SOME FURTHER RESULTS ON THE SOURCE OF SHIFT IN M1 DEMAND IN THE 1980s

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In recent years the public's demand for M1 has grown significantly more strongly than predicted by existing money demand regression equations. A number of explanations have been advanced in order to explain this strength in M1 demand. These include a rise in monetary policy uncertainty, strength in the stock market, an increase in financial transactions, disinflation of the 1980s, and financial deregulation. The purpose of this paper is to test these hypotheses. The analysis shows that none of these hypotheses can satisfactorily explain the strength in M1 demand, a result suggesting that there has been a fundamental change in the character of M1. M1 in the 1980s has become an instrument for saving as well as for effecting transactions, and this change is related to the introduction into M1 of checkable deposits that pay an explicit rate of interest. The analysis shows that one needs a broader monetary aggregate M2 in order to identify a stable money demand function.

The plan of this article is as follows. Section I presents various hypotheses that have been advanced to explain the behavior of M1 in the 1980s. Section II provides a test of these hypotheses and Section III contains conclusions. An appendix of the paper draws on recent developments in the theory of cointegrated processes to show that there continues to exist a long-run stable demand function for the stock of real M2 balances as a function of real income and a market rate of interest.

I.
HYPOTHESES ABOUT THE SOURCE OF THE RECENT STRENGTH OF M1 DEMAND

This section describes briefly some of the alternative hypotheses of the strength in M1 demand and derives their testable implications. The first is that such strength was caused by the increased volatility of money growth following the announced change in Federal Reserve operating procedures in October 1979. The main contention here is that increased volatility of money growth raised the degree of perceived uncertainty, thereby increasing the demand for money [see, for example, Mascaro and Meltzer (1983) and Hall and Noble (1987)]. An empirical implication of this hypothesis is that since M1 demand is influenced by the volatility of money growth, M1 demand regressions estimated including the volatility variable should exhibit stability.

The second hypothesis stresses the role of financial wealth and financial transactions [see, for example, Morgan Guaranty Trust (1986), Wenninger and Radecki (1986), Kretzmer and Porter (1986), and Friedman (1987)]. The strength in M1 has been accompanied by strength in the stock market, and an increased volume of financial transactions. The argument here is that the real income variable commonly used in money demand regressions does not capture adequately the increased volume of financial transactions that might have been financed by M1. Furthermore, the rise in stock prices raised the financial wealth of the households and thereby could have contributed to the strength in M1 demand. An empirical implication of this hypothesis is that conventional M1 demand regressions should contain additional variables that capture the influences of financial transactions and wealth on money demand.

The third hypothesis considered in this study attributes the strength in M1 demand to the decline in the expected rate of inflation which occurred over the 1980s [Judd (1983), Tatom (1983a, 1983b) and Rasche (1987, 1989)]. The argument here is that the demand for real money is inversely related to the expected rate of inflation. Since actual inflation (and presumably the expected rate of inflation as well) has declined over the 1980s, the demand for money has increased. This argument implies that conventional M1 demand regressions estimated including an inflation variable should exhibit parameter stability.

The fourth hypothesis relates instability in M1 demand to the nationwide introduction of interest-bearing checkable deposits in 1981. There are two versions of this hypothesis. One version emphasizes the partial nature of interest rate deregulation and the impact such deregulation had on the interest elasticity of M1 demand. There is no change, according to this view, in the nature of balances kept in M1, which remain primarily a vehicle for effecting transactions. The second version emphasizes a change in the nature of balances held in M1; such balances are now an instrument for saving as well as for effecting transactions.

Consistent with the first version is the view that since 1981 M1 demand has become more interest sensitive. The argument here is that when interest-bearing checkable deposits were introduced nationwide in 1981, rates payable on them were regulated and set below market rates (rates payable on demand deposits were still held fixed at zero). In that case, a given change in market rates causes a larger proportional change in the opportunity cost of holding interest-bearing checkable deposits than of holding demand deposits. As a result, changes in market rates might induce larger changes in checkable deposits than in demand deposits, thereby increasing the interest responsiveness of M1 as a whole as checkable deposits become a larger fraction of M1 [Simpson (1984) and Mehra (1986)]. An empirical implication of this hypothesis is that the strength observed in M1 during the 1980s should be explained by a combination of the heightened interest sensitivity of M1 demand and the sharp fall in money market rates relative to the rates offered on checkable deposits. Furthermore, since interest-bearing checkable deposits are at the source of increase in the interest elasticity of M1 demand, this view, if correct, also implies that the demand for M1-A (which is M1 minus interest-bearing checkable deposits) should have retained its structural stability over the 1980s.

