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ERRORS IN PRELIMINARY MONEY STOCK DATA AND MONETARY AGGREGATE TARGETING

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1. INTRODUCTION

Morgenstern (1963, p. 7) has suggested that the uncertain progress of the social sciences can be attributed, to some degree, to the relatively little attention paid to errors of measurement. Since then, some effort has been devoted in economics to analyzing ways in which the presence of measurement errors can affect econometric model identification and estimation (see, for example, Aigner and Goldberger, 1977). Nevertheless, little is known about the magnitude and effects of errors actually present in economic data, though some results are given by Pierce (1981). This paper analyzes an important class of errors: those in the preliminary monetary aggregate series, used in the conduct of short-run monetary policy, which are subsequently eliminated by revisions in those series. Among them, revisions in seasonal factors play a particularly important role.

The plan of the paper is as follows. The next two sections describe the way in which data were collected and revised, over the 1972-79 period. Sections 4 and 5 then discuss the formation and revision of two-month growth rates in the money stock, used by the Federal Open Market Committee (FOMC) during much of this period in monetary policy design and implementation. Statistical properties of the growth rates and of the seasonal and nonseasonal components of their revisions are investigated.

Sections 6 through 8 then investigate the effects of money stock revisions on monetary control, examining the extent to which preliminary and final data give conflicting policy signals as a result of one figure lying inside but the other outside the FOMC's tolerance limits for the money stock. Using empirical and analytical approaches (Sections 7 and 8, respectively), it is found that "wrong" signals were given about 40 percent of the time by the preliminary data then available, containing not-yet-removed revision errors. However, if improved seasonal adjustment techniques are used and if nonseasonal revisions are not a problem (perhaps more plausible after full implementation of the Monetary Control Act), it is found that this percentage can be approximately cut in half.

Section 9 presents some conclusions.

This study is limited to the 1972-79 period, for several reasons. In October 1979 some modifications in monthly operating procedures were announced, in February 1980 changes in the definition of the aggregates were introduced, and in late 1980 the Monetary Control Act, changing some bank reporting procedures, went into effect. Thus the targeted series and the targeting procedures are different today than during this period. However, the present study is still of more than historical interest. Experience with the redefined aggregates is very limited and it will be several years before enough preliminary data and revisions are available to enable a comparable study to be performed using the new aggregates. Moreover, the historical statistical characteristics (sizes, variances and autocovariances) of M-1 and of M-1A,B are broadly similar, the seasonal factor revision process is essentially unchanged, and tolerance ranges akin to those described in Sections 6 and 7 continue to be used in policy design. Thus, inference from the 70s' experience to the 80s' outlook seems warranted.

2. THE COMPUTATION OF MONETARY AGGREGATE SERIES

As noted in the Introduction we consider the money supply control by the Federal Reserve in the U.S. during the years 1972-79. In this period, control was based on monetary aggregate targeting set at the monthly meetings of the Federal Open Market Committee (FOMC). We shall limit the present analysis to M-1, the principal monetary aggregate considered, defined as the sum of currency plus private demand deposits.

The construction of the M-1 series over this period is as follows: Every week the (approximately) 5500 member banks and (in 1978-79) a sample of 600 of the (approx.) 8700 nonmember banks report their daily closing balances for the last week. The first published estimate, which becomes available 9 days after the end of the week, will be subject to several revisions. The first ones, made 1 and 2 weeks later, are primarily due to late reporting and to processing errors. More importantly, at the end of each quarter, balance sheets from nonmember banks are obtained, producing the "benchmark" revisions, which involve several months of processing time.

Since monetary policy is set for seasonally adjusted series, in order to assess how the evolution of M-1 relates to the intended policy incoming data on the aggregate is seasonally adjusted. At the beginning of each year, seasonal factors which will be using during that year are computed. This is done through a combination of X11 and judgemental corrections. In subsequent years, as more data become available, those factors are revised. The nature of seasonal factor revision is explored in the following section.

3. REVISION OF SEASONALLY ADJUSTED AGGREGATES

The Federal Reserve Board employs a multiplicative model for its seasonal adjustment (determined, as noted, by the X-11 program supplemented by judgemental modification). Denoting by S_t the seasonal factor to be applied to a not seasonally adjusted monetary aggregate X_t, the seasonally adjusted aggregate is thus

$$M_t = X_t/S_t.$$

It is convenient to work with logarithms, as aggregate growth rates are essentially the changes in the logs. Moreover, the more easily analyzed <u>additive</u> model can characterize the seasonal adjustment; that is, letting $x_t = \log X_t$, $s_t = \log S_t$ we have

$$m_t = x_t - s_t. \tag{1}$$

In (1), s_t as determined by X-11 is a symmetric moving average of x_t, written as

$$s_t = \sum_{j=-k}^{k} \nu_j x_{t-j} = \nu(L)x_t \tag{2}$$

where

$$\nu(L) = \sum_{j=-k}^{k} \nu_j L^j$$

is a polynomial in the lag operator L (defined by $L^j x_t = x_{t-j}$).

The foregoing is a characterization of the "final" seasonal adjustment, for historical data for which an adequate number of observations both before and after time t are available. With data only up to time t_i, the moving average $\nu(L)$ has to be truncated and the optimal estimate of s_t can be expressed as:

$$s_t^{(i)} = \nu_i(L)x_t. \tag{3}$$

When $t \gtreqless t_i$, $s_t^{(i)}$ represents the estimate of future, present or past seasonal component. The difference between (2) and (3) can be seen as implied by the fact that (2) uses values x_t for $t > t_i$, while (3) in effect replaces these values with some sort of forecasts (see Wallis, 1980).

If $t_2 > t_1$, then the variable

$$d_t^{(2,1)} = s_t^{(2)} - s_t^{(1)}$$

represents the <u>revision</u> in the seasonal component $s_t^{(1)}$ after the observations $x_{t_1+1}, \ldots, x_{t_2}$ have become available.

