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Comparing Time-Series and Survey Forecasts of Weekly Changes in Money: A Methodological Note

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NUMEROUS STUDIES HAVE investigated the effect of unanticipated weekly changes in the money stock (M1) on nominal interest rates (see, for example, Grossman [4], Urich and Wachtel [9], Urich [8], Figlewski and Urich [3], Roley [7], and Cornell [1, 2]). In these studies, the unanticipated change in M1 is measured as the difference between the announced change and the expected change derived from the Money Market Services, Inc. weekly survey of government securities dealers. Unlike other survey measures of expectations (the most notable example of which is the Livingston survey data), these expectations are formed by active market participants.[1] Consequently, the survey's forecast, made public before the Fed's announcement of the actual change in the money stock, is commonly thought to represent the "market's" expectation.

The concern in this paper is not with the impact of unanticipated money changes on nominal interest rates. The purpose is to compare the relative forecasting abilities of the survey predictions and those obtained from a time-series model. This question is of interest, because the weekly money series used in previous research includes certain "abnormal" weeks in which exogenous factors may significantly alter the series' stochastic properties (see, for example, Cornell [1], Urich and Wachtel [9]). Thus, the influence of these abnormal weeks—weeks that include benchmark revisions, changes in seasonal factors, and weeks in which there is a "social security effect"—is examined by comparing forecasting results for two samples; one includes these weeks and the other deletes them. Following Pearce [6], this approach allows us to test the hypothesis that the survey responses are at least weak-form rational and to see how sensitive this test is to the sample of weeks used.

Unlike previous studies, we use two survey forecast series: the median forecast, made public prior to the announced change in M1, and the mean series, constructed from individual respondents' forecasts. Zarnowitz's [10] examination of the ASA-NBER survey forecasts indicates that the mean forecast is, on average, statistically superior to the median. This finding is based on the idea that the mean forecast uses a more informationally diverse data set. Consequently, it is

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[1] It has been argued that using survey responses to approximate the market's expectation is a dubious approach at best; the problem is that many surveys do not poll actual market participants. In this study, much of the force from this line of criticism would seem to be lessened. On this point, see Kane and Malkiel [5].

of some interest here to compare mean and median survey forecasts to those generated by a time-series model.

The format of the paper is as follows. Section I describes the data. The time-series models used to forecast weekly changes in M1 are presented in Section II. In Section III the ARIMA models' forecasts are compared to the survey forecasts on the basis of several forecasting criteria. Concluding remarks are offered in Section IV.

I. Data

The data used in this study consist of actual and expected weekly changes in M1 for the period October 1979 to June 1982. Actual changes in M1 were taken from the Federal Reserve's H.6 statistical release. In each case, the figure used is the change from the previous week's initially announced figure.[2] Because this sample period encompasses a period of changing definitions, the following scheme is used: From the statement week ending October 3, 1979 to January 31, 1980, weekly M1 changes are based on the old definition. From February 8, 1980 to November 20, 1981, the money stock used is the M1B measure not adjusted for movements of NOW accounts. Finally, from November 27, 1981 to June 16, 1982, the then-current definition of M1 is used.

One aspect of this series that has not been discussed in previous studies is that it contains numerous weeks where some exogenous event may have distorted the announced change in money. Some of these events are institutional, such as benchmark revisions, which generally occur during the first and middle parts of the year, and some are seasonal factor revisions, which also tend to occur during the first part of the year.[3]

Another event which affects the announced change in M1 is the advent of so-called social security weeks. Social security weeks occur when the third day of the month—the day when many social security checks are deposited by mail into recipients' transactions accounts—falls on a weekend, or on a holiday that also happens to be a Friday or a Monday. The calendar quirk in the payment mechanism bloats the announced money supply figure for that week. This occurs because these deposits, having been made on Friday, generally are held on financial institutions' balance sheets as transaction accounts for an extra amount

[2] The data set begins in October 1979 to avoid any problems that might be associated with the change in monetary policy. Moreover, in August of 1982 the Fed announced that it would place much less emphasis on movements in M1 in conducting policy. Thus, our data set allows us to confine our study to a period in which M1-announced Fed policy was based on active pursuit of an M1 target. The terminal point of our sample is dictated by the availability of the survey's mean forecast.