An alternative view consistent with the second version is that balances held in M1 have become highly substitutable with savings-type deposits held in the non-M1 component of M2 [Judd and Trehan (1987) and Hetzel and Mehra (1989)]. This view thus attributes the strength in M1 demand to an increase in such substitutions during the 1980s. Because such substitutions net out at the level of aggregation of M2, the M2 demand function should, according to this view, continue to exhibit stability.[1]

II. EMPIRICAL RESULTS

This section presents the results of tests of various hypotheses discussed in the previous section.

An M1 Demand Regression and the Evidence on its Instability in the 1980s

The regression that underlies tests of various hypotheses is:

$$\Delta \ln/(M/P) = a + \sum_{s=0}^{n1} b_s \, \Delta \ln(Y/P)_{t-s} - \sum_{s=0}^{n2} c_s \, \Delta(R-RM)_{t-s} - \sum_{s=0}^{n3} d_s \, \Delta INF_{t-s} + U_t \qquad (1)$$

where M is the nominal money stock; P, the price level; Y, nominal income; R, a market rate of interest; RM, the own rate of return on the money stock[2]; and INF (the difference in the log of the price level), the rate of inflation. The symbol ln denotes the natural logarithm, Δ the first difference operator and Σ the summation operator. The left-hand variable in equation (1) is real money balances. The right-hand variables are a constant, real income, the difference between the yield on a money market instrument and the own rate of return on the money stock, and the rate of inflation. The equation includes contemporaneous and several lagged values of these variables. The inflation rate measures the nominal rate of return to physical assets that are held directly. If such assets are substitutes for money, then inflation would influence money demand. In that case, the sum of coefficients that appear on the inflation variables in (1) should be statistically different from zero.[3]

The results of estimating (1) for M1 over 1952Q1 to 1980Q4 are shown in the upper panel of Table I. The regression is estimated including three additional dummy variables: SHFT, CC1, and CC2. The SHFT variable captures the shift in M1 demand over 1973Q2 to 1976Q4, and CC1 and CC2 variables capture transitory effects of the credit controls in 1980Q2 and 1980Q3. The real income variable used is nominal personal income deflated by the price level, and the yield on a money market instrument is measured by the 4-6 month commercial paper rate. Both income and opportunity cost variables are statistically significant.

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[1] In this case, M1 could also appear more interest sensitive than before because savings balances held in M1 are more sensitive at the margin to swings in interest rates. Moreover, the demand function for M1-A could also appear unstable if economic agents decide to switch between demand deposits and interest-bearing checkable deposits.

[2] The own rate of return on the money stock is defined as the weighted average of the explicit own rates of return on the various components of the money stock.

[3] Inflation should have no long-run effect on money demand if physical assets are not substitutes for money. However, inflation could still appear to influence money demand in the short run if money demand adjusts with a lag to a change in the price level [Goldfeld and Sichel (1987)].

Table I

EVIDENCE ON INSTABILITY IN REAL M1 DEMAND

Real M1 demand regression

$$\Delta(M1/P) = -.004 + \underset{(4.5)}{.74}\,\Delta y \underset{(-3.2)}{-.74}\,\Delta(R-RM1) - \underset{(-1.9)}{1.27}\,\Delta INF - \underset{(-2.2)}{.005}\,SHFT - \underset{(-5.0)}{.03}\,CC1 + \underset{(3.3)}{.02}\,CC2$$

Estimation period: 1952Q1-1980Q4 $\bar{R}^2 = .68$ DW = 1.9 RHO = .38(3.8)

Coefficients on Dufour Dummies

Year/Quarter	Coefficient (t value)	Year/Quarter	Coefficient (t value)
1981/Q1	−.007(−1.0)	1985/Q1	.009 (1.5)
1981/Q2	.008 (.9)	1985/Q2	.006 (1.0)
1981/Q3	−.000 (.6)	1985/Q3	.026 (4.2)
1981/Q4	−.008 (−.9)	1985/Q4	.016 (2.7)
1982/Q1	.004 (.6)	1986/Q1	.010 (1.8)
1982/Q2	−.012(−1.7)	1986/Q2	.028 (5.0)
1982/Q3	.008 (1.3)	1986/Q3	.029 (5.1)
1982/Q4	.018 (2.9)	1986/Q4	.033 (5.9)
1983/Q1	.002 (.4)	1987/Q1	.019 (3.4)
1983/Q2	.013 (1.8)	1987/Q2	.008 (1.3)
1983/Q3	.018 (3.0)	1987/Q3	−.004(−.7)
1983/Q4	.005 (.9)	1987/Q4	.001 (.2)
1984/Q1	.005 (.9)	1988/Q1	−.003(−.5)
1984/Q2	.007 (1.2)	1988/Q2	−.005 (1.0)
1984/Q3	.004 (.7)	1988/Q3	.001 (.2)
1984/Q4	−.003 (−.5)	1988/Q4	−.000(−.1)

