart 2 plots the monthly annualized rates of growth of M_1 seasonally adjusted by the Board of Governors and M_1 seasonally adjusted by X-11 alone, from 1970 to 1976.[7] Also plotted is the difference between the two growth rates. The chart shows that while the two 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].

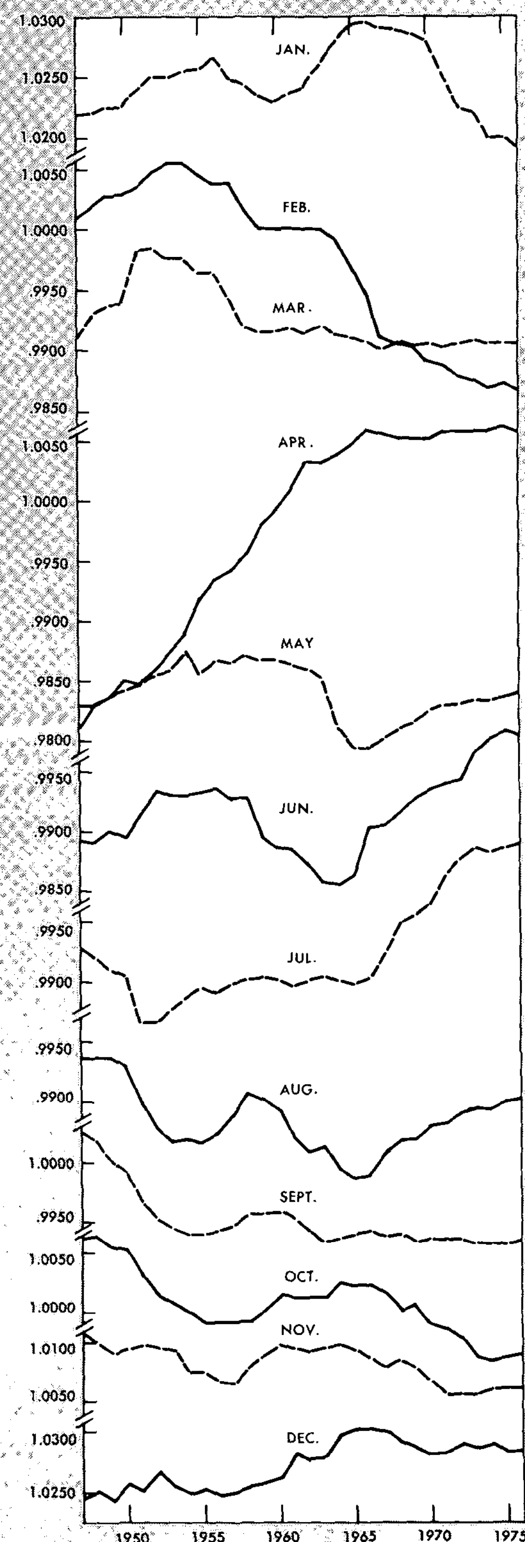
This is especially important because the money stock is a policy-controlled variable—i.e., the actions of the monetary authorities influence the seasonal pattern of the money stock. Therefore, if the policy objective of allowing the money stock to exhibit seasonality is to affect the seasonal pattern 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

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[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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