Seasonally Adjusting Money: Procedures, Problems, Proposals

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Seasonal variation in economic functions is pervasive; production, sales and leisure activities vary both substantially and systematically over the course of each week, month and year. Besides the obvious seasonal variation in agriculture, there are well-entrenched patterns in many other production, payment and consumption activities of firms and households. Automobile production lines, for example, shut down in the summer and new models are introduced in the fall; retail consumer sales are heaviest during the Christmas shopping months in the late fall; income taxes are paid in April; and July is the peak month for vacation and travel. As a result, the demand for money fluctuates seasonally as firms and households rearrange their financial portfolios to suit these varying patterns of economic activity.

For many reasons, it is useful to distinguish these seasonal variations in the data from longer-run cycles or trends. The procedures that enable these seasonal variations to be identified and, if desired, removed from the data are called seasonal adjustment techniques. In this article, we examine attempts to isolate the seasonal impulses in the money stock.

WHY SEASONALLY ADJUST MONEY STOCK MEASURES?

There are at least two different reasons for seasonally adjusting money stock measures. The first reason is for interpretative purposes. Many analysts simply want a times series for the money stock that reveals trend and cycle impulses but excludes the effects of seasonal variation. In order to exclude such variation, some method of identifying seasonal variation in the money stock is required.

The second reason concerns the setting of monetary policy. The Federal Reserve states its annual and short-run objectives in terms of seasonally adjusted monetary aggregates. These policy objectives imply that seasonal changes in money demand will be accommodated, but these changes first must be identified by some method.

The Interpretative Reason

Many economic time series are seasonally adjusted for interpretative reasons. A standard analysis of time series data partitions each observation into three primary factors: (1) trend-cycle, C; (2) seasonal, S; and (3) irregular or random, E. Consider, for example, the time series for demand deposits, D. Traditional analysis would represent D as

(1) $D_t = C_t S_t E_t$.

If the seasonal factor S_t is known, a "seasonally adjusted" measure of demand deposits can be obtained by dividing by the seasonal factor:

(2) $\frac{D_t}{S_t} = C_t E_t$.

Since the seasonal factor is intended to remove seasonal variation, it will be less than 1.0 when demand is seasonally low and greater than 1.0 when demand is seasonally high; over the year, by construction, it averages 1.0. Consequently, by seasonally adjusting the data, the trend-cycle variation is revealed more clearly. If analysts are interested primarily in the trend-cycle element in demand deposits, they will find seasonally adjusted demand deposit data useful in their analyses.

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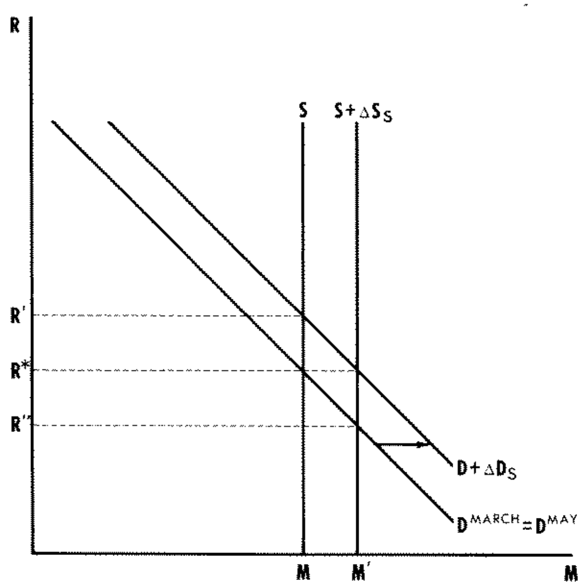
Figure 1
The Effect of Seasonal Demand Variation Can Be Offset by Seasonal Supply Variation



The Policy Reason

The money stock is also of major interest to policymakers who are trying to promote desirable economic and financial conditions by exercising control over the money stock.

The effects of seasonal variation in the demand for money are illustrated in figure 1, which presents a simple money demand-supply relationship. The demand for money, given by economic trends and business cycle forces, is depicted as D; the arrow indicates an increase in money demand caused by purely seasonal factors, for example, by an April income-tax-related shift. As the figure shows, if the money supply were not adjusted to offset this seasonal demand shift, there would be an excess demand for money at the original equilibrium interest rate R*. Depending on the assumed adjustment process, this disequilibrium could result in increases in interest rates (to R') as individuals and firms attempt to adjust their portfolios, or in lower aggregate demand for goods and services as individuals and firms attempt to build up money balances by spending less.[1]

If the seasonal demand shift is known in advance and if it is relatively costless to alter the money supply, then the money supply could be increased — from S to $S + \Delta S_s$ — to eliminate the disequilibrium effects of the seasonal demand shift. Conversely, if money demand declines seasonally after April and if monetary authorities want to eliminate any adjustment process associated with an excess supply of money, the money supply could be reduced to offset the impact of this seasonal disturbance.