FD (32,95) = 3.08**

** Significant at .01 level

Notes: The real M1 demand regression tabulated in the upper panel is estimated over 1952Q1 to 1980Q4. P is the implicit deflator for personal consumption expenditures; y, nominal personal income deflated by p; R, the 4-6 month commercial paper rate; RM1, the own rate of return on M1; and INF, the rate of inflation. All variables are in natural logarithms except R and RM1. SHFT is 1 from 1973Q2 to 1976Q4 and zero otherwise. CC1 and CC2 are respectively 1 in 1980Q2 and 1980Q3 and zero otherwise. All the variables are entered as simple distributed lags with 5 contemporaneous and lagged values and the sum of the estimated coefficients is tabulated. Parentheses contain t values. A Hildreth-Lu procedure is used to estimate the regression. The coefficients on Dufour dummies reported in the lower panel of Table I are from the real M1 demand regression that is estimated over 1952Q1 to 1988Q4. Dufour dummies are zero-one dummy variables defined for each observation over 1981Q1 to 1988Q4. FD is the F statistic that tests the null hypothesis that Dufour dummy variables do not enter the M1 demand regression equation.

The structural stability of this regression is investigated using the Dufour test [Dufour (1980)], which is a variant of the Chow test and uses an F statistic to test the joint significance of dummy variables introduced for each observation of the interval for which structural stability is examined. A small F statistic indicates structural stability.

The results of performing the Dufour test for the period 1981Q1 to 1988Q4 appear in the lower panel of Table I. That is, the regression equation (1) was reestimated over the period 1952Q1 to 1988Q4 with separate shift dummies introduced for each quarter from 1981Q1 to 1988Q4. The F statistic for Dufour dummies used in this regression [FD (32,95), Table I] is 3.08, which exceeds the 5 percent critical value of 1.6. This result implies that the M1 demand regression is not stable. A look at the estimated coefficients and the associated t values on these Dufour dummies, also tabulated in Table I, indicates observations whose mean values are inconsistent with the regression equation (1). Such observations are found in years 1982, 1983, 1985, 1986, and 1987. These coefficients are mostly positive, implying strength in real M1 that could not be explained by the M1 demand regression.

Tests of Various Hypotheses

The first and second explanations of the strength in M1 demand in the 1980s are tested by estimation of regression equation (1) augmented by the addition of the relevant variable suggested by each explanation. These regressions were first estimated over 1952Q1 to 1988Q4 and F statistics were calculated to test the significance of relevant variables. Structural stability of the expanded M1 demand regressions is then investigated by the Dufour test.

Column (1) of Table II shows the estimation over 1952Q1 to 1988Q4 of the real M1 demand regression equation that contains a variable measuring the volatility of money growth (VOL1). This variable VOL1 is calculated as an eight-quarter moving standard deviation of M1 growth [Hall and Noble (1987)]. The maintained hypothesis is that changes in VOL1 and money demand are positively correlated. The estimated coefficient on VOL1, though positive, is not statistically significant. The t value for the sum of coefficients on VOL1 is .5 and the F value for their joint-significance is 1.1 (see F1 values in Table II). These values are below the relevant 5 percent critical values. The F statistic for the Dufour dummies is 2.7, which is significant at the 1 percent level (see the FD value in Table II). These estimates thus suggest that the strength observed in M1 demand in the 1980s could not be explained by the rise in the volatility of M1 growth.[4]

Columns (2), (3), and (4) of Table II show estimation over 1952Q1 to 1988Q4 of the real M1 demand regression equation with variables measuring respectively the real value of stocks (SP), the real value of financial transactions on the New York Stock Exchange (SVP) and the real net worth of the households (W).[5] It is hypothesized that changes in

[4] Another way to test this hypothesis is to examine the effect of the volatility of money growth on M1 velocity. This relationship has recently been reexamined in Mehra (1989) and Brocato and Smith (1989). The evidence presented there is not favorable to the hypothesis that the decline observed in the velocity of M1 in the 1980s was caused by the increased volatility of M1 growth.