The properties of d_t are easily understood if we consider that the information in the new observations between t_1 and t_2 consists of two parts: one already included in the past realizations of the variable (i.e., the conditional forecast) and one that is truly new (i.e., the innovations $a_{t_1+1}, \ldots, a_{t_2}$). Specifically, $d_t^{(2,1)}$ is the result of a linear filter applied to these (t_2-t_1-1) innovations.

Although revision of a seasonal factor could theoretically extend into the infinite future, in practice the contribution of x_{t+k} in the estimation of s_t is negligible for large enough k and, after three additional years of data have become available, revision of the seasonal factor is completed and the estimate is taken to be final.

4. THE RATES-OF-GROWTH OF M-1 SERIES

It will be convenient to separate the revisions in monetary aggregates into "seasonal revisions", stemming from revision in seasonal factors, and "nonseasonal revisions" stemming from nonmember bank benchmarking and other sources. The monthly M-1 series will be denoted M_j^i. The superscript i refers to seasonal adjustment and the subscript j to nonseasonal revisions. In particular:

$$i = \begin{cases} u, \text{ unadjusted series} \\ a, \text{ preliminary adjusted series} \\ A, \text{ final adjusted series} \end{cases}$$

$$j = \begin{cases} 0, \text{ preliminary series} \\ f, \text{ final series.} \end{cases}$$

Thus, for example, M_0^u denotes the unadjusted first published monthly series of M-1, and M_f^A the final seasonally adjusted series, after all revisions have been performed (the subscript t will be deleted, except when specifically needed). The preliminary seasonal factor, s^0, is given by M_0^u/M_0^a, and the final seasonal factor, s^f, by M_f^u/M_f^A.

Since FOMC policy directives are set for the rates-of-growth over a two-month period, the M-series will be transformed into a series m_t, computed as

$$m_t = 6(M_t - M_{t-2})/M_{t-2} \times 100\%.$$

or alternatively, to a very close approximation, as

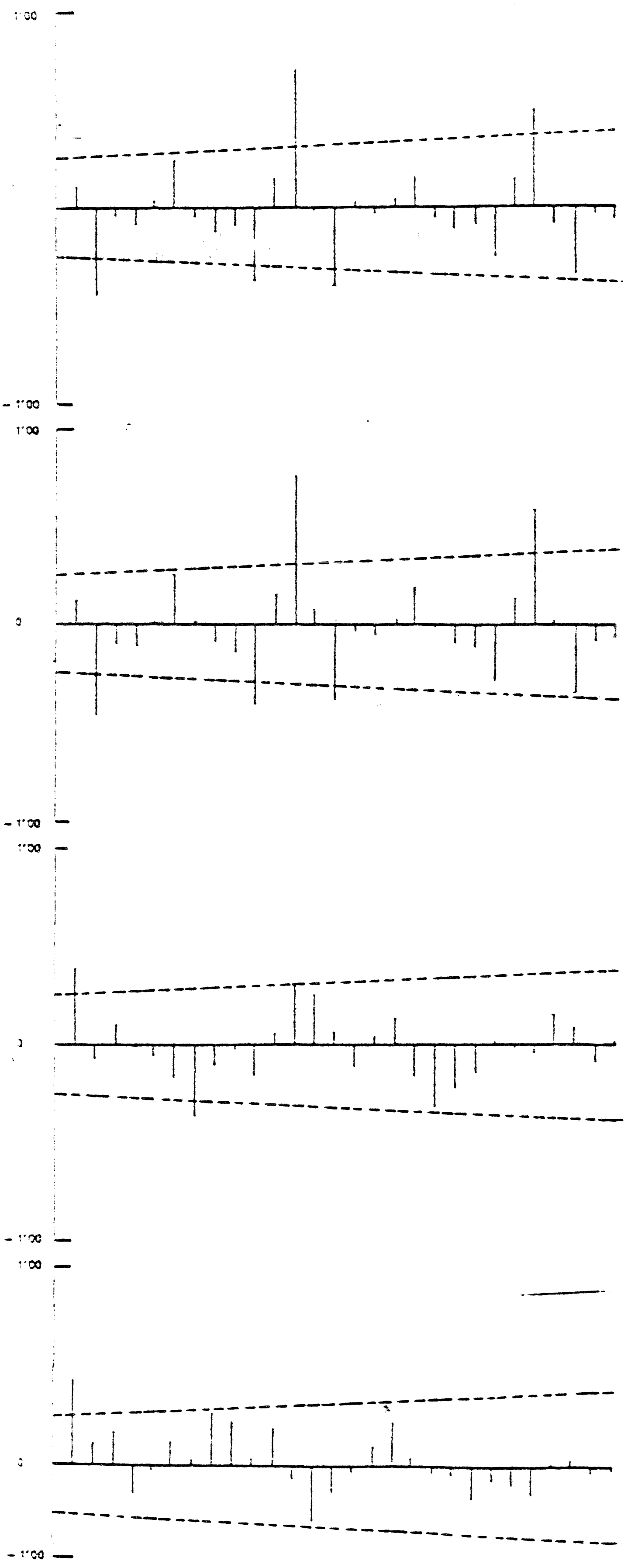
$$m_t = 6(1 + L)\ \nabla \log M_t \times 100\%.$$

Thus, all values of m are expressed as annualized (not compounded) percentage growth rates. Since we use two years at the beginning and end of the period in order to compute the final seasonal factors, the m-series cover the years 1974-77 and consist of 48 observations.[1]

The autocorrelation functions of the m-series are given in Figure 1. It is seen that nonseasonal revisions have little (if any) effect on the stochastic structure of the series. On the contrary, preliminary seasonal adjustment does change seasonal and nonseasonal (mostly, low-order) autocorrelation. Seasonal revisions contribute further to modifying these autocorrelations. If we consider the first two moments, it is seen that the two series m_0^a and m_f^A have similar means (5.59 and 5.67, respectively), but that the standard deviation is significantly reduced after seasonal revisions have been performed (from 4.43 to 2.73). If we denote by σ_j^i the standard deviation of m_j^i, since $\sigma_0^u = 13$ then approximately $\sigma_0^u = 3\sigma_0^a = 5\sigma_f^A$. Thus preliminary seasonal adjustment removes two thirds of the standard deviation of the unadjusted first published series, and seasonal factor and other revisions raise this proportion to 80%.

