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Tax Rate Changes, Interest Rate Volatility, and the Decline in Velocity, 1981-1983

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TAX RATE CHANGES, INTEREST RATE VOLATILITY, AND THE DECLINE IN VELOCITY, 1981 - 1983

by

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I. INTRODUCTION

One of the most puzzling economic events in the U. S. during this decade has been the dramatic decline in the growth rate of the income velocity of money. From the fourth quarter of 1981 to the second quarter of 1983, the velocity growth rate fell by nearly 4% as opposed to its 3% trend growth rate. Traditional models have been unable to fully capture this unusual behavior of velocity, over predicting its rate of growth. The present study is concerned with this over prediction problem and attempts to more accurately explain the decline in the velocity growth rate in the 1981-1983 period. It examines the extent to which increased interest rate volatility in the early 1980's and the Reagan tax cuts may have contributed to the decline of the velocity growth rate from 1981 to 1983.

The results from an empirical model of velocity growth indicate that the inclusion of both of these factors improves the forecasting ability of the model, that the Reagan tax cuts have only modestly contributed to the decline of the velocity growth rate, and that the increased interest rate volatility does not appear to have had any perceptible influence on this rate in the early 1980's.

The remainder of this paper is organized as follows. The next section contains a brief discussion of the central hypotheses of this paper. This is followed by Section III where the methodology used to test these hypotheses is outlined. The empirical results are reported in Section IV. In the final section some concluding remarks are offered.

II. THE HYPOTHESES

From the fourth quarter of 1981 through the second quarter of 1983, velocity growth rate declined sharply. Several hypotheses concerning the unusual behavior of velocity growth have been offered in the literature [Gordon (1984), Judd (1983), Tatom (1983, 1984)]. However, these hypotheses have not been able to fully explain the recent decline in the velocity growth rate, in that the models which incorporated them over predicted this rate. This suggests that the recent movements in velocity growth are not yet fully understood, and that there are other factors that should be taken into account. Two factors that have been suggested, but not directly or fully analyzed, are interest rate volatility and income tax rates.[1] The relationship between each of these factors and velocity growth will now be explained.

Several studies have documented the effect of increased interest rate

volatility on aggregate output, financial markets and money demand [Evans (1984), Friedman (1982), Garner (1986), McGibany and Nourzad (1986), Tatom (1985)]. Increased interest rate volatility raises the level of uncertainty in the economy which, in turn, leads rational economic agents to increase their money holdings relative to nonmoney assets. Given that for any growth rate of nominal GNP, money growth is inversely related to velocity growth, increased interest rate volatility should decrease the velocity growth rate. Thus, velocity growth is responsive not only to growth of interest rates, but also to their volatility, ceteris paribus.

Turning to income tax rates, the rationale for their inclusion in a model of velocity growth derives from the fact that consumption expenditures depend on disposable personal income, so that lower personal taxes result in higher consumption spending. This, in turn, leads households to demand higher transactions balances [Holmes and Smyth (1972)]. Aside from disposable .pa income, the after-tax rate of return is another channel through which the effect of taxes is transmitted to money demand [Tanzi (1982)].

Similar reasoning applies to businesses. Firms' money demand is a positive function of capital investment, which is negatively related to the before-tax equilibrium rate of return. Lower corporate tax rates reduce this rate of return, increasing corporate demand for cash balances. Therefore, the public's (households and firms) demand for money is negatively related to taxes.[2] Once again, given the inverse relationship between money growth and velocity growth, as income taxes increase, the velocity growth rate should increase, ceteris paribus.[3]

III. THE METHODOLOGY

In conducting our empirical analysis of the effect of interest rate volatility and income taxes on velocity growth, we proceed as follows. First, we test the hypotheses that these two factors separately exert a significant influence on the velocity growth rate. For this purpose, we add these two variables to a model of velocity growth that has recently been suggested by Tatom (1984). This allows us to control for the effect of those factors that he found to have contributed to the recent decline in velocity growth.