[5] SP is calculated as the Standard and Poor's 500 composite index divided by the price level used to deflate money balances. SVP is the product of the volume of shares traded on the NYSE and the Standard and Poor's 500 composite index divided by the price level used to deflate M1. W is calculated as the net worth of households divided by the price level. These variables have been employed previously by various authors.

Table II

REAL M1 DEMAND REGRESSION EQUATION: TESTING ALTERNATIVE HYPOTHESES

Independent Variables	(1)	(2)	(3)	(4)	(5)
constant	−.004(−1.8)	−.004(−1.5)	−.004(−1.9)	−.004(−1.6)	−.004(−1.8)
Δy	.92 (3.9)	.81 (3.2)	.80 (3.5)	.79 (3.0)	.87 (3.9)
Δ(RCP−RM1)	−1.41 (−4.9)	−1.21 (−4.2)	−1.15 (−4.4)	−1.25 (−4.8)	−1.31 (−5.5)
ΔINF	−1.55 (−1.9)	−1.75 (−2.1)	−1.77 (−2.3)	−1.39 (−1.6)	−1.69 (−2.4)
ΔVOL1	.001 (.5)				
ΔSP		.03 (1.0)			
ΔSPV			.03 (1.99)		
ΔW				.08 (.6)	
SER	.00597	.00608	.00595	.00605	.00586
$\bar{R}^2$	.69	.68	.69	.68	.69
F1	1.1 (5,115)	.24 (5,115)	1.24 (5,115)	.4 (5,115)	4.3**(5,127)
FD	2.7** (32,83)	2.92**(32,83)	2.82**(32,83)	3.3** (32,83)	3.1** (32,95)

** significant at .01 level

Notes: The regressions tabulated here are estimated over the period 1952Q1 to 1988Q4. SP is the real price of stocks; SPV, the real value of the product of volume of shares traded on the NYSE and the Standard and Poor's common price index; W, the real net worth of households; RM1, the own rate of return on M1; and VOL1, the eight-quarter moving standard deviation of M1 growth. Other variables are defined as in Table I. Five contemporaneous and lagged values of these variables enter the money demand regression. F1 tests the hypothesis that the additional variable suggested by the relevant hypothesis does not enter the M1 demand regression. FD is the statistic for the Dufour test applied to the expanded M1 demand regression over 1981Q1 to 1988Q4.

these variables and money demand are positively correlated. As can be seen, however, the only variable that does attain statistical significance is SVP (t value on the sum of coefficients on SVP is 1.9). But none of the variables is significant by the F test. The Dufour test results indicate that the expanded M1 demand regressions are not stable over the period 1981Q1 to 1988Q4 (see FD values in columns (2) through (4) of Table II).

Column (5) of Table II shows the estimation of the real M1 demand regression with the inflation variables (INF). The variable INF is statistically significant (both t and F values are significant at the 5 percent level). This suggests that part of the observed strength in M1 in the 1980s is due to a decline in the rate of inflation. However, as indicated by the Dufour test, this regression remains structurally unstable over the period 1981Q1 to 1988Q4 (see the FD value in Column (5) of Table II).

Column (6) of Table III presents the estimation of the real money demand regression over 1952Q1 to 1988Q4 with real M1 as the dependent variable and with the additional variable (D88*R – RM1) that is the product of a zero-one dummy (D88)and the opportunity cost variable (R – RM1). D88 equals one over 1981Q1 to 1988Q4 and zero otherwise. The dummy variable, D88*R – RM1, captures a possible change in the interest elasticity of M1 demand in the 1980s. As can be seen, this variable is statistically significant, suggesting a heightened interest sensitivity of M1 demand. However, even after allowing for a rise in the interest elasticity of M1 demand, the expanded M1 demand regression does not explain all of the strength of M1 in the 1980s, a result indicated by the Dufour test applied over the interval 1985Q1 to 1988Q4.[6] The coefficients that appear on Dufour dummies and the F statistic for the Dufour test are presented in Table IV. The F value is large and indicates continuing structural instability.

Furthermore, removing interest-bearing checkable deposits from the definition of money does not render the money demand equation stable either. Column (7) of Table III shows the estimation of a real money demand equation over 1952Q1 to 1988Q4 with M1-A as the dependent variable. The Dufour test

[6] This amounts to estimating the expanded M1 demand regression over 1952Q1 to 1984Q4 and examining its stability over 1985Q1 to 1988Q4. The assumption implicit in this approach is that the expanded estimation period (1952Q1 to 1984Q4) is long enough to provide reliable estimates of the new interest elasticity of M1 demand.