By targeting on seasonally adjusted measures of money, the Fed essentially has indicated a willingness to accommodate the estimated seasonal influences.[2] Yet, the graphical analysis suggests this policy response will be successful in easing seasonally induced disruptions in money demand only if 1) the seasonal impulses coming from the demand side are correctly estimated, and 2) these estimates are available in a timely fashion. Successful policy actions require that the *preliminary* or original estimates of seasonal variation be reliable, because it is the preliminary estimates that are used to guide policy. Revisions in seasonally adjusted money stock estimates that come about one, two or more years from now, for example, are of no use to policymakers who must make their decisions now. Before evaluating the accuracy of seasonally adjusted money measures in terms of their timeliness and reliability, we briefly outline the procedures employed in seasonal adjustment of the money stock.

CURRENT SEASONAL ADJUSTMENT PROCEDURES

Seasonal adjustment of monetary data by the Federal Reserve Board of Governors currently is accomplished by the X-11 ARIMA procedure, an extension of the X-11 seasonal adjustment program first developed by Julius Shishkin at the Bureau of the Census of the U.S. Commerce Department.[3] The X-11 seasonal

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[1]The reader should not conclude from figure 1 that the money market clears by interest rate changes alone; it can clear through many other important channels. Figure 1 is best thought of as a pedagogical device.

[2]While there is no explicit statement by the Board explaining its use of seasonally adjusted data, William Poole and Charles Lieberman, "Improving Monetary Control," *Brookings Papers on Economic Activity* (2:1972), pp. 293–335, conclude that:

> "efficient resource allocation requires the monetary authorities to eliminate seasonality in interest rates arising from seasonality in the demand for money, while giving full scope to seasonality in interest rates arising from that in aggregate demand." (p. 332)

[3]For a detailed description of the basic procedure, see Julius Shishkin, Allan H. Young and John C. Musgrave, "The X-11 Variant of the Census Method II Seasonal Adjustment Program," U.S. Department of Commerce, Bureau of the Census, Technical Paper 15. Washington, D.C.: Government Printing Office, 1967. For a concise description, see Thomas A. Lawler, "Seasonal Adjustment of the Money Stock: Problems and Policy Implications," *Economic Review*, Federal Reserve Bank of Richmond (November/December 1977), pp. 19–27, especially p. 23; also William P. Cleveland and David A. Pierce, "Seasonal Adjustment Methods," *Federal Reserve Bulletin* (December 1981), pp. 875–81.

adjustment procedure is used worldwide to seasonally adjust a broad variety of social and economic data from U.S. unemployment to Israeli tourism. Consequently, its application to monetary data is both well-understood and widely accepted.[4]

The present seasonal adjustment of the monetary aggregates is accomplished in two steps. First, each component of the monetary aggregate is seasonally adjusted separately. Second, the resulting data are summed to obtain the seasonally adjusted monetary aggregate. This procedure is used because the individual components have different seasonal patterns; for example, checkable deposits have a different seasonal pattern than currency, and both have different patterns from those of small time deposits or large certificates of deposit.[5]

The Basic X-11 Procedure

The X-11 procedure for estimating the seasonal factors consists of two steps: First the data are detrended. Then, the seasonal factors are estimated from the detrended series.

The first step is accomplished by fitting a trend line to the actual series over a sufficient time span so that the estimate will be unaffected by shorter-term seasonal or random variations. Once estimated, the trend, C_t, can be removed from equation 1 to yield

$$(3) \quad \frac{D_t}{C_t} = S_t E_t.$$

Fluctuations of this series around its mean value of 1.0 are due to either seasonal or random causes.

The second step, that of estimating S_t, is accomplished by calculating the ratio of the detrended monetary measure at time t to a weighted moving average of monetary data centered around t. The weighting scheme is symmetric; for example, an observation 4 periods before t will receive the same weight as an observation 4 periods after t. Moreover, the weights are chosen so as to emphasize near observations in time more than distant ones; thus, an observation 4 periods away will receive more weight than an observation 5 periods away. The weights for months more than three and a half years away in either direction are very small.

If at any point this ratio of the detrended monetary component to its weighted moving average exceeds unity, either seasonal or random variation probably has caused it to rise at that point. If the ratio consistently exceeds unity for the same point in a year for a number of years in succession, however, random variation can be disregarded.

In the basic X-11 process, these steps of detrending and deseasonalizing are undertaken iteratively with a variety of refinements at each phase, primarily to reduce the influence of so-called "outliers," that is, observations whose discrepancies are so much greater than other observations that trend-cycle or seasonal variation cannot reasonably account for the discrepancy.[6]

The basic X-11 procedure, as just noted, uses data symmetrically centered about the observation being seasonally adjusted. Thus, fully adjusting current data is impossible; to do so would require having the as yet unknown future values of the variable. Consequently, the basic X-11 program does not adjust current observations based on a symmetric weighted moving average calculation. Instead, it has an arbitrary set of end-weights for adjusting current and recent past data. Thus, the preliminary estimates of the seasonal factors are based only on known, past data. As the data required for the moving average calculation become available, they are incorporated in the X-11 seasonal adjustment process, and the estimates of seasonal fac-

[4]Nonetheless, alternative procedures have been proposed to improve on various perceived shortcomings of the X-11 method. See Arnold Zellner, ed., *Seasonal Analysis of Economic Time Series*, Proceedings of the Conference on the Seasonal Analysis of Economic Time Series (Washington, D.C., September 9–10), 1976; and Geoffrey Moore, and others, *Seasonal Adjustment of the Monetary Aggregates*, Report of the Committee of Experts on Seasonal Adjustment Techniques (Board of Governors of the Federal Reserve System, October 1981).

