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TESTS OF GRANGER-CAUSALITY BETWEEN VELOCITY AND MONEY GROWTH VARIABILITY: EVIDENCE FROM JAPAN

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I Introduction

A number of studies have been done investigating the erratic behavior of the velocity of money in the United States during the 1980s.[1] The apparent end to the constant trend of velocity has called into question the stability of the demand for money function and, in the opinion of some economists, seriously undermines the monetarist position.[2]

Several hypotheses, ranging from financial innovation to declines in the rate of inflation, have been offered to account for this volatility in the velocity of money. But as Robert Rasche[3] notes, "the existing state of our knowledge (about the behavior of M1 velocity) is fundamentally unsatisfactory. The mechanism behind the change in the character of velocity has not been indentified, and the literature does not appear to rule out any of the major competing hypotheses."

Milton Friedman[4], argues that the U.S. velocity decline of the early 1980s supports the monetarist position and attributes the decline in velocity to the extreme volatility of money growth at the beginning of the 1980s. This volatility created uncertainty with regard to economic variables and increased the demand for real money balances, a contributing factor to the decline in GNP. This hypothesis is supported by Hall and Noble[5], who provide empirical evidence that the variability of money, as measured by the standard deviation of money growth, causes velocity in the Granger sense. If this monetarist position is accepted, the case for a monetary rule is strengthened.

The Hall-Noble study, however, is not without controversy. Brocato and Smith test both the full period utilized by Hall-Noble and various subperiods and find that although the Friedman hypothesis is supported for the full period this is evidence of Gordon's "demise of monetarism" in the post-October 1979 period.[6]

The conflicting results of these various studies calls for further study of the relationship between velocity and money growth, particularly using data for a country other than the United States.[7] The purpose of this study is to test the robustness of the Friedman hypothesis and empirically investigate factors that effect the variability of velocity using data for Japan. By doing so the strength or weakness of the monetarist position can be further evaluated.

II Monetary Aggregates and Velocity

The degree to which money growth affects velocity growth will, of course, vary with the choice of monetary aggregates. As Friedman[8] notes, the degree of variability in the growth of the money aggregate will depend on the method of calculation. At this point it would be helpful to review the monetary aggregates of Japan.[9]

The narrow definition of money (M1) in Japan is cash currency plus deposit money. Time deposits are regarded as quasi-money and when added to M1 comprise M2. Certificates of Deposit (CDs), first issued in May 1979, are taken as a form of time deposits and are included in the aggregate M2+CDs. In comparing monetary aggregates between the United States and Japan, U.S. M1 is generally compared with Japanese M2+CDs. The different aggregates are used for two reasons according to Dotsey.[10] The main reason is that these are the aggregates that each central bank pays the closest attention to and generally uses as an intermediate target. The Bank of Japan emphasizes M2+CDs as an indicator of monetary policy since its degree of controllability is superior to that of M1. Most of the components of Japanese M2+CDs, like that of U.S. M1, are subject to reserve requirements and binding interest rate ceilings. The CD component in Japan is under quantity restrictions and is relatively small. This fact adds to the similarity of Japanese

M2+CDs and U.S. M1 data.

III Empirical Implementation

The Granger causality test asserts that a variable X "Granger causes" a variable Y if, after taking into consideration the effect of other relevant information, variations in X can be used to predict fluctuations in Y. In the same respect, Y "Granger causes" X if variations in Y can be used to predict movements in X. The test involves estimating an equation of the following form:

$$GVEL_t = \sum_{i=1}^{p} \alpha_i GVEL_{t-i} + \sum_{i=1}^{q} \beta_i SDM_{t-i} + \varepsilon_t \quad (1)$$

where GVEL is the quarterly growth of velocity of money, and SDM is a measure of the variability of money growth. SDM is calculated as an eight quarter (current and seven lagged values of money growth) standard deviation of money growth and ε is a white noise error term.[11] P is the number of lags on the velocity variable and q is the number of lags on the money variability variable.

The Granger causality test is implemented by calculating the F-statistic based on the null hypothesis that the set of the coefficients of the lagged values of SDM are not statistically different from zero (i.e., $\Sigma\beta_i=0$). If the null hypothesis is accepted, than it can be concluded that the standard deviation of money growth does not cause velocity. If the null hypothesis is rejected, there is evidence that the standard deviation of money growth causes velocity.