Table III

REAL MONEY DEMAND REGRESSION EQUATIONS: TESTING ALTERNATIVE HYPOTHESES

Independent Variables	Dependent Variable (6) (M1/p)	(7) (M1A/p)	(8) (M1/p)	(9) (M2/p)
constant	–.006(–3.0)	–.009(–4.0)	–.006(–2.7)	.000 (.01)
Δy	.95 (4.7)	1.1 (4.8)	.91 (4.5)	1.0 (6.6)
ΔINF	–1.73 (–2.5)	–1.0 (–1.2)	–1.32 (–1.9)	–2.21 (–4.2)
ΔR		–.012(–4.8)		
Δ(R – RM1)	–.79 (–2.9)		–1.26 (–5.7)	
Δ(R – RM2)				–2.07 (–8.7)
D88	.003 (1.4)		.006 (2.43)	
D88*(R – RM1)	–1.34 (–3.1)			
SER	.00555	.00696	.00578	.00442
$\bar{R}^2$	.72	.64	.70	.78
DW	1.94	1.97	1.95	1.99

Notes: D88 is a dummy variable, taking values 1 in 1981Q1 to 1988Q4 and zero otherwise. D88*(R – RM1) is the product of D88 and (R – RM1). RM2 is the own rate of return on M2 and is calculated as a weighted average of the explicit rates paid on components of M2. Other variables are defined as before. The regressions tabulated above are estimated over the period 1952Q1 to 1988Q4.

Table IV

COEFFICIENTS ON DUFOUR DUMMIES IN REAL MONEY DEMAND REGRESSIONS

Year/Quarter	Eq. 6	Eq. 7	Eq. 9	Year/Quarter	Eq. 6	Eq. 7	Eq. 9
1981/Q1		−.066(−9.5)	−.008(−1.9)	1985/Q1	.012 (2.0)	−.001 (−.1)	.007 (1.4)
1981/Q2		−.021(−2.6)	.002 (.4)	1985/Q2	.013 (2.1)	−.000 (−.0)	−.009(−1.9)
1981/Q3		−.013(−1.7)	.004 (.7)	1985/Q3	.018 (2.9)	.013 (2.1)	.000 (0.0)
1981/Q4		−.018(−2.2)	−.005 (−.9)	1985/Q4	.005 (.8)	.009 (1.5)	−.003 (−.7)
1982/Q1		−.009(−1.3)	−.006(−1.1)	1986/Q1	.005 (.9)	.003 (.5)	−.003 (−.7)
1982/Q2		−.013(−1.8)	−.007(−1.4)	1986/Q2	.024 (4.1)	.017 (3.1)	.006 (1.3)
1982/Q3		−.011(−1.6)	.002 (.4)	1986/Q3	.027 (4.5)	.014 (2.5)	.007 (1.4)
1982/Q4		.004 (.7)	.003 (.7)	1986/Q4	.030 (5.1)	.016 (2.8)	.004 (.8)
1983/Q1		−.011(−1.8)	.024 (5.0)	1987/Q1	.015 (2.4)	.001 (.2)	.000 (.8)
1983/Q2		−.001 (−.2)	.000 (0.0)	1987/Q2	.000 (.1)	−.001 (−.1)	−.000 (−.1)
1983/Q3		.005 (.8)	−.003 (−.6)	1987/Q3	−.006(−1.0)	−.009(−1.6)	−.002 (−.4)
1983/Q4		.002 (.3)	.000 (0.0)	1987/Q4	.001 (.2)	.001 (.3)	−.002 (−.4)
1984/Q1		−.006(−1.1)	−.003 (−.7)	1988/Q1	.003 (.6)	−.007(−1.2)	.001 (.2)
1984/Q2		.002 (.4)	.001 (.2)	1988/Q2	.007 (1.2)	−.004 (−.8)	.001 (.2)
1984/Q3		.006 (.1)	−.002 (−.5)	1988/Q3	.004 (.7)	−.002 (−.0)	−.008(−1.6)
1984/Q4		−.007(−1.1)	−.001 (−.3)	1988/Q4	−.000 (.0)	−.003 (−.5)	−.008(−1.6)
FD1					3.1**(16,105)		
FD2						1.7*(28,95)	
FD3							1.4(31,95)

Notes: The regression equations 6, 7, and 9 above correspond respectively to regressions reported in columns 6, 7, and 9 of Table III. These regressions are reestimated including Dufour dummy variables. Regressions 7 and 9 include Dufour dummies defined over 1981Q1 to 1988Q4, whereas the regression 6 includes Dufour dummies defined over 1985Q1 to 1988Q4. FD1, FD2, and FD3 are the F statistics that test the joint significance of the relevant Dufour dummy variables.

when applied to this regression over 1982Q1 to 1988Q4[7] does not indicate structural stability (see Table IV for the coefficients that appear on Dufour dummies and for the relevant F statistic). The M1-A regression fails to explain the strength of M1-A in 1985 and 1986.