[5]This procedure, however, may be inferior to seasonal adjustment of the components jointly. For example, the currency and checkable deposit components each should be seasonally adjusted separately but use information from the other series. See John Geweke, "The Temporal and Sectoral Aggregation of Seasonally Adjusted Time Series," in *Seasonal Analysis of Economic Time Series*, pp. 411–27, and comments by Michael Lowell, pp. 428–30, and John B. Taylor, pp. 431–32.

[6]This culling of outliers is accomplished by computing a moving standard deviation and reducing the weight of any observation lying, say, more than three standard deviations from the trend-cycle seasonal expected value. The rationale for this removal is that failure to do so would bias the estimates of the seasonal factors due to the presence of a deviation in the data for S_t E_t which is not a seasonal or random factor; however, this procedure injects a judgmental element into the estimation that, while well-intentioned, dilutes the objectivity of any analysis performed using the adjusted data. See "The BLS Seasonal Factor Method, "*BLS Handbook of Methods for Surveys and Studies*, U.S. Department of Labor, Bureau of Labor Statistics (1976), p. 273; also, Pierce, "Seasonal Adjustment Methods." In the BLS study, the foundation for this outlier adjustment is called a credence factor, which refers to the low probability of an observation lying more than two or three standard deviations from the mean. In the Board study, the method is referred to as judgmental.

Table 1

Tests for Bias in Preliminary 1982 Monthly Seasonally Adjusted M1 Growth Rates

Equation 1:				Equation 2:			
$\%\Delta\ M1R_t^u = \beta_0 + \beta_1\ \%\Delta\ M1P_t^u$				$\%\Delta\ M1R_t^s = \beta_0' + \beta_1'\ \%\Delta\ M1P_t^s$			
β_0	β_1	R^2	DW	β_0'	β_1'	R^2	DW
−0.105	0.998	0.999	1.65	3.419	0.581	0.681	2.26
(0.119)	(0.005)			(1.480)	(0.126)		
t-statistic testing H_0: $\beta_0 = 0$; $t_c = -0.88$				t-statistic testing H_0: $\beta_0' = 0$; $t_c = 2.31^*$			
t-statistic testing H_0: $\beta_1 = 1$; $t_c = -0.40$				t-statistic testing H_0: $\beta_1' = 1$; $t_c = -3.33^*$			

NOTE: *Denotes rejection of null hypothesis at the 5 percent level. Standard error of coefficient estimate in parentheses.

tors are revised. On many occasions these revisions have been quite sizeable.

The Current X-11 ARIMA Procedure

The Board of Governors' Committee of Experts on Seasonal Adjustment Techniques felt that the revisions resulting from application of the basic X-11 program were excessive and recommended changes to reduce the size of revisions.[7] One of the procedures recommended was the adoption of the X-11 ARIMA procedure, which replaces the use of the arbitrary end-weights in the adjustment of current data with the application of centered weights using *forecasts* of the underlying series for the future values needed.

These forecasts come from *A*uto*r*egressive, *I*ntegrated *M*oving *A*verage (ARIMA) time series models. Revisions in the seasonal adjustment factors are limited only to the errors associated in forecasting future values. Unlike the basic X-11 program then, the weights which are applied to the not seasonally adjusted data (including any forecasted data) associated with specific time periods will be the same for the preliminary seasonal adjustment and all subsequent revisions. In this regard, it was believed that the X-11 ARIMA would result in smaller revisions of seasonally adjusted money stock measures.[8]

X-11 ARIMA: THE PROBLEM OF MONEY STOCK REVISIONS

Previous analyses indicated that revisions in the estimates of seasonally adjusted money stock measures based on the basic X-11 program were large and that the preliminary seasonally adjusted data generally were biased measures of the subsequently revised data.[9] In 1982, the X-11 ARIMA seasonal adjustment procedure was adopted with the intent of improving the preliminary seasonally adjusted estimates by reducing the size of these subsequent revisions in money measures. We now evaluate the performance of this new procedure.

Not-Seasonally-Adjusted Money Growth Rates

Table 1 evaluates this new procedure by examining the relationship between preliminary and revised

[7]See Moore, and others, "Seasonal Adjustment of the Monetary Aggregates."

[8]The current seasonal adjustment of monetary data also encompasses one further refinement referred to as intervention analysis. Intervention analysis is undertaken when extraordinary events — such as a redefinition of monetary aggregates or other change in the rules governing monetary institutions — is believed to have altered the behavior of the observed monetary aggregates. An example of this was the imposition of credit controls from March through June of 1980. This program imposed restraints on commercial bank lending and, therefore, reduced demand deposits. Without somehow offsetting this effect, the estimated seasonal adjustment factors would have been distorted by this non-seasonal event. Although the X-11 ARIMA program has the capability of removing individual outliers, it can incur difficulties when such outliers represent a run of consecutive, unusual observations, as with the credit controls. In the case when a sharp swing in the series occurs over a few periods in succession, the present procedure *preadjusts* the underlying series, through intervention analysis, to minimize the effects such occurrences would have on the seasonal adjustment procedure. See Cleveland and Pierce, "Seasonal Adjustment Methods," pp. 876–78.