Next, the velocity growth rate is forecast and direct contributions of all explanatory variables to the simulated values are calculated. This is done using the model without the interest rate volatility and tax rate variables, as well as the model which includes these variables. A comparison of the results from the two models will indicate whether the inclusion of both variables improves the forecasting ability of the model, and the extent to which the increased interest rate volatility in the early 1980's and the Reagan tax cuts may have contributed to the decline of the velocity growth rate in the sample period.

The hypotheses tested by Tatom can be classified into two categories. The first contains hypotheses pertaining to the behavior of the traditional determinants of velocity in the critical period, 1981:Q4 - 1983:Q2. These include moderating interest rates beginning in late 1981, and diminishing inflationary expectations following the fall in the inflation rate in 1981. The hypotheses in the second category include those regarding the response of

velocity to transitory or permanent shocks in the economy. These include increased international demand for U. S. dollars, financial innovations, the 1981-1982 recession, and the erratic behavior of money growth.

His findings indicate that "[t]he dominant factor responsible for the large negative growth rates of velocity in several quarters over the recent past has been the volatile pattern of money growth. This effect has been both direct, ..., and indirect, through the cyclical experience [recession] created by the periods of relatively slow money growth" [Tatom (1984), p. 47]. However, after controlling for the effect of these factors, the model still over predicts the velocity growth rate, as indicated by the presence of large negative forecast errors.[4]

We modify Tatom's model by retaining only those shock factors that he found to have a significant impact on velocity growth in the critical period (the variability of money growth and the 1981-1982 recession), in addition to the traditional determinants of velocity growth (real income, interest rates and expected inflation). To this modified model we add measures of interest rate volatility and income taxes. Therefore, our model is as follows

$$\dot{V}_t = a_0 + a_1\dot{Q}_t + a_2\dot{R}_t + a_3\Delta\dot{P}_t + \sum_{j=0}^{4} a_{4+i}\Delta\dot{M}_{t-i} + a_9\Delta\dot{GAP}_t + \sum_{j=1}^{4} a_{10+i}VR_{t-i} + \sum_{j=0}^{2} a_{14+i}\dot{T}_{t-i} + U_t \qquad (1)$$

where V is velocity of money; Q is real income; R is the rate of interest; P is the price level; M is the money stock; GAP is the GNP gap; T is the income tax rate; VR is interest rate volatility; U is a random error term; t is a quarterly time index; and dots indicate proportionate rates of growth.

We quantify the arguments in (1) as follows. Real GNP is used for real income; Moody's AAA bond yield is used for interest rates; the implicit GNP deflator is used for the price level; the money stock is measured in terms of M1; and the GNP gap is the ratio of potential to actual real GNP. Note that in (1), Δ P is used as a proxy for the expected inflation rate, on the assumption that expectations are not regressive (i.e., they are unbiased). Further, money growth enters (1) in first-difference form in order to capture the erratic behavior of money.

All of the above measures, variable specifications and lag structures are those used by Tatom (1984). For interest rate volatility and income tax rates, which are of particular interest to our analysis, we use the following measures. The volatility of interest rates is measured by a moving standard deviation similar to that used by Evans (1984), Tatom (1985), and McGibany and Nourzad (1986). In our model, the 24-month moving standard deviation of Moody's AAA bond yield provided the best results.[5] The income tax rate is the ratio of total Federal income tax revenue to before-tax income, making this an average tax rate.[6] The optimal lag structures for both variables were chosen based on F-tests of consecutive addition of individual and groups of lags. Having specified the model, we now turn to a discussion of the estimation results.