1/ Strictly, we should have used a third year at both ends for the factors to be final; however, the revision associated with the third year are comparatively very small. The 1974-77 sample period has the further features that (i) complete information on tolerance ranges (Section 6) is available for this period but not earlier, and (ii) some unusual benchmark adjustments occurred in 1972 and 1973 which are atypical of subsequent experience.

Figure 1. Autocorrelation Functions of m-Series



a) m_0^u

b) m_f^u

c) m_0^a

d) m_f^A

5. THE REVISION-ERROR SERIES

Our error-component model can be written as:

$$m_0^a = m_f^A + d^T$$
$$d^T = d^S + d^N \qquad (4)$$

where d^T, d^S and d^N represent the total, seasonal and nonseasonal revisions, respectively.

The components d^S and d^N of the total revision can be computed in two different ways, as schematized in Figure 2, where m_0^A is obtained from $M_0^A = M_0^u/s^F$ and m_f^a is obtained from $M_f^a = M_f^u/s^0$. In fact, both procedures yield virtually identical results, and in what follows we shall assume $d^N = d^{N1}$ and $d^S = d^{S1}$.

The series d^N and d^S can be assumed orthogonal ($\rho = -.002$), as can the series m_f^A and d^T ($\rho = -.017$).

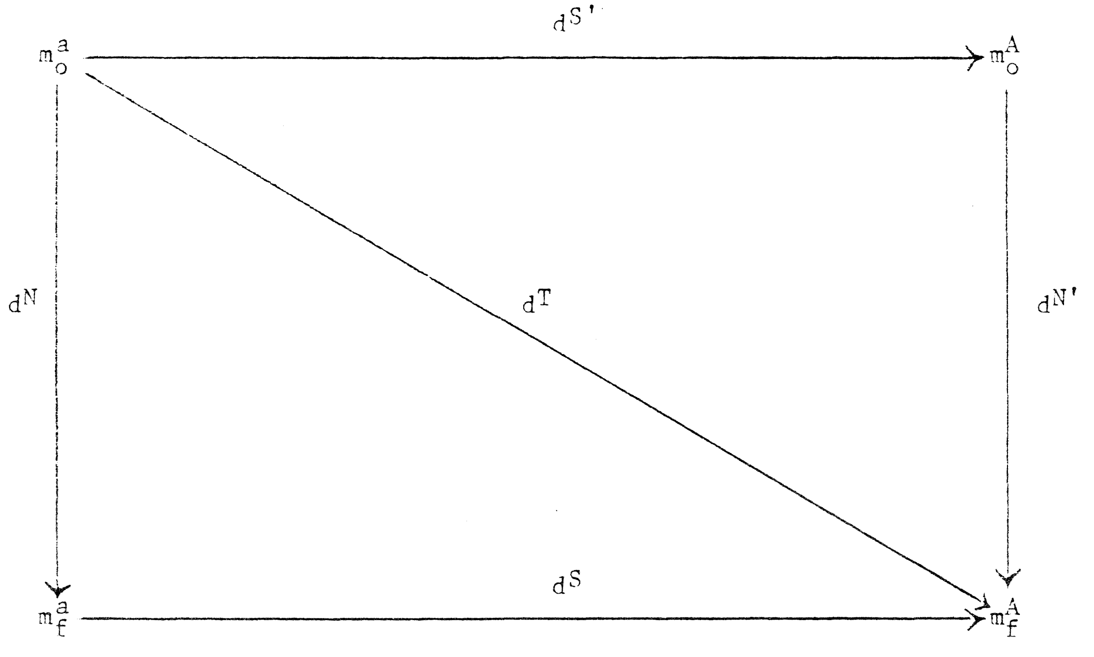
Figure 3 exhibits the ACF of the d-series. It is seen that d^N has low-order autocorrelation and very little seasonality, while d^S is strongly seasonal. Also, its ACF is in fair agreement with the "theoretical" ACF which can be derived from the stochastic modelling interpretation of X-11, as shown in Table 1, which shows that judgemental seasonal revisions have no effect on the stochastic structure of the d^S series.

The first two moments of the d-series are as follows:

	Mean	Standard Dev.
d^T	.09	3.42
d^S	.01	2.72
d^N	.08	2.08

Thus the means are roughly zero, and the standard deviation of d^S exceeds that of d^N.

Figure 2. Preliminary and Revised M-1 Growth Rates (m), and Revisions (d)