We use the initially announced data because it is known with certainty by the forecasters before the next announcement. Using the one-week-revised-to-first-announced change in M1 would impart information to the forecaster that would not be available, i.e., the revision itself. Moreover, because the revision was found to be a white noise process ($Q(12) = 8.20$), it seemed quite reasonable statistically to calculate the change in M1 by using the first-announced-to-first-announced change (see also Cornell [1, 2]).

[3] The benchmark/seasonal weeks deleted include 1/30/80, 6/11/80, 1/7/81, 6/10/81, and 1/6/82.

of time, relative to weeks in which the deposit takes place during the week. During such weeks, the analyst is required to forecast not only the size of the social security effect itself, but also the underlying change in the money supply.[4]

The data used to measure the market's expectation of the weekly change in M1 are the survey forecasts obtained from Money Market Services, Inc. This firm conducts a telephone survey each week to get the expectations of 50 to 60 government securities dealers about the magnitude of the pending money supply change. Prior to 1980 the poll was conducted each Tuesday and Thursday before the Fed's (Thursday) money supply announcement. From February 1980, when the money supply announcement day was moved to Friday, to the end of our sample, only a Tuesday survey had been conducted. Consequently, we use only the survey forecasts compiled from the Tuesday survey.

Our survey forecast series consist of the median and mean values. It is interesting to compare the results based on these measures for two important reasons. First, such a comparison has not been made using the weekly M1 data because only the median forecast is made available publicly; the mean forecast must be generated from the individual respondents' predictions. The second reason is that use of the two series implies different presumptions about the use of information in generating "market" forecasts. Because the mean forecast weights all individuals equally, it is more susceptible to the large outliers that frequently are found. The median forecast, on the other hand, is not influenced by outliers and may, as is generally thought, better represent the market's "average" forecast. Thus, in the empirical tests below, the time-series models' forecasts are compared with the median and mean survey forecasts to determine which series best forecasts weekly M1 changes.

II. Modelling the Weekly Changes in M1

Two ARIMA models are developed in this section to predict weekly changes in M1. One model is constructed using all of the available weekly data, an approach used in previous studies. The other model is constructed using the data set in which weeks characterized by a benchmark revision, seasonal adjustment revision, and/or a social security effect are deleted.

The time-series models were determined by first examining the autocorrelations from the two weekly series. The autocorrelations for the series that uses all weeks are presented in Table I. Spikes at lags 1 and 13 clearly exceed the two standard error bound. The estimated autocorrelations at lags 7 and 22 also are about two standard errors from zero. Using the information contained in Table I along with the partial autocorrelation function, some preliminary specification tests revealed that the "best" model for this data set is an AR model with terms

[4] The social security weeks omitted from the sample are the weeks ending 11/7/79, 2/6/80, 5/7/80, 8/6/80, 8/10/80, 4/8/81, 5/6/81, 7/8/81, 10/7/81, and 4/7/82. During these weeks, the average change in M1 was $5.5 billion. This is more than two standard errors away from the mean of the series that excludes these weeks.