[9]See Poole and Lieberman, "Improving Monetary Control," pp. 320–33; Lawler, "Seasonal Adjustment," pp. 24–25; and Courtenay C. Stone and Jeffrey B.C. Olson, "Are the Preliminary Week-to-Week Fluctuations in M1 Biased?" this *Review* (December 1978), pp. 13–20.

monthly growth rates in the narrow money stock, M1. Equation 1 evaluates the importance of revisions in the not-seasonally-adjusted (NSA) M1 measures. In this equation, revised growth rates of NSA M1 ($\%\Delta M1R_t^u$) are regressed against the preliminary NSA growth rates ($\%\Delta M1P_t^u$).[10] If these revisions of NSA measures, attributable to the removal of processing errors and benchmark revisions, are random in nature, then the preliminary growth rate measures will be reliable estimates of revised growth rates.[11] If so, we expect to find the intercept coefficient β_0 in equation 1 of table 1 to be insignificantly different from zero, and the slope coefficient β_1 to be not different from unity. Moreover, the residuals should show no evidence of serial correlation, and the R^2 should be close to 1.0. If these conditions are not met, the preliminary growth rates are providing poor and/or biased estimates of revised growth rates. An examination of the results in table 1 reveals that all of these conditions are met for equation 1. Therefore, we conclude that the preliminary NSA M1 growth rates are unbiased and reliable estimates of the revised unadjusted growth rates.

Seasonally Adjusted Money Growth Rates

Now consider the same issue regarding seasonally adjusted M1 growth rates. Equation 2 regresses the revised seasonally adjusted growth rate of M1 ($\%\Delta M1R_t^s$) on the preliminary seasonally adjusted measure ($\%\Delta M1P_t^s$). Again, if the preliminary growth rate is a good estimate of the revised growth rate, we should observe that β_0 is close to zero, that both β_1 and the R^2 are close to one, and that the error term is serially uncorrelated. The empirical results indicate that only this last condition is satisfied. Both the estimate of the intercept term, β_0, and the slope coefficient, β_1, are significantly different from their desired values. The R^2 is also much smaller than that for equation 1.

The findings imply that preliminary seasonally adjusted estimates are biased predictors of revised seasonally adjusted monthly growth rates, and that the effects of revisions in seasonal factors on M1 growth rates are large relative to the effects of revisions in the underlying NSA data. Thus, adopting the new adjustment procedure has not eliminated the bias problem or the effects of large revisions in seasonal factors.

X-11 ARIMA AND THE PROBLEM OF EX-POST SMOOTHING

To better understand the bias problem, consider chart 1, in which revised and preliminary monthly M1 growth rates for 1982 are plotted. If the preliminary growth rates were good estimates of revised growth rates, then a plot of both growth rates should be along the "perfect fit" line — the 45° dashed line, designated as A. As illustrated, however, the estimated line (shown as the solid line B) relating revised and preliminary growth rates, as given by equation 2, is significantly different from this.

The results in table 1 and chart 1 indicate that preliminary money data are not reliable estimates of revised data, and that the revisions have "smoothed" the monthly growth rates relative to preliminary estimates as well. Line B intersects Line A at a growth rate of 8.1 percent — very close to the 1982 average monthly growth rate using either revised or preliminary data (8.2 percent each). Consider observations of preliminary growth rates above this 8.1 percent level. The fact that line B is below the perfect fit line A in such cases indicates that the revised growth rates generally will be less than preliminary growth rates. That is, preliminary growth rates above the mean will be revised downward, closer to the sample period mean.

Alternatively, when preliminary growth rate estimates are less than 8.1 percent, line B lies above line A, indicating that the revised growth rates generally will be larger than the preliminary growth rates. In these cases, the growth rates generally will be revised upward closer to the sample period mean. It is not at all surprising, then, that the variance of revised seasonally adjusted growth rates is much less than that of the preliminary — 38.6 and 71.7 percent, respectively. This smoothing can be seen directly in chart 2 by the wider distribution of the preliminary (black line) relative to the revised seasonally adjusted growth rates (orange line).