o: Preliminary data with respect to nonseasonal effects

f: Final data with respect to nonseasonal effects

a: Seasonally adjusted using preliminary seasonal factors

A: Seasonally adjusted using final seasonal factors

Figure 3. Autocorrelation Functions of d-Series

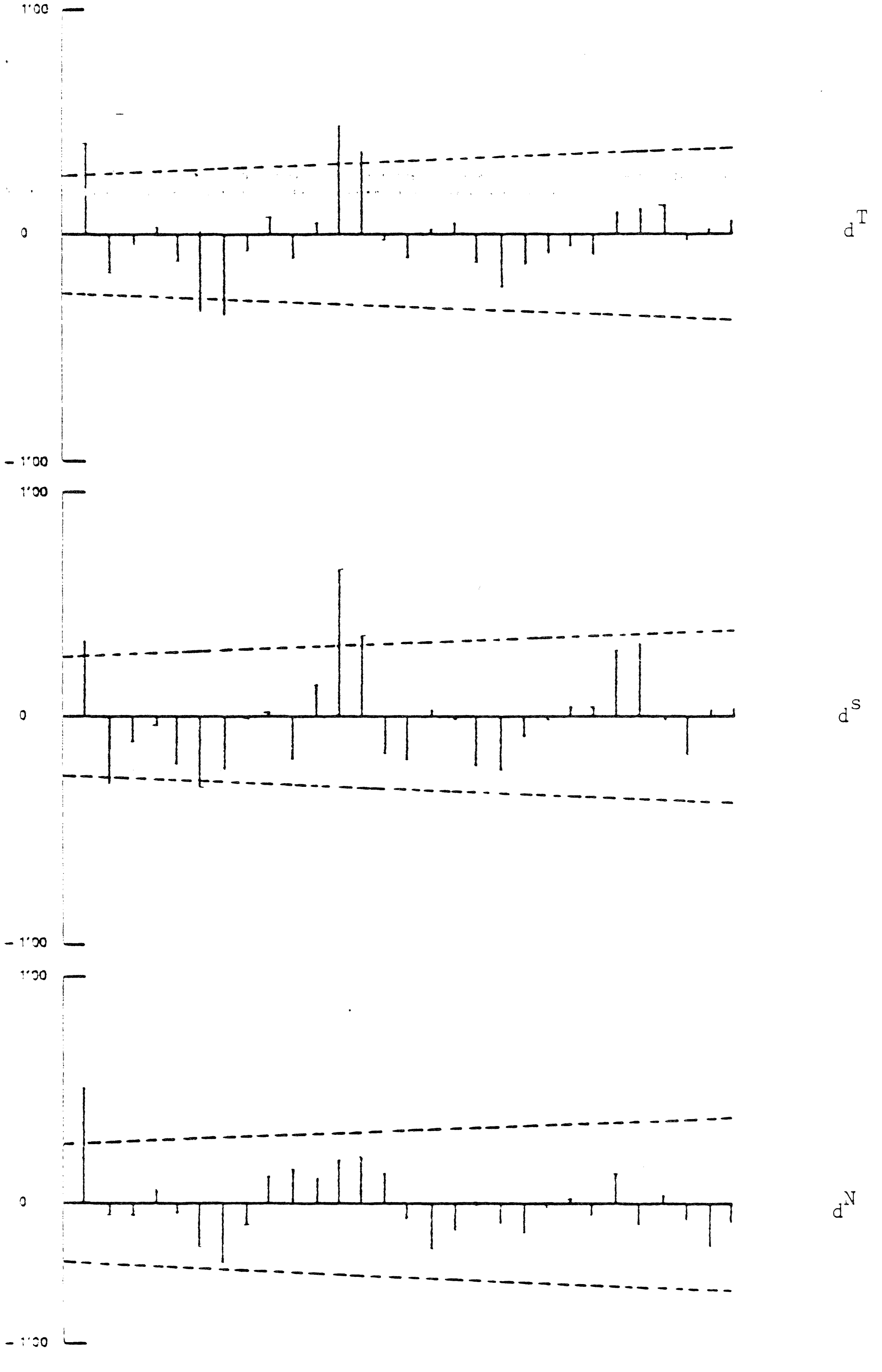


Table 1

Lag	ACF of d^s	Theoretical AC
1	.38	.52
5	-.27	-.26
6	-.30	-.15
7	-.24	-.30
11	.14	.21
12	.65	.64
13	.37	.36
23	.05	.07
24	.29	.28
25	.33	.17

6. EFFECTS OF REVISION ERRORS ON MONETARY CONTROL

At each monthly meeting the Federal Open Market Committee (FOMC) sets a target range for the rate of growth of the monetary aggregates over a two-month period. Policy action depends in part on whether or not the growth of the aggregates falls within this range. More precisely, policy action depends on whether a forecasted aggregate (conditional on taking no action) falls within the range for the current two-month period. Since data on forecasts are unavailable, we use actual figures instead, noting that in any event the actual figures' behavior would ordinarily exert the dominant influence on the subsequent forecasts. (See Wallich and Kier (1978) for further discussion of short-run monetary control).

At a particular FOMC monthly meeting, in order to set the range of tolerance for the next two-month period consistent with the longer term objectives, it is crucial to known whether growth over the last period was appropriate or not. If growth of M-1 was way-off target, actions should be taken to bring it back to the tolerance range (or, alternatively, the longer run objectives could be modified).

To judge whether last period M-1 growth was as desired or went out of bounds, only the preliminary figure is available, m_0^a. The question we address next is the extent to which the monetary authority may take different actions by relying on the preliminary growth rate than would be appropriate if the final growth rate were known. Insofar as the range of tolerance is intended to be for "true" M-1 growth rates, or at least the reported final rates, policy actions taken on the basis of such signals may be regarded as mistakes, caused by errors in the money supply data.

We are therefore interested in estimating the likelihood that the presence of revision error in m_0^a may cause this preliminary figure to indicate that growth was as desired when it was not, or that growth was not as desired when in fact it was. We shall investigate this likelihood two different ways, empirically and analytically.

7. REVISIONS AND MONETARY TARGETING: AN EMPIRICAL APPROACH

Table 2 and Figure 4 show the evolution of the range of tolerance and of the m_0^a and m_f^A series for the years we consider. The midpoint of the range remained roughly constant (at about 5.75), and the width increased steadily (from 2 percentage points in early 1975 to 6 percentage points at the end of 1977). This increasing width possibly reflects the Fed's growing awareness that the available measurements of M-1 were rather volatile.

Examining Table 2 and Figure 4, it is seen that, out of 48 times, the preliminary figure m_0^a gave a wrong signal 21 times, or a proportion of 44%. Of these, 13 times indicated that growth was beyond the bounds when the opposite was true of the final figure, 6 times it appeared to be as desired when it was not, and twice the growth rate was shown to be out of bounds but on the wrong side (for example, that it was growing too fast when in fact it was not growth enough).

