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Monetary Aggregates as a Target Variable: A Comment

Abdur Chowdhury
Marquette University, abdur.chowdhury@marquette.edu

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Abdur R. Chowdhury was affiliated with Bentely University at the time of publication.

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I. Introduction

In a recent article in the *Southern Economic Journal,* McMillin and Fackler [2] used vector-autoregressive (VAR) models to investigate the empirical relationships among nominal income, high-employment expenditures, and various monetary and credit aggregates in terms of the characteristics of a good intermediate target variable. Among the various monetary aggregates analyzed, their results suggest that *M1* is subject to feedback from nominal income while *M2* is free of such feedback. A well-known, desirable property of a good target of policy is that it should be free from feedback from non-policy variables. Hence they argue that *M2*, in contrast to *M1*, possesses one of the characteristics of a good intermediate target variable.

The purpose of this note is to show that their results are sensitive to the introduction of an interest rate in their trivariate VAR models. In the presence of an interest rate, *M2* is also found to be subject to an indirect feedback from income. Moreover, the note also concludes that the choice of an optimal target variable should not be limited only to the monetary aggregates as has been usually done in the literature. Recent works have called into question empirical results which exclude the rate of interest. Specifically, Sims has shown that the addition of an interest rate to a VAR system that contains money, a price variable, and an output measure has significant implications for the role of money shocks in altering prices and output [4]. Based upon Sims's results and upon the fact that interest rates are an important link in the transmission mechanism from policy variable to nominal income, an interest rate is added to the *M2* system estimated by McMillin and Fackler (hereinafter M-F). The model is presented and discussed in section II while section III contains concluding remarks.

II. The Model

The four variable model is presented in this section. This model is estimated by adding an interest rate to the trivariate *M2* system specified in M-F's study. The relevant interest rate used is Moody's AAA corporate bond rate.[1] Quarterly data for the sample period 1959:1-1979:4 for nominal *GNP*, the *M2* definition of money stock, nominal high employment expenditures, and Moody's AAA corporate bond rate are used to estimate the model. For

1. For the monetary policy variable *M2*, two models for nominal income have been developed—one using a short-term interest rate (commercial paper rate) and the other using a long-term interest rate (Moody's AAA corporate bond rate). Akaike has shown that in selecting a model from a set of models, the minimum AIC criterion should be used [1]. He defines AIC as an estimate of minus twice the expected log likelihood of the model whose parameters are determined by the method of maximum likelihood. The calculation of AIC show that in case of *M2*, the model with *AAA* bond rate has an AIC value of −1613.1 while the model with commercial paper rate has an AIC value of −1473.6. Based on this result, it can be concluded that the long-term interest rate seems to be more relevant in explaining nominal income.

purposes of comparison, the sample period is same as in M-F's paper. Following the estimation procedure outlined in their paper, the four variable model for the *M2* system is tentatively specified as

$$\begin{bmatrix} Y \\ M2 \\ AAA \\ EHE \end{bmatrix} = \begin{bmatrix} a_{11}^{10}(L) & a_{12}^{14}(L) & a_{13}^{1}(L) & a_{14}^{1}(L) \\ 0 & a_{22}^{12}(L) & a_{23}^{1}(L) & 0 \\ a_{31}^{12}(L) & 0 & a_{33}^{12}(L) & a_{34}^{10}(L) \\ 0 & 0 & a_{43}^{4}(L) & a_{44}^{3}(L) \end{bmatrix} \begin{bmatrix} Y \\ M2 \\ AAA \\ EHE \end{bmatrix} + \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \\ e_3 \\ e_4 \end{bmatrix} \tag{1}$$

where *Y*, *M2*, *AAA* and *EHE* are respectively the detrended nominal income, broad money supply, Moody's AAA corporate bond rate and high employment expenditures; a_{ij}^{k} represents the k lag coefficients on variable j in equation i, the c_i are constants and the e_i are error terms. This system is estimated using the full-information maximum likelihood (FIML) method.

In order to check for the adequacy of the specification (1), the system is over- and under-fitted. A section of the results of these adequacy tests are presented in Table I. The tests check for the Granger-causality implications of specification (1). In hypotheses (1)–(7) and (32)–(34), the model is simplified by constraining various lag polynomials to be zero. Alternately, the zero restrictions are eased in hypotheses (8)–(12). The other tests shorten or extend the lags on the respective variables. The results suggest that specification (1) is an adequate VAR representation of the four variables in question.