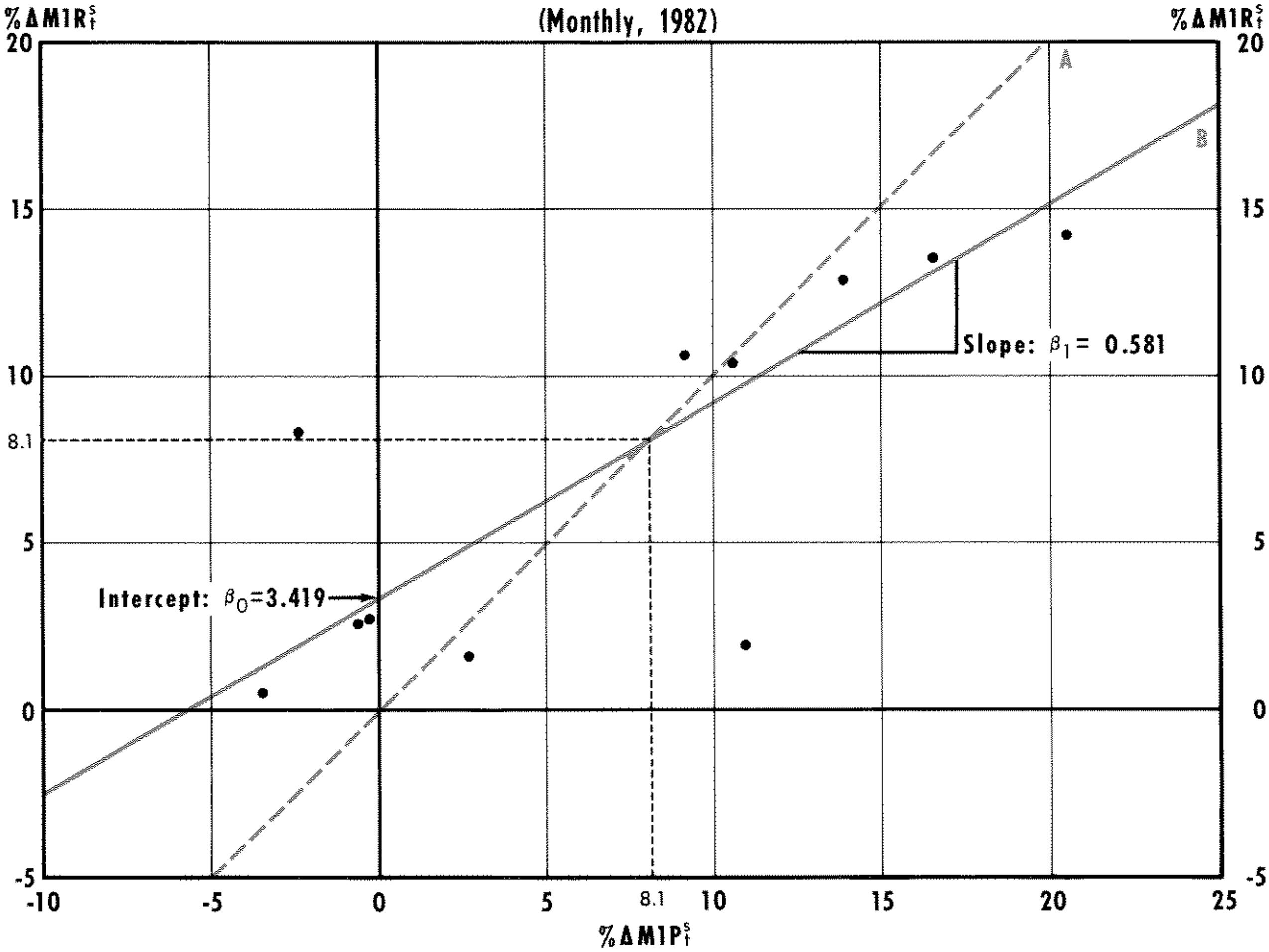
While the use of the X-11 ARIMA seasonal adjustment procedure has not eliminated the bias problem, there is evidence to suggest that its preliminary estimates represent some improvement over those of the basic X-11 procedure. When Stone and Olsen estimated a weekly growth rate equation similar to equation 2 in table 1, they found the R^2 to be only 0.44 and β_1 to be only 0.21 for 1977.[12] The fact that both of these

[10] All percent changes ($\%\Delta$) are calculated as delta logs of monthly data expressed in annual rates. For example, $\%\Delta M1P_t^u = (\ln M1P_t^u - \ln M1P_{t-1}^u) \times 1200$.

[11] For a discussion of these revisions, see Richard W. Lang, "Benchmark Revisions of the Money Stock and Ranges of Money Stock Growth," this *Review* (June 1978), pp. 11–19.

[12] Stone and Olson, "Are the Preliminary Week-to-Week Fluctuations in M1 Biased?" table VI, p. 19. For a more direct comparison using weekly data, see table 2 below.

Chart 1
The Relationship Between Preliminary and Revised M1 Growth Rates



coefficients have moved closer to 1 in 1982 suggests that the X-11 ARIMA procedure provides preliminary seasonally adjusted estimates that are closer to the revised numbers. This improvement is encouraging. It remains true, however, that the preliminary measures upon which policy is based are biased.