IV. THE RESULTS

In order to test our hypotheses discussed in Section II, we estimate Equation (1) over the entire sample period, 1948:Q3 - 1983:Q2. The results are reported below, where the numbers in parentheses are t-statistics.

$$\dot{V}_t = \underset{}{2.32} + \underset{(3.23)}{.24}\dot{Q}_t + \underset{(3.45)}{.01}\dot{R}_t + \underset{(0.85)}{.48}\Delta\dot{P}_t - \underset{(7.04)}{.78}\Delta\dot{M}_t - \underset{(-11.24)}{.53}\Delta\dot{M}_{t-1} - \underset{(-5.78)}{.40}\Delta\dot{M}_{t-2}$$

$$- \underset{(-3.82)}{.32}\Delta\dot{M}_{t-3} - \underset{(-3.34)}{.04}\Delta\dot{M}_{t-4} - \underset{(-0.50)}{.58}\Delta\dot{GAP}_t + \underset{(-6.40)}{.018}VR_{t-1} - \underset{(1.20)}{.024}VR_{t-2}$$

$$+ \underset{(-1.00)}{.029}VR_{t-3} - \underset{(1.19)}{.024}VR_{t-4} + \underset{(-1.65)}{.007}\dot{T}_t + \underset{(0.60)}{.039}\dot{T}_{t-1} + \underset{(3.44)}{.034}\dot{T}_{t-2}, \qquad (2)$$
$$(3.17)$$

$$\bar{R}^2 = .78 \qquad F = 34.02 \qquad DW = 1.93 \qquad RHO = \underset{(5.52)}{0.43}.$$

Based on the adjusted R-squared, the F-statistic, and sign and significance of the parameter estimates, it appears that (2) captures the variation of velocity growth satisfactorily. Seventy-eight percent of the variation in the dependent variable is accounted for by the model as a whole, and the independent variables are jointly significant at the 1% level of significance. The traditional determinants of velocity growth, Q, R, and P, have the expected signs, and all but the interest rate are significant at the 5% level. The latter finding is not unusual, as Tatom (1983, 1984) also found the interest rate variable to be of the expected sign, but not to be significantly different from zero. Further, the two factors Tatom found to be most responsible for the decline in velocity growth, changes in the growth of M1 and the GNP gap, perform as expected.

Regarding the test of our two hypotheses, we obtain mixed results. The hypothesis that tax rates exert a direct influence on velocity growth is supported, as all included tax rate variables have the expected signs, and two are significantly different from zero. Further, an F-test for the joint significance of these variables revealed that they add significantly to the explained variation of velocity growth, and the sum of the three tax rate variables is significantly different from zero.[7] These results are consistent with those reported by McGibany and Nourzad (1985).

The hypothesis that interest rate variability exerts a negative influence on velocity growth cannot be accepted. The signs of the variables fluctuate, with only the four-quarter lagged volatility measure displaying a significant negative effect at the 10% level of significance. Further, an F-test of joint significance revealed that the addition of interest rate volatility does not add significantly to the explained variation of velocity growth, and the sum of the volatility variables is not significantly different than zero.[8] A possible explanation for this finding is as follows.

It has been suggested that increased interest rate volatility has been

caused by more variable money growth since 1979 [Tatom (1985), Garner (1986)]. If this is the case, and the latter factor is a good predictor of the former, then interest rate volatility carries no additional information when added to a model which also contains money growth variability. It is interesting to note that although we find no statistical evidence in our sample showing that interest rate volatility is correlated with changes in money growth, we do find that there is a statistically significant relation from the absolute value of the change in money growth to our measure of interest rate volatility.[9] Based on the above, we conclude that the effect of interest rate volatility on velocity growth cannot be separated from that of changes in the growth rate of money in our model.

We are now in position to examine the extent to which the inclusion of tax rates to a model of velocity growth improves the accuracy of ex-post forecasts from the model. In order to do this, we twice re-estimate (1) over the shorter period 1948:Q3-1981:Q3; once with all variables included, and then with the tax rate variables excluded.[10] In both cases, the estimation results are in general conformity with those reported in (2). In particular, when tax rates are present, they have the expected positive signs and are generally significant (with t-statistics of 0.62, 3.15, and 2.80, respectively).