The assumptions

$$E(m_0^a) = E(m_f^A) = \ell$$

$$m_0^a = m_f^A + d^T$$

$$m_f^A \perp d^T,$$

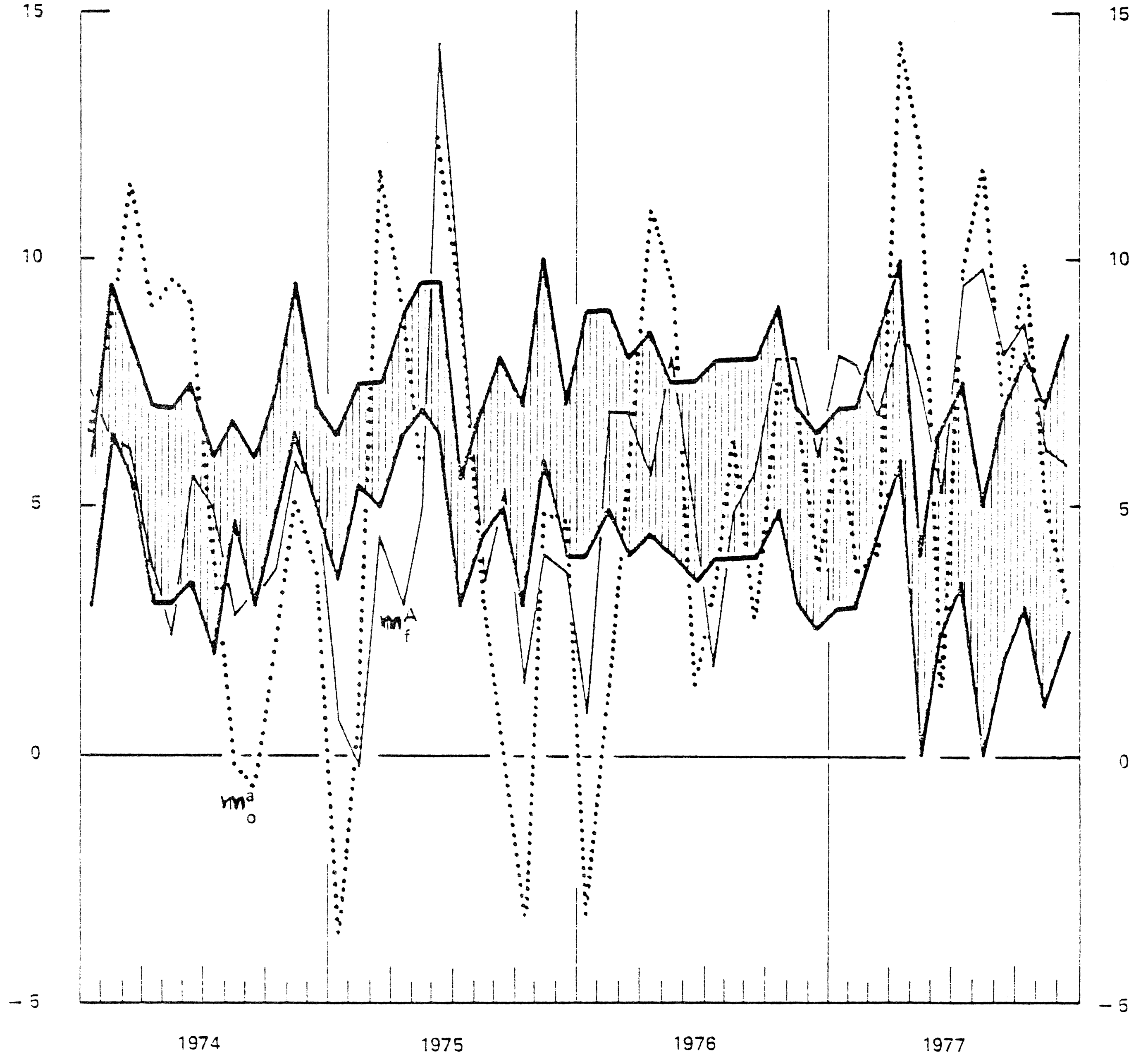
where ℓ is the midpoint of the range, which are evidently satisfied by our series, imply that (on the average) m_f^A will be closer to ℓ than m_0^a.

A related point concerns the relationship between the revision error at time t and future policies with respect to monetary aggregates. Assume, for example, that $(m_0^a)_t$ shows a very large departure from the range of tolerance set for period t and, for the sake of simplicity, let $d^T = d^S$.

Table 2. Tolerance Range and Actual Values of Preliminary and Final M-1 Two-Month Growth-Rate Series, Monthly, 1974-1977

Tolerance Range		m_0^a	m_f^A	m_0^A	m_f^a
lower limit	upper limit				
3	6	6.52	7.37	11.66	2.23
6.5	9.5	8.94	6.43	11.73	3.64
5.5	8.5	11.57	6.11	7.74	10.01
3	7	9.02	3.72	5.45	7.31
3	7	9.60	2.40	7.27	4.74
3.5	7.5	9.11	5.67	6.98	10.41
2	6	4.08	5.00	1.62	7.47
4.25	6.75	-.21	2.81	1.08	1.51
3	6	-.64	3.23	3.03	-.44
4.75	7.25	2.35	3.37	4.49	1.73
6.5	9.5	5.13	6.01	4.67	6.50
5	7	3.62	5.13	2.75	6.00
3.5	6.5	-3.60	.64	1.24	-4.21
5.5	7.5	.63	-.21	4.54	-4.12
5	7.5	11.72	4.46	8.57	7.60
6.5	9	8.88	2.97	4.49	7.35
7	9.5	5.64	5.05	3.33	7.37
6.5	9.5	12.50	14.34	10.9	15.93
3	5.5	9.73	8.98	7.59	11.12
4.5	7	3.06	3.50	3.50	3.06
5	8	.20	5.35	3.08	2.47
3	7	-3.25	1.43	-.84	-.97
6	10	4.89	4.08	4.26	4.70
4	7	4.69	3.68	3.64	4.73
4	9	-3.23	.81	-.59	-1.83
5	9	1.21	6.90	5.08	3.04
4	8	6.09	6.88	6.46	6.51
4.5	8.5	10.91	5.62	5.85	10.69
4	7.5	9.45	8.00	6.38	11.07
3.5	7.5	1.39	4.77	2.97	3.19
4	8	3,37	1.78	2.02	3.11
4	8	6.34	4,93	4.54	6.73
4	8	2.76	5.71	4.51	3.95
5	9	7.45	8.02	7.49	7.98
3	7	7.05	7.99	7.68	7.36
2.5	6.5	3.68	5.99	5.92	3.74
3	7	6.39	8.08	7.97	6.49
3	7	3.66	7,84	7.10	4.55
4.5	8.5	4.02	6.33	5.40	5.46
6	10	14.34	8.68	8.36	14.16
0	4	12.13	7.32	8.15	11.36
2.5	6.5	1.31	5.21	3.32	3.19
3.5	7.5	9.70	9.46	7.94	11.21
0	5	11.74	9.73	10.21	11.30
2	7	6.61	8.03	8.79	5.35
3	8	9.37	8.71	9.38	9.20
1	-	5.08	6.12	5.70	5.52
2.5	8.5	3.06	5.90	5.04	3.93