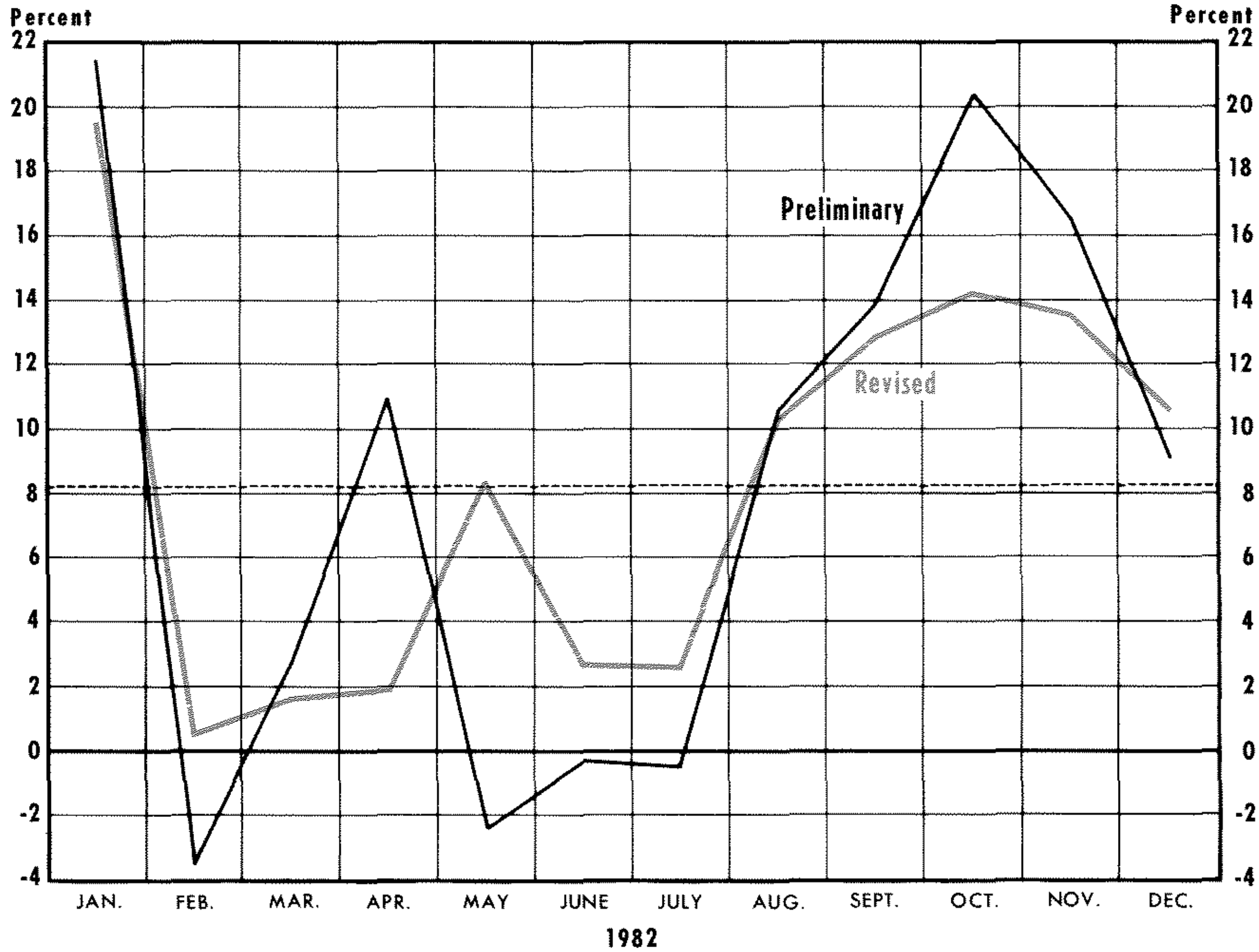
X-11 ARIMA AND THE PROBLEM OF MONEY SUPPLY SHOCKS

In order to accommodate seasonal money demand variation, the money supply must be varied seasonally. The influence that the Federal Reserve has on the money stock complicates the issue of seasonal adjustment. Fluctuations in the quantity of money may be due to supply-side variations as a result of actions taken by the Federal Reserve, as well as demand-side variations whether seasonal, random or trend-cycle. The fact that the money stock is affected by Fed actions makes it important that the seasonal variation in the demand for money be isolated. Presumably, it is this effect that the Fed would want to accommodate. Unfortunately, the present seasonal adjustment procedure fails to isolate demand shifts from supply impulses.

As we have seen, this procedure is based on the behavior of the money stock itself. The problem is that the time series of money stock data records the history of both demand- and supply-side effects. For example, figure 2 shows the same increase in the money stock from one month to the next that was illustrated earlier in figure 1. Since the change in the money stock is identical in both cases, present seasonal adjustment

Chart 2

Seasonally Adjusted M1 Growth Rates



NOTE: Horizontal dashed line represents an 8.2 average of preliminary and revised seasonal growth rates.

procedures would result in identical estimates of the seasonal factors. Yet, there is an important difference. It is only in the case of figure 1 that the change was due to seasonal variation in the demand for money. In figure 2, the increase in money stock is a result of Fed actions with no seasonal change in the demand for money.