The actual, as well as the simulated velocity growth rates for the seven quarters beginning with 1981:Q4 from the two models are reported in Table 1. Note that the mean error, root-mean-square-error (RMSE), and Theil inequality coefficient (U) associated with the model with tax rates are smaller than those of the model without tax rates.[11] In particular, the inclusion of income tax rates improves the RMSE by nearly 18%. However, the results indicate that both models still over predict velocity growth in several quarters. Thus, while the inclusion of tax rates does improve the accuracy of ex-post forecasts from the model, it does not completely eliminate the over prediction of velocity growth in the critical period.

Let us turn to an examination of the impact that the Reagan tax cuts may have had on the decline in the velocity growth rate in the critical period. For this purpose, we calculate the direct contributions to the forecasts of this rate attributable to the regressors of the model. The results are presented in Table 2.[12] These confirm the finding by Tatom (1983, 1984) that, on average, the dominant factors contributing to the decline in velocity growth in the critical period were the recession that coincided with this period, and the erratic behavior of money growth. Our results also indicate that, on average, tax cuts have made the next largest contribution to the decline in velocity growth. However, given the small magnitude of the direct contribution of the tax variables relative to those of the recession and money growth variability, it does not appear that the Reagan tax cuts have been a major factor responsible for the unexpected decline in velocity growth.

TABLE 1

ACTUAL AND SIMULATED GROWTH RATES OF THE INCOME VELOCITY OF M1, 1981:Q4-1983:Q2[a]

	81:Q4	82:Q1	82:Q2	82:Q3	82:Q4	83:Q1	83:Q2	MEAN ERROR	RMSE	THEIL U
ACTUAL	-2.08	-9.87	2.49	-3.54	-10.66	-4.29	0.12			
SIMULATED with tax rates	-3.10	-10.88	0.76	-0.91	-10.16	-1.05	4.94	-1.06	2.56	8.02
without tax rates	-3.31	-10.37	1.45	-0.08	-9.67	0.05	5.88	-1.68	3.12	9.83

a. In percentages.

TABLE 2

DIRECT CONTRIBUTION OF THE EXPLANATORY VARIABLES TO SIMULATED VELOCITY GROWTH, 1981:Q4-1983:Q2[a,b,c]

QUARTER	VELOCITY GROWTH	CYCLE	MONEY GROWTH	INTEREST RATE	INFLATION RATE	TAX RATE	UNEXPLAINED COMPONENT
1981:Q4	-3.10	-7.95	2.39	0.10	-0.03	-0.60	2.44
1982:Q1	-10.88	-5.89	-4.39	0.06	-2.65	-0.45	2.44
1982:Q2	0.76	-4.52	4.15	-0.23	-0.23	-0.86	2.44
1982:Q3	-0.91	-1.51	-1.10	-0.20	-0.12	-0.43	2.44
1982:Q4	-10.16	-2.03	-8.63	-0.85	-0.31	-0.78	2.44
1983:Q1	-1.05	-0.73	-2.29	-0.12	0.55	-0.90	2.44
1983:Q2	4.94	5.65	-2.19	-0.18	-0.59	-0.19	2.44
AVERAGE	-2.91	-2.43	-1.72	-0.20	-0.48	-0.52	2.44

a. In percentages
b. The contributions are calculated using the coefficients of Equation (2) estimated over the period 1948:Q3-1981:Q3 and the actual changes in the corresponding variables during the forecast period.
c. The unexplained component refers to the estimated intercept term of the model over the short sample.

V. SUMMARY AND CONCLUDING REMARKS

In this paper, we have shown that the hypothesis that interest rate volatility has a negative influence on the growth rate of velocity cannot be accepted. We have pointed out that this may be a result of the inability to separate the effects of interest rate volatility from that of money growth variability. Further, using a more complete model than has been previously used, we have reaffirmed the finding that income taxes exert a positive influence on velocity growth.

We have also provided evidence suggesting that the inclusion of tax rates in a model of velocity growth improves the forecasting ability of the model. This is particularly true for the period 1981-1983 in which there was both a series of tax cuts as well as a dramatic decline in the velocity growth rate. However, we have found that incorporating tax rates does not completely eliminate the over prediction of the velocity growth rate that characterized most models in the early 1980's, in that a large part of the variation of the growth of velocity has remained unexplained.