Table I

Sample Autocorrelations for Weekly Change in M1, Full Data Set

Lag	1	2	3	4	5	6	7
Autocorrelation	−0.24	−0.08	−0.12	0.09	0.07	0.03	−0.17
Standard Error	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Lag	8	9	10	11	12	13	14
Autocorrelation	0.05	0.14	−0.18	−0.06	−0.13	0.35	−0.10
Standard Error	0.10	0.10	0.10	0.10	0.10	0.11	0.11
Lag	15	16	17	18	19	20	21
Autocorrelation	−0.17	−0.14	0.19	0.04	−0.06	−0.14	−0.02
Standard Error	0.11	0.11	0.11	0.11	0.12	0.12	0.12
Lag	22	23	24				
Autocorrelation	0.24	−0.06	−0.04				
Standard Error	0.12	0.12	0.12				

Table II

Sample Autocorrelations for Weekly Change in M1, Abnormal Weeks Omitted

Lag	1	2	3	4	5	6	7
Autocorrelation	−0.03	0.01	−0.08	−0.01	−0.09	0.04	−0.05
Standard Error	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Lag	8	9	10	11	12	13	14
Autocorrelation	−0.03	−0.07	−0.12	−0.06	0.08	0.06	−0.12
Standard Error	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Lag	15	16	17	18	19	20	21
Autocorrelation	−0.02	−0.02	−0.16	0.06	0.05	0.08	−0.01
Standard Error	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Lag	22	23	24				
Autocorrelation	−0.01	−0.03	0.08				
Standard Error	0.10	0.10	0.10				

at 1, 7, and 13 lags. The estimated model is (standard errors in parentheses):

$$(1 + \underset{(0.08)}{0.1966}B + \underset{(0.080)}{0.1824}B^7 - \underset{(0.082)}{0.3587}B^{13})\Delta M_t = \underset{(0.227)}{0.5531} + a_t \tag{1}$$

$$Q(12) = 13.68 \qquad \text{SE} = 2.630$$

The results in Equation 1 indicate that the model has adequately captured the movement in weekly M1 changes. Each of the estimated AR coefficients is statistically significant at the 5 percent level.[5] The reported Q-statistic, distributed as a χ^2 with 12 degrees of freedom, is less than the critical 5 percent value of 21.0. Thus, we cannot reject the hypothesis of white noise residuals or the empirical model.

[5] Note that the money series using all observations has a significant, positive trend estimated to be $0.55 billion.

Table III

Comparing Forecasts of Weekly Changes in M1

	Full Data Set			Subset[b]		
		Survey			Survey	
Forecast Statistics[a]	ARIMA	Median	Mean	ARIMA	Median	Mean
MAE	\$2.00	\$1.90	\$1.89	\$1.73	\$2.42	\$1.65
RMSE	\$2.59	\$2.45	\$2.41	\$2.12	\$3.18	\$1.98
B	0.0	0.02	0.02	0.00	0.03	0.00
V	0.37	0.46	0.47	1.00	0.34	0.29
CV	0.63	0.52	0.51	0.0	0.62	0.71

[a] All errors are in terms of \$ billions. MAE is the mean absolute error; RMSE is the root-mean-square error; B, V, and CV are, respectively, the fraction of forecast error due to bias, unequal variance, and unequal covariance between actual and predicted series.

[b] Subset data exclude benchmark revision, seasonal revision, and social security weeks (see footnotes 4 and 5).

Table II presents the autocorrelation function for the weekly series that excludes the abnormal weeks. The striking feature of these autocorrelations is that none of the lags is significantly different from zero. This condition, confirmed by the series' $Q(12)$-statistic of 6.94, indicates that omitting the abnormal weeks from the sample reduces the weekly M1 changes to a white noise series. In other words, the time-series model used to forecast weekly changes in M1 when these weeks are absent is simply:

$$\Delta M_t = \mu_t + \epsilon_t \tag{2}$$

or the series' mean (μ_t) plus a random error component. Since the expected value of ϵ is zero, the best time-series forecast is simply the mean. During our sample, the mean of this series was \$−0.036 billion with a standard deviation of \$2.15 billion. Statistically, therefore, our time-series model's forecast of the change in money for weeks not influenced by benchmark revisions, seasonal changes, or social security effects is no change at all.[6]

III. Comparing the Forecasts

The relative forecasting abilities of the survey and time series models are compared for each of the two data sets. If we find that once the abnormal weeks are deleted from the sample—weeks in which the forecaster clearly is given the advantage over an empirical model that must attempt to "explain" the general behavior of a given series—the survey forecasts are not superior to the time-series model's, then the superiority of the survey forecasts must be questioned.