One of the difficulties of applying the Granger test is the selection of the appropriate lag lengths. The procedure of selecting arbitrary lags is quite common, but too short or too long lags may lead to results that are either biased or inefficient. In order to attempt to minimize the problems associated with lag selection two methods of selecting lag lengths are employed. The first follows that of Hall-Noble which chooses four and eight quarter lags of velocity growth and money volatility. In the second, lag lengths are determined by using Hsiao's [12] minimum final prediction error (FPE) criterion.[13]

A requirement of Hsiao's FPE criterion is that the series is

stationary. This is done by examining the plots and autocorrelation function of both the original and transformed series. GVEL is then regressed on its own lags,

$$GVEL_t=\sum_{i=1}^{m}\alpha_i GVEL_{t-i}+\varepsilon_t \tag{2}$$

where m is the maximum lag length allowed for all variables.[14] The ordinary least squares estimation of the above equation is then used to determine the lag length which minimizes FPE, according to the formula

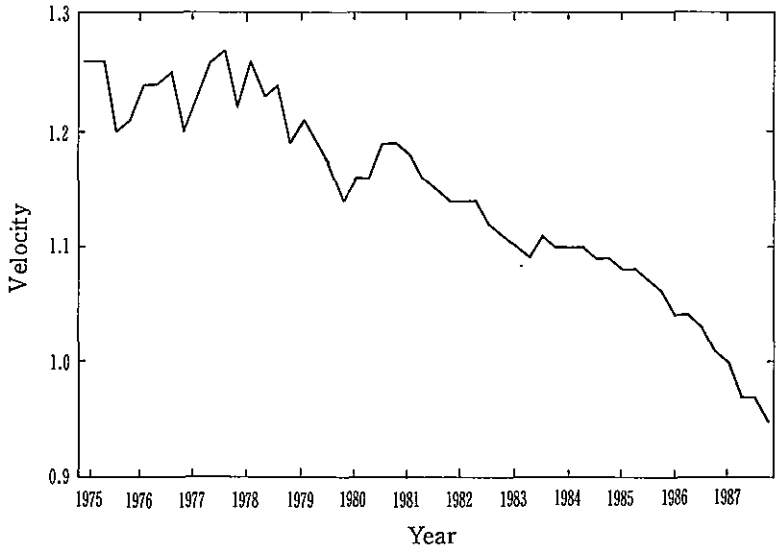
$$FPE(K)=[(n+K+1)/(n-K-1)]\,[SSE(p)/n] \tag{3}$$

where SSE is the sum of squares due to error. The value of K is the appropriate lag length for GVEL. Using the optimal lag length for GVEL, the optimal lag length for SDM, q, is determined by minimizing the FPE (p, q) given by the formula

$$FPE(K,q)=[(n+K+q+1)/(n-K-q)]\,[SSE(p,q)/n]. \tag{4}$$

The data for this study are for the time period 1975:1 through 1987:4. Focusing on Japan for the post 1974 period is important for a number of reasons. Firstly, Japan represents a major industrialized country with an established equity market. Secondly, Japanese monetary policy is similar to that of the United States with both the Bank of Japan and the Federal Reserve basically using the interbank market interest rate as their policy instrument.[15] Thirdly, the dramatic structural changes which the Japanese economy has undergone since 1973-1974 have significantly affected the money supply aggregates. For the relevant time period, the trend in the velocity of M2+CDs has demonstrated a clear pattern declining consistently since 1974 (see Figure 1).

Figure 1 - Velocity of M2+CDs



Source: The money supply variable and income variable are taken from Bank of Japan, *Economic Statistics Annual* [1].

IV Tests of Granger-Causality

In the Hall-Noble study, as well as that by Brocato-Smith, the velocity variable is entered in first-difference form and the volatility variable enters in level form, reflecting the assumption that velocity is first-difference stationary but SDM is level stationary. For this study the first difference of the velocity variable and the level of the volatility variable also yielded stationary series.

The results of the Granger-causality tests are presented in Table 1. The F-statistics reported are calculated under the null hypothesis that

TABLE 1

Granger-Causality Tests

$$GVEL_t=\sum_{i=1}^{p}\alpha_i GVEL_{t-i}+\sum_{i=1}^{q}\beta_i SDM_{t-i}+\varepsilon_t$$

Equation	p	q	F[a]
(1)	8	8	2.90*
(2)	8	6	2.83*
(3)	8	4	4.39*
(4)	8	2	7.46*
(5)	4	8	3.46*
(6)	4	6	2.64*
(7)	4	4	3.73*
(8)	4	2	6.02*
(9)	0	8	2.82*
(10)	0	4	3.58*
(11)[b]	1	1	3.32*

[a] F-statistics have q and 49-p-q-1 degrees of freedom, and test that all i are jointly insignificant.

[b] Lag lengths based on minimum FPE criterion.