An examination of specification (1) reveals that the introduction of an interest rate in the trivariate *M2* system estimated by M-F changes the causality implications. They found that *M2* is free of reverse causation from nominal income. In specification (1), $a_{12} \neq 0$ and $a_{21} = 0$ implies that *M2* directly Granger-cause *Y* while *Y* do not directly Granger-cause *M2*. Hypotheses tests (1) and (8) in Table I support this conclusion. However, tests (4), (5) and (34) in Table I indicate that the null hypotheses $a_{23} = 0$ and $a_{31} = 0$ are individually as well as jointly rejected at at least 2.5 percent significance level. This indicates that the nominal income causes the interest rate which, in turn, causes *M2*. Thus there is an indirect causality between *Y* and *M2*, indicating feedback exists between the two through other variables. This is in sharp contrast to the findings of M-F. A number of other substantive points can be made about the causality implications of specification (1). First, the equation for nominal income contains lagged values of *M2*, *AAA* and *EHE*, hence all these three variables Granger-cause *Y*. Second, a feedback exists between *Y* and *AAA*, and between *AAA* and *EHE*. Third, high employment expenditures is caused by neither income nor money. This is consistent with the findings of M-F but contrary to those of Mehra and Spencer [3].

Sims has recently shown that the strength of the Granger causal relations can be measured from variance decompositions [5]. Variance decompositions (VDC's) show the proportion of forecast error variance for each variable that is attributable to its own innovations and to shocks to the other system variables. Thus, if either *M2* or *EHE* explain only a small portion of the forecast error variance of *Y*, it can be interpreted as evidence of a weak Granger-causal relation. For purposes of comparison, VDCs are calculated for the trivariate model estimated by M-F as well as for the four variable model. The results are given in Table II. The VDCs are examined based on two different orderings.

Table I. Results of Hypotheses Tests for the M2 Model

Hypothesis	Chi-Square Statistics	Degrees of Freedom
(1) $a_{12}(L) = 0$	30.36**	14
(2) $a_{13}(L) = 0$	6.84**	1
(3) $a_{14}(L) = 0$	8.02***	1
(4) $a_{23}(L) = 0$	7.46**	1
(5) $a_{31}(L) = 0$	25.80*	12
(6) $a_{34}(L) = 0$	26.32***	10
(7) $a_{43}(L) = 0$	13.48**	4
(8) $a_{21}(L) = a_{21}^{4}(L)$	4.46	4
(9) $a_{24}(L) = a_{24}^{4}(L)$	4.80	4
(10) $a_{32}(L) = a_{32}^{4}(L)$	3.92	4
(11) $a_{41}(L) = a_{41}^{4}(L)$	4.10	4
(12) $a_{42}(L) = a_{42}^{4}(L)$	5.02	4
(13) $a_{11}(L) = a_{11}^{8}(L)$	9.68**	2
(14) $a_{12}(L) = a_{12}^{12}(L)$	9.02*	2
(15) $a_{22}(L) = a_{22}^{10}(L)$	8.60*	2
(16) $a_{31}(L) = a_{31}^{10}(L)$	10.78***	2
(17) $a_{33}(L) = a_{33}^{10}(L)$	11.20***	2
(18) $a_{34}(L) = a_{34}^{8}(L)$	9.88**	2
(19) $a_{43}(L) = a_{43}^{2}(L)$	8.70*	2
(20) $a_{44}(L) = a_{44}^{1}(L)$	10.26**	2
(21) $a_{44}(L) = a_{11}^{12}(L)$	4.04	2
(22) $a_{12}(L) = a_{12}^{15}(L)$	3.78	1
(23) $a_{13}(L) = a_{13}^{3}(L)$	3.10	2
(24) $a_{14}(L) = a_{14}^{3}(L)$	3.56	2
(25) $a_{22}(L) = a_{22}^{14}(L)$	2.88	2
(26) $a_{23}(L) = a_{23}^{3}(L)$	4.10	2
(27) $a_{31}(L) = a_{31}^{14}(L)$	2.88	2
(28) $a_{33}(L) = a_{33}^{14}(L)$	4.24	2
(29) $a_{34}(L) = a_{34}^{12}(L)$	3.02	2
(30) $a_{43}(L) = a_{43}^{6}(L)$	2.84	2
(31) $a_{44}(L) = a_{44}^{5}(L)$	2.26	2
(32) $a_{12}(L) = a_{13}(L) = a_{14}(L) = 0$	17.46**	6
(33) $a_{31}(L) = a_{34}(L) = 0$	44.62***	22
(34) $a_{23}(L) = a_{31}(L) = 0$	30.02**	13