Summary forecast statistics based on the median and mean survey forecasts, as well as the time-series forecasts, are presented in Table III. When all weekly observations are used, both survey measures predict the change in M1 slightly

[6] This finding suggests that the positive trend estimated in Equation (1) comes from the weeks deleted.

better than the time-series model.[7] For example, in terms of the mean absolute error (MAE) statistic, the survey forecasts improve upon the time-series predictions by slightly over 5 percent. The reductions based on the root-mean-squared errors (RMSE) are slightly larger, 6 percent for the median forecast and 8 percent for the mean. The Theil decomposition statistics indicate that, for each series, most of the forecast error is split between unequal variance (V) and unequal covariance (CV). Thus, when all the weekly observations are used, we cannot reject the hypothesis that the survey forecasts are, on average, better than those produced by the time-series model. Consequently, we cannot reject the notion that the survey responses exhibit weak-form rationality. The results also indicate a slight improvement over the median by the mean forecasts.

Forecast statistics using the subset data also are reported in Table III.[8] The effect on the different series' forecasting records is quite dramatic. When the abnormal weeks are deleted, both the time-series and mean forecast records improve slightly, as one would anticipate. Using the subset data, the mean forecasts continue to provide slightly better predictions than the time-series model; the MAE is about 5 percent lower, and the RMSE is about 7 percent lower. The median forecasts, on the other hand, become noticeably worse upon deleting the abnormal weeks. For example, its MAE increases by 27 percent to \$2.42, and the associated RMSE rises by 30 percent to a value of \$3.18. The subset results indicate that, based on the median forecasts, we cannot reject the time-series model as a superior forecasting tool relative to the survey. In contrast, the relative superiority of the mean forecast, vis-à-vis the time-series model found using the full data set, is maintained when the abnormal weeks are deleted.

The superior forecasting performance of the mean relative to the median survey prediction indicates that the median series does not fully incorporate all available information—information that is represented best by the full distribution of survey responses. Moreover, because the median forecast also performs worse than the time-series forecast, it does not meet the criterion of weak-form rationality when the abnormal weeks are deleted. These results are important because (a) they indicate the importance of accounting for the abnormal weeks as defined in this paper, and (b) they suggest that the mean forecasts series may be more useful in studies of forecast efficiency, especially as it relates to the impact of money changes, both anticipated and unanticipated, on nominal rates of interest.

IV. Conclusion

The evidence presented in this study indicates that once weeks in which benchmark adjustments, changes in seasonal factors, and/or social security effects are

[7] It should be recognized that this comparison imparts some information to the time-series model not available to the individual forecaster; namely, the future value of M1 changes. One approach would be to estimate the model up to some period t, predict $t + 1$, and iterate the estimation sample by one week. In this paper, we have chosen the less computationally laborious procedure of using in-sample errors. For a similar approach, see Urich and Wachtel [9].

[8] The argument in footnote 7 is not applicable when the subset data is used. This is because the series is white noise, i.e., each value is time independent. Consequently, the time-series forecaster is not given undue advantage over the survey respondent.

omitted from the sample, time-series forecasts of the weekly change in the money supply are more accurate, on average, than those obtained from survey median forecasts. When such weeks are not deleted from the sample, the survey is slightly better than the time-series forecasts, suggesting that survey forecasts meet the condition of weak-form rationality. Perhaps the most interesting finding is that the median forecast series, most often used to represent market expectations, is inferior to the mean survey forecast. This suggests that the median does not incorporate the diversity of information used to construct the mean values. Previously reported results of market interest rate responses based on money series constructed using the median forecast may, therefore, incorrectly express the effect of money changes. This clearly is an avenue for a continuing research agenda investigating the efficiency of the financial markets.

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