Possible extensions of the analysis of this paper include the use of alternative measures of income tax rates. For example, Social Security taxes and state and local income taxes may be incorporated into the tax rate measure. This is particularly important given that it has been argued that the effects of the Reagan tax cuts may have been partly offset by increases in these taxes. Further, in constructing an aggregate measure of tax rates, one may wish to separate personal from corporate taxes to determine whether or not both sectors have contributed to the unusual behavior of velocity growth in a similar manner.

FOOTNOTES

1. The effect of interest rate volatility has been analyzed by Garner (1986) and McGibany and Nourzad (1986), but in the context of a money demand model. The effect of income tax rates on velocity growth was first analyzed by McGibany and Nourzad (1985). However, there are several differences between their model and that used here. For example, they used a three-equation recursive model with a different simulation methodology. Further, they did not include expected inflation, nor a quantitative recession variable in their model. In addition, their analysis was not concerned with the extent to which Reagan tax cuts may have contributed to the unusual decline in velocity growth.

2. For examples of empirical studies which specify money demand as a function of disposable income see de Leeuw (1965), Hamburger (1966), and de Leeuw and Gramlich (1968). For examples of studies that include income tax rates in models of money demand see Tanzi (1982), Roth (1985), and McGibany and Nourzad (1986).

3. Given that in traditional macroeconomic models (where money demand is not a function of taxes) the tax multiplier is negative, one may argue that changes in income taxes have an offsetting effect on velocity growth through their effect on nominal GNP growth. But, as Holmes and Smyth (1972) have shown, when money demand is specified as a function of taxes, the tax multiplier need not be negative.

4. Over the forecast period, the mean error from Tatom's model is more than 42% of the mean of the actual velocity growth rate. Further, in 5 out of the 7 quarters, the forecast errors are negative.

5. While Evans (1984), and McGibany and Nourzad (1986) both use a 12-month moving standard deviation, Tatom (1985) uses a 20-quarter measure. We also tried 3, 6, 12, 18 and 36-month measures, and obtained results consistent with those reported in Equation (2). However, of all volatility measures, the 24-month measure displayed the lowest forecast error statistics.

6. It may be argued that the appropriate tax rate variable is the marginal, rather than the average rate. Aside from the fact that, at the theoretical macroeconomic level, this is a debatable issue, data limitations prevent constructing an aggregate measure of marginal tax rates on a quarterly basis. It should also be pointed out that our measure of income tax rates does not include state and local taxes. McGibany and Nourzad (1985) have reported that the inclusion of these taxes does not appreciably affect the results with respect to velocity growth.

7. The F-statistic for joint significance of the inclusion of the tax rate variables is 5.31 with 3 and 117 degrees of freedom. The sum of the tax rate variables is 0.08, with a t-statistic of 3.30.

8. The F-statistic for joint significance of the inclusion of the interest rate volatility variables is 1.19 with 4 and 117 degrees of freedom. The sum of the volatility variables is -0.001, with a t-statistic of -0.21.

9. The simple correlation coefficients between any of the money growth variables and any of the volatility variables revealed no significant linear association. However, when we regressed the once-lagged volatility measure on the absolute values of lagged changes in the money growth rate (up to seven lags), we found a strong positive influence from the latter to the former.

10. The results are not markedly affected by the inclusion or exclusion of the volatility measures. All of the results pertaining to the shorter sample period are available from the authors upon request.

11. Simulations of velocity growth when the volatility measures are included have slightly smaller RMSE and Theil U statistics. However, the simulations were significantly lower (more negative) than those reported in Table 1, with an average simulated velocity growth rate of -4.45%, actually under predicting this rate.

12. The direct contributions of the variables reported in Table 2 are virtually identical to those calculated when using a model that includes the volatility measures. The contribution of the volatility variable is nearly - 1.70%, which explains the large negative average simulated velocity growth rate from this model, as was reported in footnote 11.

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