Column (8) of Table III shows the estimation of a real money demand regression over 1952Q1 to 1988Q4 with real M1 as the dependent variable and with the addition of a dummy variable (D88) that takes values unity over 1981Q1 to 1988Q4 and zero otherwise. This regression incorporates the hypothesis that there was a one-time shift in the drift of real M1 demand over the 1980s. However, even after one allows for this shift in the constant term, the real M1 demand regression remains unstable, a result indicated by the Dufour test applied to this regression over 1985Q1 to 1988Q4. The F statistic [(16,110)] is 3.2, which is above the 5 percent critical value of 1.7.

Column (9) of Table III shows the estimation of a real money demand regression with real M2 as the dependent variable. This regression incorporates the hypothesis that a broader definition of money is needed in order to capture increased substitutions between components of M1 on the one hand and savings-type deposits included in M2 on the other [Hetzel and Mehra (1989)]. The results of applying the Dufour test to this regression over 1981Q1 to 1988Q4 are presented in Table IV (see column under Eq. 9). Except for one large coefficient that appears on the Dufour dummy for 1983Q1, the other coefficients are small and not significant. The F statistic [31,95] for these other coefficients is 1.4, which is below the 5 percent critical value of 1.5. This result

[7] In order to avoid distorting effects of the nationwide introduction of NOW accounts in January 1981, the observations for the year 1981 are excluded in computing the F statistic for the Dufour test.

implies that except for one-time shift in 1983Q1 M2 demand has been stable in the 1980s.[8] Additional evidence consistent with the existence of a stable long-run M2 demand function over 1952Q1 to 1988Q4 is presented in the Appendix.

III. CONCLUDING REMARKS

This article has examined empirically several explanations of the instability in M1 demand of the 1980s. The econometric evidence presented here does not support explanations that assign a key role to the behavior of the volatility of M1 growth, the rate of inflation, the real value of stocks, the volume of financial transactions, or the financial wealth of households.

The most probable cause of the shift in M1 demand thus is the introduction into M1 of checkable deposits that pay interest. One view is that this development might have raised the interest elasticity of M1 demand while having no effect on the demand of M1-A (currency plus demand deposits). The evidence does not support this view. True, M1 demand does appear more interest sensitive. But the M1 demand regression estimated including the variable that captures this shift in the interest elasticity of M1 demand does not explain all the strength in money demand. Moreover, it also appears that the demand for M1-A shifted in the 1980s.

The other view, which receives considerable support here, is that the financial deregulation has altered the character of M1 demand. M1 has become an instrument for saving as well as for effecting transactions. As a result, elements of M1 are highly substitutable with the savings instrument included in the non-M1 component of M2. An empirical implication of this view is that the broader monetary aggregate M2, which internalizes such substitutions, has a stable demand function. The evidence presented in the text and the Appendix is consistent with this implication.

[8] This one-time shift in M2 demand is due to the introduction of MMDAs in December 1982 and Super-NOWs in January 1983.

References

Brocato, Joe, and Kenneth L. Smith. "Velocity and the Variability of Money Growth: Evidence from Granger-Causality Tests." *Journal of Money, Credit, and Banking* 21 (May 1989): 258-61.

Dufour, Jean-Marie. "Dummy Variables and Predictive Tests for Structural Change." *Economics Letters* 6 (1980): 241-47.

Engle, Robert F., and Byung Sam Yoo. "Forecasting and Testing in Co-Integrated Systems." *Journal of Econometrics* 35 (May 1987): 143-59.

Engle, Robert F., and C.W.J. Granger. "Co-Integration and Error Correction: Representation, Estimation and Testing." *Econometrica* 55 (March 1987): 251-76.

Friedman, Milton. "Money and the Stock Market." *Journal of Political Economy* 96 (April 1988): 221-45.

Fuller, W.A. *Introduction to Statistical Time Series*. New York: Wiley, 1976.

Goldfeld, Stephen M., and Daniel E. Sichel. "Money Demand: The Effects of Inflation and Alternative Adjustment Mechanisms." *Review of Economics and Statistics* 69 (August 1987): 511-15.