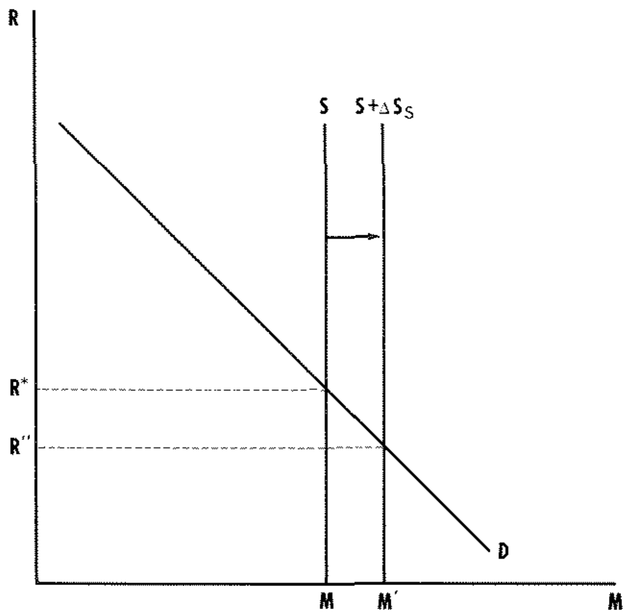
Why is this estimation problem a concern? To see the inherent difficulties, consider a policy action based on a faulty seasonal estimate. Suppose, for example, that a seasonal increase in the demand for money is "expected", but never occurs (figure 2 is again relevant). The Fed would increase the supply of money, but demand would remain unchanged. As an excess supply of money developed, the public would increase its purchases of goods and services or financial assets. Thus, as a result of the incorrect estimation of the seasonal impulse, the monetary authorities would cause the type of economic disruptions they were trying to mitigate. Additionally, since the quantity of money would increase, the seasonal adjustment procedure would continue to show that there was a seasonal impulse in the data. Consequently, monetary authorities would have little reason to suspect that there were any problems with their actions when they examined the behavior of seasonally adjusted money stock.

PROPOSED ALTERNATIVE METHODS

These problems and others have led to a number of proposals for modifying or replacing current procedures. They range from improving the specifications of

Figure 2

Misestimated Seasonal Demand Variation Leads to Inappropriate Money Supply Variation



seasonal demand variation — for example, a model-based seasonal adjustment — to forsaking seasonal adjustment altogether.[13]

Model-Based Seasonal Adjustment

The Board of Governors' Committee of Experts on Seasonal Adjustment Techniques recommended consideration of another seasonal adjustment procedure: "Model-based approaches to seasonal adjustment of monetary aggregates should be developed and applied on a current and a continuing basis."[14] The advantages of this procedure with respect to the currently employed X-11 ARIMA include explicit allowance for both deterministic and stochastic influences within the seasonal adjustment procedure and separation of short-run variations in seasonal factors from long-run stable factors. Thus, this procedure has the potential of avoiding ex-post smoothing, which plagues the X-11 adjustment procedures, while at the same time allowing for endogenous estimation of changes in seasonal factors.[15] It is clear, however, that this procedure would depend on the judgment of the modeler in selecting the deterministic elements.

The model-based procedure's potential advantage over the purely statistical analysis of the X-11 ARIMA procedure is its ability to explicitly model the behavioral aspects underlying money demand. These aspects include both the calendar characteristics and the opportunity costs and motivations of money holding; their inclusion, at least in principle, provides a way to distinguish between supply- and demand-induced movements of the money stock.[16]

Table 2 presents tests on weekly growth rates of seasonally adjusted M1, using both the model-based and the X-11 ARIMA procedure. As in table 1, the revised estimated growth rates, seasonally adjusted by each procedure, are regressed on the preliminary estimated growth rates. Once again, reliable policy guidance requires that the preliminary estimates be unbiased predictors of the revised estimates, which implies that the β_0 and β_1 shall be, respectively, insignificantly different from zero and unity. As can be seen, the X-11 ARIMA estimates are biased at the weekly level as they were at the monthly level, but the model-based procedure estimates satisfy both criteria. The Durbin-Watson statistic, however, is in the ambi-

[13]These problems with seasonal adjustment procedures are not unknown to the Federal Reserve Board of Governors; they are outlined in the report of its Committee of Experts on Seasonal Adjustment Techniques. Of the Committee's 10 recommendations for improving seasonal adjustment procedures, five addressed the need for reducing revisions of the estimated seasonal factors, and five, in various ways, asserted the need for the Board to "set forth its views on policy with respect to seasonal variations in the demand for and supply of money and credit." Moore, and others, "Seasonal Adjustment."

[14]Moore, and others, "Seasonal Adjustment," Recommendation 3, p. 2.

[15]Another substantial advantage of this procedure is that it is a weekly model. Thus, in contrast to the X-11 ARIMA procedure, the model-based procedure directly handles calendar quirks such as holidays, the varying number of weeks in a month or even the day of the week upon which schedule-by-date transactions occur. These anomalies change the monthly transaction patterns in a way that a monthly based procedure cannot systematically or dependably assess.

[16]In order to obtain these advantages, the model-based procedure assumes that the seasonality in a monetary aggregate has both a deterministic and a stochastic component. The procedure first obtains estimates of the deterministic component in order to isolate the stochastic component as a residual; then it identifies the stochastic structure as an ARIMA model; and finally, it estimates simultaneously both deterministic and stochastic components. See David A. Pierce, Michael R. Grupe, and William P. Cleveland, "Model-Based Seasonal Adjustment of the Weekly Monetary Aggregates" (Board of Governors of the Federal Reserve System, October 1982), mimeo. This multipart procedure has been used to estimate seasonal factors and to provide an alternative seasonally adjusted M1 series since January 1982 (reported in the Board of Governors' H.6 statistical release). As the Committee of Experts suggested, this will "build up a fund of experience with model-based approaches so that their advantages and disadvantages can be appraised in a realistic environment." Moore, and others, "Seasonal Adjustment," p. 2.