Figure 4. M-1 Growth-Rate Revisions
and Tolerance Region (Shaded)



According to (4), the large value for $(m_0^a)_t$ can be due to a large value for $(m_f^A)_t$ and/or to a large value for d_t^s. If policy makers believe that what is happening is that the true rate is way-off target, they will tighten future growth of M-1. If, on the contrary, they suspect a very large error, growth of the aggregate might not be very much affected. Hence the two different possibilities can lead to rather different growth rates for future periods.

Since the final estimate of s_t depends on those future rates of growth, it turns out that depending upon which policy is adopted, different final estimates of s_t will be obtained. Thus, eventually, different revision errors d_t^s will result. Therefore, as far as we can tell, given a particular $(m_0^a)_t$, how far from target $(m_f^A)_t$ happens to be depends on future policy, which after all was supposed to be set as a function of that departure. Or, to put it another way, how misleading $(m_0^a)_t$ is as an indicator of the true underlying growth rate depends on policy adopted at times subsequent to t. However, we shall not concern ourselves with what the revision error series might have been if different monetary policies had been adopted.

We observed that the proportion of time that m_0^a gave the wrong signal was 44%. Since this is due to the presence of seasonal and nonseasonal revisions in the preliminary data, it is of interest to investigate how the two types of revision contribute separately to that proportion.

Figure 5 plots m_0^A versus m_f^A for the years 1974-79. Out of 48 times, the "preliminary" figure yielded the wrong signal only 9 times. Thus knowledge of d^s would have improved considerably the reliability of preliminary information. On the other hand, when m_f^a is compared to m_f^A (Figure 6),