Hall, Thomas E., and Nicholas R. Noble. "Velocity and the Variability of Money Growth: Evidence from Granger-Causality Tests." *Journal of Money, Credit, and Banking* 19 (February 1987): 112-16.

Hetzel, Robert H., and Yash P. Mehra. "The Behavior of Money Demand in the 1980s." *Journal of Money, Credit, and Banking* 21 (November 1989), forthcoming.

Judd, John P. "The Recent Decline in Velocity: Instability in Money Demand or Inflation?" Federal Reserve Bank of San Francisco *Economic Review* (Summer 1983), pp. 12-19.

Judd, John P., and Bharat Trehan. "Portfolio Substitution and the Reliability of M1, M2 and M3 as Monetary Policy Indicators." Federal Reserve Bank of San Francisco *Economic Review* (Summer 1987), pp. 5-23.

Keeley, Michael C., and Gary C. Zimmerman. "Deposit Rate Deregulation and the Demand for Transactions Media." Federal Reserve Bank of San Francisco *Economic Review* (Summer 1986), pp. 47-62.

Kretzmer, Peter E., and Richard D. Porter. "The Demand for the Narrow Aggregate—Is a Transaction Approach Sufficient?" Board of Governors of the Federal Reserve System, 1986.

Mascaro, Angelo, and Allan H. Meltzer. "Long- and Short-Term Interest Rates in a Risky World." *Journal of Monetary Economics* 12 (November 1983): 485-518.

Mehra, Yash P. "Recent Financial Deregulation and the Interest Elasticity of M1 Demand." Federal Reserve Bank of Richmond *Economic Review* 72 (July/August 1986): 13-24.

Morgan Guaranty Trust Company. "Demystifying Money's Explosive Growth." *Morgan Economic Quarterly* (March 1986), pp. 10-13.

Simpson, Thomas D., and Richard D. Porter. "Changes in the Financial System: Implications for Monetary Policy." *Brookings Papers on Economic Activity* (1: 1984), pp. 241-65.

Tatom, John A. "Was the 1982 Velocity Decline Unusual?" Federal Reserve Bank of St. Louis *Review* 65 (August/September 1983a): 5-15.

————. "Alternative Explanations of the 1982-83 Decline in Velocity." In *Monetary Targeting and Velocity*, Conference Proceedings, Federal Reserve Bank of San Francisco, 1983b, pp. 22-56.

Trehan, Bharat, and Carl Walsh. "Portfolio Substitution and Recent M1 Behavior." *Contemporary Policy Issues* 5 (January 1987): 54-63.

Wenninger, John. "Responsiveness of Interest Rate Spreads and Deposit Flows to Changes in Market Rates." Federal Reserve Bank of New York *Quarterly Review* 11 (Autumn 1986): 1-10.

Wenninger, John, and Lawrence J. Radecki. "Financial Transactions and the Demand for M1." Federal Reserve Bank of New York *Quarterly Review* 11 (Summer 1986): 24-29.

APPENDIX

COINTEGRATION AND THE EXISTENCE OF A STABLE LONG-RUN M2 DEMAND FUNCTION

Introduction

This appendix presents alternative statistical evidence consistent with the existence of a long-run M2 demand function during 1952Q1 to 1988Q4. The evidence consists of showing that real M2 balances are cointegrated[9] with real income and a market rate of interest, which means that there exists a stable long-run demand function for real M2 balances as a function of real income and a market rate of interest.

A Long-Run Money Demand Equation

The transactions models of money demand suggest that the public's demand for real money balances depends upon a scale variable commonly measured by real income and an opportunity cost variable commonly measured by a market interest rate. Consider, for example, the following linear semi-log specification (1)

$$\ln(M/P)_t = a + b \ln y_t - c R_t + u_t \qquad (1)$$

where M is the nominal stock of money; P, the price level; y, real income; R, a market rate of interest; and u, the error-term. The symbol ln denotes the natural logarithm. The variables in (1) are the long-run determinants of real money demand. In the short run, actual real money balances could differ from the value suggested by such determinants. This is implied by the presence of the error term u_t in (1). However, if equation (1) is true, then u_t is a stationary zero mean process.

It should be pointed out that if the parameter b in (1) is unity, then (1) could be expressed as a velocity equation (2)

$$\ln(Py/M) = a' + c' R_t + e_t \qquad (2)$$

where all variables are as defined above.