Table 2

Comparative Results of Tests for Bias in Preliminary 1982 Weekly Seasonally Adjusted M1 Growth Rates — X-11 ARIMA and Model-Based Procedures

X-11 ARIMA				Model-Based			
$\%\Delta\, M1R_t^s = \beta_0 + \beta_1\, \%\Delta\, M1P_t^s$				$\%\Delta\, M1R_t^s = \beta_0' + \beta_1'\, \%\Delta\, M1P_t^s$			
β_0	β_1	R^2	DW	β_0'	β_1'	R^2	DW
4.080	0.492	0.579	2.46	2.011	1.140	0.486	2.50
(1.779)	(0.060)			(3.565)	(0.167)		

X-11 ARIMA	Model-Based
t-statistic testing H_0: $\beta_0 = 0$; $t_c = 2.29^*$	t-statistic testing H_0: $\beta_0 = 0$; $t_c = 0.56$
t-statistic testing H_0: $\beta_1 = 1.0$; $t_c = -8.47^*$	t-statistic testing H_0: $\beta_1 = 1.0$; $t_c = 0.83$

NOTE: *Denotes rejection of null hypothesis at the 5 percent level. Standard error of coefficient estimate in parentheses.

guous region for negative serial correlation (2.43 – 2.53 at the 5 percent level), and the R^2 is much lower than 1.0 and even low relative to that for the X-11 ARIMA estimates. Nonetheless, these model-based results are an improvement over the X-11 ARIMA results to the extent that the preliminary estimates of the revised growth rates are both unbiased and not subject to the smoothing criticism of the current procedure.

Year-Over-Year Growth Rates

Some monetary economists have become so skeptical of seasonally adjusted money stock data that they now suggest that it no longer be calculated. For example, Poole and Lieberman were concerned that "one of the dangers of the X-11 model is that outliers are all too easily explained away by superficial appeal to changing seasonals."[17] Thus, concerned observers of monetary targeting have suggested using the year-over-year growth rates of NSA aggregates, thereby avoiding the problem of biased preliminary seasonally adjusted data. Since both the current and one year earlier NSA values would be from a similar point in the seasonal cycle, the only seasonal effect on the year-over-year growth rate would result from a change in the seasonal factor from one year to the next. This change will be minor relative to the seasonal factor itself and will not yield any long-run seasonal impulse in the data reported in this fashion.[18]

This procedure would avoid both the criticism that the seasonal adjustment procedure has overly smoothed the data, thereby destroying important information, and the misinterpretation of supply-side shocks as seasonal demand shifts (see figure 2). Reporting NSA aggregate growth rates in this fashion alleviates the concern that important information may be discarded in the adjustment process.

CONCLUSIONS

Money stock measures currently are adjusted for seasonal variation via a variant of the X-11 seasonal adjustment program. The use of this program has many shortcomings, especially for policymakers. The preliminary estimates of the seasonal factors, which policymakers must use in implementing policy, are biased. This implies that policies may have been executed on faulty information. There is also a concern that revised estimates of seasonally adjusted money measures under the present procedure have been

[17]Poole and Lieberman, "Improving Monetary Control," p. 332. The Shadow Open Market Committee has recommended eliminating seasonal adjustment of the monetary aggregates altogether. In its place, the Committee has recommended reporting NSA aggregates for the most recent period and for the corresponding period of the previous year. See also the "Policy Statement of the Shadow Open Market Committee, March 16, 1981," *Annual Report*, Center for Research in Government Policy and Business, Graduate School of Management, University of Rochester (June 1981), pp. 31–35, especially p. 33.

[18]The Committee of Experts on Seasonal Adjustment Techniques noted the usefulness of measuring money growth in this fashion:

> "The ordinary 12-month change does have the advantage of not being affected at all by seasonal adjustment revisions because it can be computed from unadjusted data."

Moore, and others, "Seasonal Adjustment," p. 48.

overly smoothed, destroying information for ex-post analyses of policy. Finally, the present seasonal adjustment technique does not differentiate among the various factors affecting the monetary stock. It has been suggested that monetary policy should accommodate seasonal demand impulses, yet the present technique does not attempt to isolate these impulses from those due to non-seasonal changes in the money supply.

There currently are two alternative solutions to the problems cited above. One solution would be to improve upon the seasonal adjustment procedure itself. A model-based adjustment procedure, which does not result in systematic revisions of seasonal factors, is one possibility. The model-based approach investigated here satisfies both the unbiasedness and the no-smoothing criteria. There remains a question, however, regarding the ability of this procedure to isolate seasonal demand variation.

At the other extreme, there is the belief that estimation problems associated with seasonal adjustment are insuperable. Some critics have even recommended that seasonally adjusted data no longer be published. In this case, monitoring year-over-year growth rates of not-seasonally-adjusted money represents a feasible process for tracking the trend-cycle component of the money stock. Whether or not one of these extremes is selected, it is clear that seasonal adjustment problems present a challenge for a policy based on the targeting of a monetary aggregate that cannot be ignored.