Figure 5. Differential M-1 Growth Rates
Due to Nonseasonal Revision

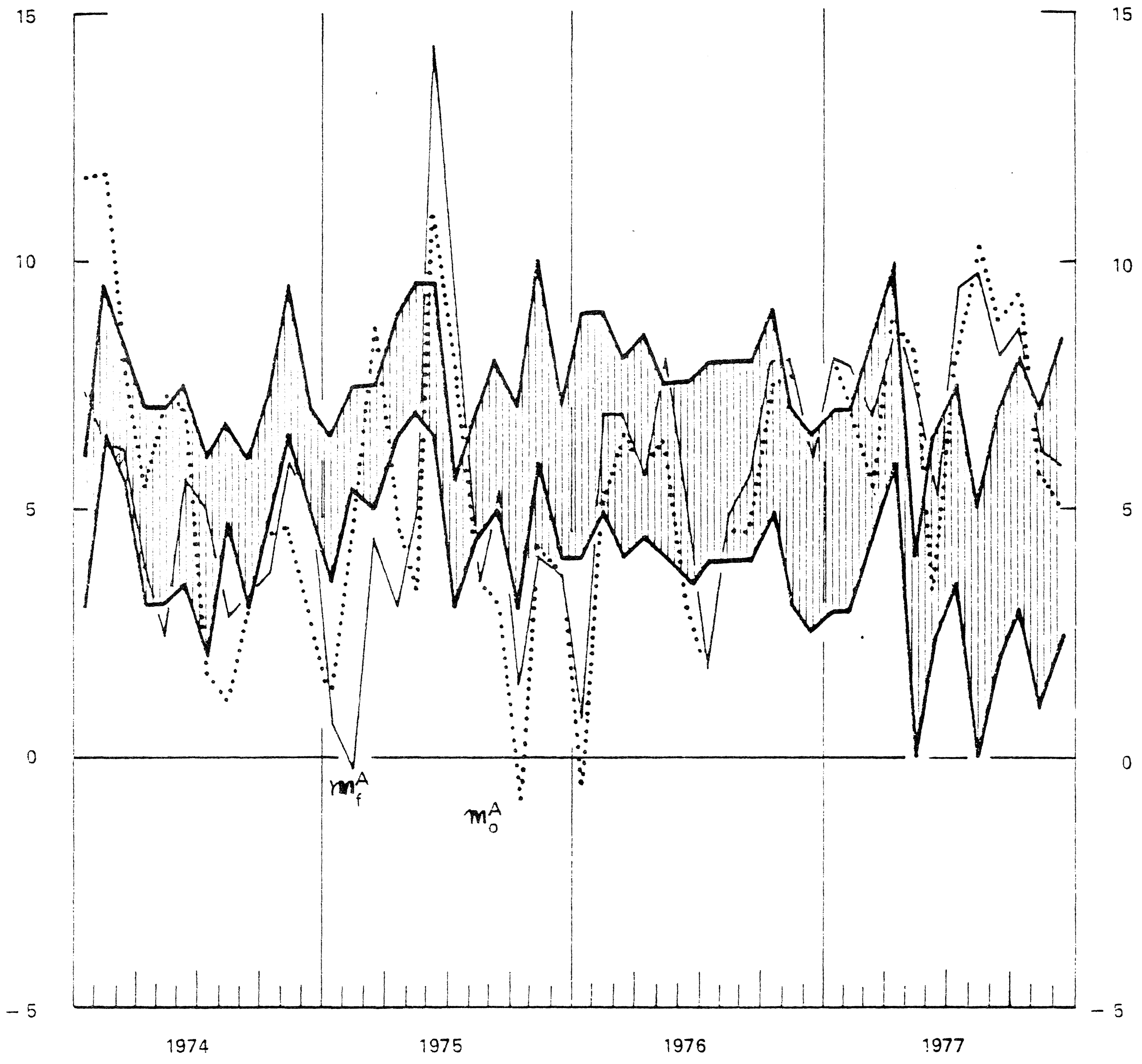
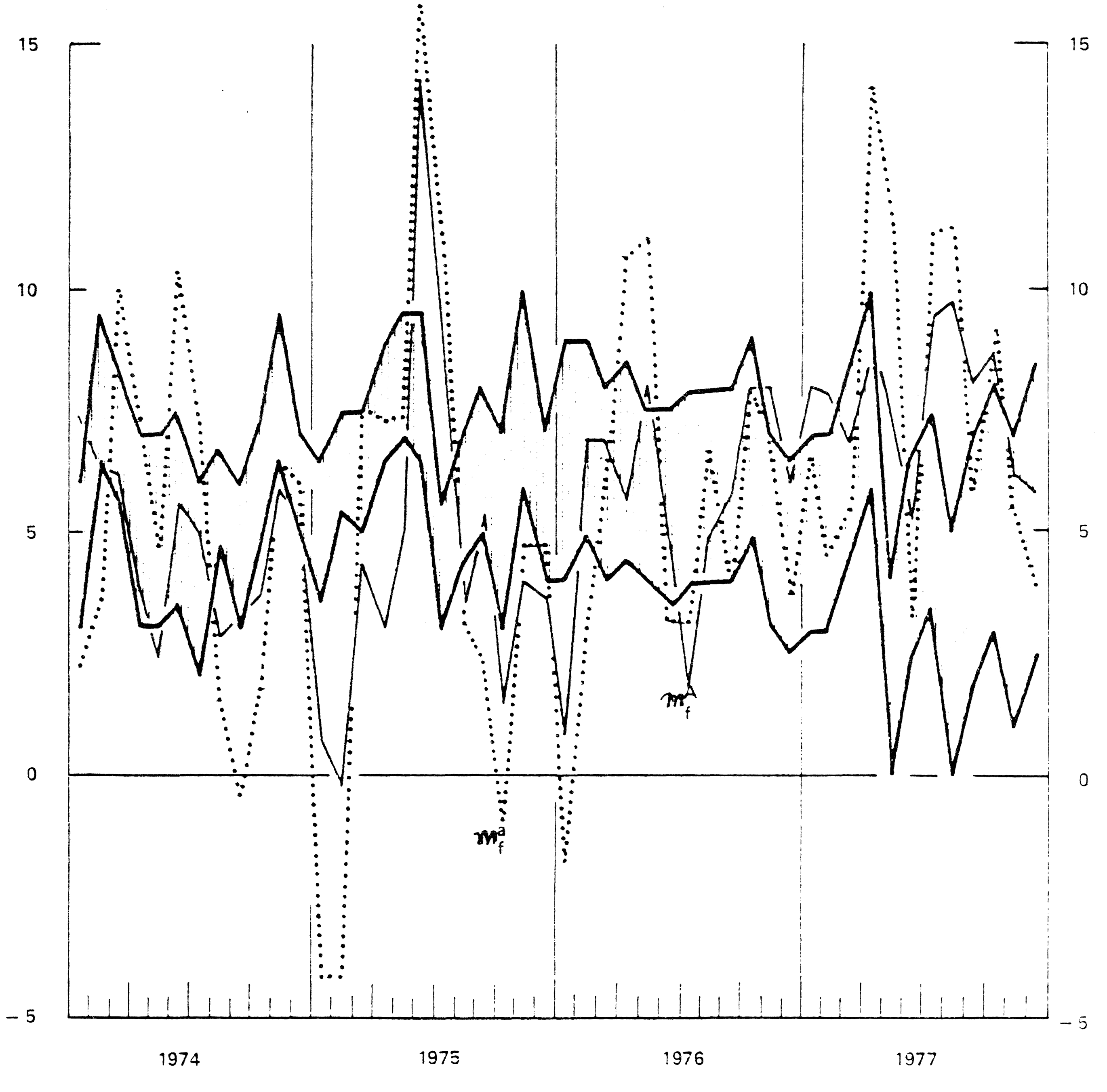


Figure 6. Differential M-1 Growth Rates
Due to Seasonal Revision



it is seen that, out of 48 times, m_f^a gave the wrong signal 20 times. Consequently, seasonal revisions are the ones that are responsible for most of the unreliability of preliminary information.

Since the difference between the performance of m_f^a and m_0^A as "signals" of whether or not growth is as desired is proportionately larger than the difference between the standard deviations of the revision error that each one contains (d^S and d^N, respectively), from the point of view of monetary policy seasonal revision errors seem to be particularly perverse. In this regard, we note that since d^S has relatively large positive AC (Figure 3), large (positive or negative) values of preliminary seasonal errors would tend to persist.

A related and important question is whether these effects could be attenuated by anticipating (forecasting) these revision errors. The use of improved preliminary seasonal adjustment procedures, in particular X11-ARIMA (Dagum, 1980), is known to result in on-average smaller revisions. Of possibly even greater consequence, a "concurrent" seasonal adjustment, which would employ all information on the aggregates through the current month (rather than ignoring data since the previous December) in estimating seasonal factors, could significantly reduce the variance of the seasonal revision error d_t^S.