* significant at .025 level
** significant at .01 level
*** significant at .005 level

The orderings for the trivariate *M2* model are (a) *M2*, *Y*, *EHE* and (b) *EHE*, *Y* and *M2*. These VDC's are presented in Table II.1.A (first ordering) and Table II.1.B (second ordering). A twenty quarter horizon is employed in order to allow the dynamics of the system to be worked out. It is found that regardless of the ordering the variance in *M2* and *EHE* is almost completely explained by their own innovations. Innovations in *M2* explain about 50 percent of the variation in *Y* in both the orderings. On the other hand, innovations in *Y* do not explain any variation in *M2*. The variance decomposition results support the causality implication of the M-F study that there is a one-way causality from *M2* to *Y*. Thus it may be implied from these results that *M2* is an appropriate intermediate target variable. However, it will be seen that this conclusion is sensitive to the introduction of an interest

Table II. Variance Decomposition Results for the Trivariate and Four-Variable Model

1. System: *Y*, *M2*, *EHE*

A. Ordering: *M2*, *Y*, *EHE*

Relative Variation Explained in	Due to Innovation in *M2*	*Y*	*EHE*
M2	100.0	0	0
Y	50.2	35.5	14.0
EHE	1.9	8.8	89.3

B. Ordering: *EHE*, *Y*, *M2*

Relative Variation Explained in	Due to Innovation in *EHE*	*Y*	*M2*
EHE	100.0	0	0
Y	13.3	37.2	49.5
M2	2.1	0.4	97.5

2. System: *Y*, *M2*, *AAA*, *EHE*

A. Ordering: *M2*, *Y*, *AAA*, *EHE*

Relative Variation Explained in	Due to Innovation in *M2*	*Y*	*AAA*	*EHE*
M2	57.3	4.6	33.9	4.2
Y	55.2	26.8	11.9	6.1
AAA	47.7	4.5	31.4	16.4
EHE	7.9	9.2	2.8	80.1

B. Ordering: *EHE*, *Y*, *AAA*, *M2*

Relative Variation Explained in	Due to Innovation in *EHE*	*Y*	*AAA*	*M2*
EHE	90.1	1.1	8.1	0.7
Y	7.4	33.2	15.7	43.7
AAA	18.8	6.4	41.9	32.9
M2	7.1	2.7	39.9	50.3

rate into these models. The VDC's for the models incorporating an interest rate are shown in Table II.2.

In the four-variable model, innovations in *AAA* explains 34 percent of the variation in *M2* in the first ordering and 40 percent in the second ordering. This is completely different from the trivariate model where almost all variations in *M2* are explained by its own innovations. Hence there is a strong causal relationship from *AAA* to *M2*. Failure to include *AAA* rate in this model may lead to biased estimates due to an omitted variable. Irrespective of the ordering, innovations in *Y* explain at least about 5 percent of the variation in *AAA*, while *AAA* explains at least 12 percent of the variation in *Y*. This suggests the presence of feedback between these two variables and supports the causality implications in Table I. Moreover, it can also be argued that an indirect feedback exists between nominal income and *M2* through the interest rate. Finally, it can be noted that innovations in *Y* explain about 5 percent of the variation in *M2* in the first ordering and 3 percent in the second ordering. This is in sharp contrast to the trivariate model where innovations in *Y* fail to explain any variation in *M2*. Thus it can be argued that in the presence of an interest rate, *M2* is no longer exogenous to income.

III. Conclusions

The above result suggests the problems in using monetary aggregates as an intermediate target variable. Hence the question of selecting an optimal target variable should not be limited only to the monetary aggregates, such as, *M1* and *M2*, as has been usually done in the literature. The possibility of using credit or other financial aggregates should also be explored. In this regard, M-F's study seems to point to the right direction.

Abdur R. Chowdhury
Bentley College
Waltham, Massachusetts

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