* Significant at .05 level

the coefficients of the lagged standard deviations of money growth are zero. Equations (1) through (10) are consistent with Friedman's hypothesis that variability of money growth causes velocity in the Granger sense. The M2+CDs dependent variable specification is significant for all lag-lengths selected. The empirical results imply that money growth volatility does help to predict velocity.[16]

The minimum final prediction error occurs when the velocity and money growth variables are lagged one quarter each. This is represented by equation (11) in which the F-statistic of 3.32 provides statistical evidence that the standard deviation of money growth causes velocity in the Granger sence.

V Conclusion

This paper empirically investigates the effect of money growth volatility on the velocity of the Japanese monetary aggregate M2+CDs for the time period 1975:1 through 1987:4. The data are subject to various lag specifications to test for Granger-causality.

The regression estimates support Friedman's velocity hypothesis that money growth volatility affects velocity.

Notes

(1) Brocato, J. and K. L. Smith, "Velocity and the Variability of Money Growth: Evidence from Granger-Causality Tests-Comment," *Journal of Money, Credit and Banking*, No. 19 May 1989, pp.259-61; Friedman, Milton, "Monetary Variability: United States and Japan," *Journal of Money, Credit, and Banking*, No.15 August 1983, pp.339-43; Friedman, Milton, "Lessons from the 1979-82 Monetary Policy Experiment," *The American Economic Review Papers and Proceedings*, No.74 May 1984, pp.397-400; Hall, T. E., and N. Noble, "Velocity and the Variability of Money Growth: Evidence from Granger-Causality Tests," *Journal of Money, Credit and Banking*, No.19 February 1987, pp.112-16; Mehra, Y., "Velocity and the Variability of Money Growth: Evidence from Granger-Causality Tests-Comment,"*Journal of Money, Credit, and Banking*, No.21 May 1989, pp.262-66.

(2) Gordon, R. J. "The Gordon Update." A supplemental newsletter for use with R.J. Gordon's *Macroeconomics*, Spring 1983.

(3) Rasche, Robert H., "M1-Velocity and Money Demand Functions: Do Stable Relationships Exist?" *Carnegie-Rochester Conference Series on Public Policy*, No.27 1987, pp.9-88.

(4) Friedman (1984), *op. cit.*, page 398.

(5) Hall and Noble, *op. cit.*, pp. 112-115.

(6) Gordon, *op. cit.*

(7) Studies on the relationship between velocity and the variability of money growth for other countries include: Chowdhury, Abdur, "Velocity and the Variability of Money Growth — Some International Evidence," *Economics Letters* No.27 1988, pp.355-360; and Bordes, Christian, "Friedman's Velocity Hypothesis — Some Evidence from France," *Economics Letters* No.32 1990, pp.251-255.

(8) Friedman (1983), *op. cit.*, page 342.

(9) Friedman (1984) compares end-of-the-month and average daily data on the rates of change of money growth for Japan and shows that the variability is extremely

sensitive to the time period chosen. Friedman's point is well taken, although the results in his article must be interpreted with caution, as it appears Friedman's calculations were based on questionable data. The note to Table 2 [p.343] indicates that M1 for Japan includes large certificates of deposits. Large certificates of deposit are included in M2 in Japan, not M1. Data on the monetary aggregates for this study are based on end-of-the month data.

(10) Dotsey, *op.cit.* page 106.

(11) Several alternative specifications of the standard deviation of money growth involving different lag lengths were tested. In all cases the results were similar to those presented here.

(12) Hsiao, Cheng, "Autoregressive Modelling and Money-Income Causality Detection," *Journal of Monetary Economics* No.7 January 1981, pp.85-106.

(13) The method of implementing Hsiao's FPE criterion follows that of Grabowski, R., Sharma, S. C., and Dhakal, D., "Exports and Economic Development," *Economics Letters* No.31 February 1990.

(14) The highest lag chosen is eight quarters. This was necessary to conserve degrees of freedom.

(15) Dotsey, *op. cit.* page 209.

(16) Tests were also conducted using the change in the inflation rate and income as independent variables. The F-values for all lag lengths tested did not reject the null hypothesis that either inflation or income does not cause velocity to change.

貨幣の流通速度と貨幣量の増加に関するグレンジャー・カウザリティ・テスト：日本の場合

〈要　約〉

デニス　C．マコーナック

本論は，貨幣量の増加が貨幣の流通速度に影響を及ぼすという，フリードマンの仮説の正当性をしめすものである。日本のデータを用いたグレンジャーのカウザリティ・テストを補完するものとして，日本の総貨幣量M2＋CDs の変化が流通速度におよぼす影響を考慮した。さまざまなラグを考え，また回帰推定を考えに入れたデータは，上記のフリードマンの流通速度に関する仮説――貨幣量の増加は貨幣の流通速度に影響を及ぼす――を支持するものであった。