8. REVISIONS AND MONETARY TARGETING: A MODEL-BASED APPROACH

The frequency with which preliminary data yielded a wrong signal was computed using the actual revision errors for the years 1974 to 1977. These errors are the sum of nonseasonal and seasonal revisions. The seasonal revisions themselves are the sum of the revisions associated with X11 plus "judgemental" ones.

We noted in Section 6.1 that to a degree, using the X11-ARIMA method, revision errors can be forecasted, so that it may be possible to reduce their magnitude. In order to get an idea of the degree to which this would increase the reliability of preliminary data in monetary aggregate targeting, we shall compute the probability of a wrong signal when the only revisions are those associated with this method.

In Pierce (1980a) it is shown that, for the period we consider, the unadjusted monthly series of M-1 have stochastic structures fairly close to the ARIMA approximation to X11 developed by Cleveland (1972). However, forecasts computed by X11 follow a more naive formula than the one implied by that structure.[1] Thus we replace the X11 forecasting mechanism with ARIMA forecasting through the Cleveland specification.[2]

Since seasonal revisions originate from replacing variable forecasts with realizations, if the former are improved, revisions should decrease. Minimum MSE forecasts obtained from the Cleveland ARIMA specification,

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1/ The seasonal factors forecasted one year ahead are equal to last year's factors plus one half of the change between last year's and the one the year before.

2/ The results are practically unaffected when an alternative ARIMA specification also used by Pierce is considered.

under the assumption that it is the correct one, should minimize revisions (among procedures which forecast the seasonal factors into the following year). We shall compute the probability of a wrong signal for the case in which the only errors are the seasonal revisions implied by an X11-ARIMA seasonal adjustment method applied to the Cleveland specification. Obviously, that probability can be seen as an estimate of a lower bound for the precision of the preliminary data we consider.[1]

Let e_t denote the deviation of m^A with respect to the midpoint of the range of tolerance for period t, and α_t denote the midrange of the interval of tolerance set for the growth of M-1 over that period.[2] Assume that $P(e_t, s_t^s)$ is the joint distribution of the pair of variables e_t and d_t^s. For a given month, the probability that the preliminary estimate m_t^a yields the wrong signal is the probability that any of the following statements occur:

1. m_t^a falls within the tolerance range, m_t^A does not,
2. m_t^A falls within the tolerance range, m_t^a does not,
3. both fall outside the range, but in opposite sides.

It can be seen that these three probabilities can be expressed as[3]:

1/ The ideal situation is one in which no nonseasonal errors are present, no misspecification exists and the variable is forecasted optimally.

2/ To a first approximation, e_t can be interpreted as a forecast error (see Lombra and Torto (1975)).

3/ See Maravall (1980). For simplicity, subscripts have been deleted.

$$P_1 = 2\int_{e=\alpha}^{\infty} \int_{d^s=e-\alpha}^{e+\alpha} P(d^s|e)P(e)d(d^s)de,$$

$$P_2 = 2\int_{e=0}^{\alpha} [1 - \int_{d^s=e-\alpha}^{e+\alpha} P(d^s|e)d(d^s)]P(e)de,$$

$$P_3 = \int_{e=\alpha}^{\infty} \int_{d^s=e+\alpha}^{\infty} P(d^s|e)P(e)d(d^s)de + \int_{e=-\alpha}^{\infty} \int_{d^s=e-\alpha}^{-\infty} P(d^s|e)P(e)d(d^s)de$$

Under the assumption that the Cleveland model is correct, d_t^s will be normally distributed, with mean zero and variance which can be derived from the moving average structure for the revision in the M-1 series. Since

$$d_t^s = m_t^A - m_t^a = [\log M_t^A - \log M_t^a] - [\log M_{t-2}^A - \log M_{t-2}^a]$$

$$= r_t - r_{t-2},$$

where r_t denotes the total revision in the seasonal factor forecasted a year in advance, it follows that

$$\mathrm{var}(d_t^s) = 2\ \mathrm{var}\ (r_t)\ [1 - \rho(2)],$$

where $\rho(2)$ is the lag 2 autocorrelation or r_t. Since $\rho(2) = .15$ and $\mathrm{Var}(r_t) = .18$ (see Pierce, 1980), expressed in terms of annualized percent points,

$$\sigma_s - 1.5.$$

The variable e_t can also be assumed normally distributed, with zero mean and standard deviation $\sigma_e = 3.11$. Furthermore, we shall assume that the series of deviations with respect to the range midpoint and the series of seasonal revisions are independent.[1]

1/ The coefficients of skewness (μ_3) and kurtosis (μ_4) for the e and d^s series are as follows: (continued on bottom of next page)

Setting $\alpha = 2.5$ (i.e., a tolerance range of 5 percent points), the probability $P = P_1 + P_2 + P_3$ can be computed, yielding:

$$P = .20.$$

Thus when the only error in preliminary data is due to the seasonal revisions, and these are the ones associated with optimal forecasting through a correctly specified model, the probability of a wrong signal becomes 20%.

(continued from previous page)

	e_t	d_t^s
μ_3	.22	-.10
μ_4	2.60	2.65

Since $Var(\mu_3) \doteq 6/T = .125$ and $Var(\mu_4) \doteq 24/T = .5$ (Durand 1971, pp. 346-249)), both e_t and d_t^s can be assumed to have marginal normal distributions. Considering that the correlation between e_t and d_t^s is .02, the assumptions stated in the paragraph seem reasonable.

9. CONCLUSIONS

To summarize, analysis of the revision errors in monetary aggregates indicates that they strongly affect reliability of preliminary figures and set a lower bound to the "finesse" with which short-run monetary policy can be implemented. And although reliability could increase through improvements in present procedures, there seems to be a nonnegligible "lower bound to that lower bound", due to the (unavoidable) presence of seasonal factor revisions even when efficient methods for determining preliminary seasonally adjusted series are employed.

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