Testing the Existence of a Long-Run M2 Demand Function: The Issue of Cointegration

The variables in the money demand equation (1) above have stochastic trends and hence are nonstationary. The proposition that this equation describes the long-run relationship among the variables can be interpreted to mean that the stochastic trend in real money balances is related to stochastic trends in real income and the nominal rate of interest. This implication is related to the concept of cointegration discussed in Granger (1986), which states that cointegrated multiple time series share common stochastic trends. Hence, the existence of a stable long-run M2 demand function (1) can be examined using the test of cointegration discussed in Engle and Granger (1987).

This test for cointegration consists of two steps. The first tests whether each variable in equation (1) has a stochastic trend. One does this by performing a unit root test on the variables. The second step tests whether stochastic trends in these variables are related to each other. In particular, the question of interest here is whether the stochastic component in real M2 balances is related to stochastic components in real income and the nominal rate of interest. This can be examined by estimating the cointegrating regression of the form (3)

[9] Let X_{1t}, X_{2t}, and X_{3t} be three time series, each first difference stationary. Then these series are said to be cointegrated if there exists a vector of constants (α_1, α_2, α_3) such that $Z_t = \alpha_1 X_{1t} + \alpha_2 X_{2t} + \alpha_3 X_{3t}$ is stationary. The intuition behind this definition is that even if each time series is nonstationary, there might exist linear combinations of such time series that are stationary. In that case, multiple time series are cointegrated and share some common stochastic trends. We can interpret the presence of cointegration to imply that long-run movements in these multiple time series are related to each other.

$$\ln(M/P) = \gamma_0 + \gamma_1 \ln y_t + \gamma_2 R_t + U_t \qquad (3)$$

and then testing whether the residual U_t has a unit root. If U_t does not appear to have a unit root while the left-hand and right-hand variables have a unit root, then the variables are said to be cointegrated. In that case, ordinary least squares estimates of (3) are consistent and can be used to calculate long term elasticities.

Test Results for Cointegration

The test used to detect a unit root in a given time series X_t is the Augmented Dickey-Fuller (ADF) test [Fuller (1976)] and is performed estimating the following regression

$$\Delta X_t = e + f T + \sum_{s=1}^{n} g_s \Delta X_{t-s} + h X_{t-1} + \epsilon_t \qquad (4)$$

where ϵ_t is an independent and identically distributed disturbance and n is the number of lagged values of first differences that are included to allow for serially correlated errors. If there is a unit root in X_t, then the estimated coefficient h in (4) should not be different from zero. The results of estimating (4) for real M2 balances, M2 velocity, real income, the opportunity cost variable and the nominal rate of interest are presented in Table V. These test results shown are consistent with the presence of a unit root in each of the relevant variables. The only exception is the opportunity cost variable measured as the difference between the market rate of interest (R) and the own rate of return on M2 (RM2). This variable, R – RM2, appears stationary over the period 1952Q1 to 1988Q4. Hence, in tests for cointegration the opportunity cost of holding M2 is measured by the market rate of interest (R).

Table VI presents results of regressing real M2 balances on levels of real income and the market rate of interest and M2 velocity on the level of the market rate of interest. Regressions are presented for two measures of income, real personal income and real GNP. The results of applying the formal ADF test for detecting a unit root in the residual series are also reported there. The estimated coefficient that appears on the lagged level of the residual in the relevant regressions range between –.10 to –.20 and are generally significantly different from zero at the 5 percent level (see coefficient values $\hat{h}$ and the associated t values in panels 1 though 4 in Table VI). This result implies that the residuals U_t in (3) and e_t in (2) are stationary.

Table V

UNIT ROOT TEST STATISTICS

Augmented Dickey-Fuller Equation

$$\Delta X_t = e + f T_t + \sum_{s=1}^{n} g_s \Delta X_{t-s} + h X_{t-1}$$

X	h	t statistic (h=0)	Q(sl)
lnrM2	–.02	–1.40	32.8(.62)
lnrM22	–.03	–1.90	42.7(.20)
lnrpy	–.01	–.9	28.3(.81)
lnry	–.04	–2.0	18.8(.99)
R	–.14	–2.9	30.1(.74)
R – RM2	–.23	–3.90*	36.9(.42)
lnVM2	–.067	–2.6	41.4(.25)
lnVM22	–.10	–2.7	43.3(.18)

Notes: The Augmented Dickey-Fuller regression is estimated over the period 1952Q1 to 1988Q4. ln is the natural logarithm. rM2 is M2 deflated by the implicit price deflator for consumption expenditures; rM22, M2 deflated by the implicit GNP deflator; ry, real GNP; rpy, real personal income; R, the 4-6 commercial paper rate; VM2, nominal personal income divided by M2; VM22, nominal GNP divided by M2; T, time trend; and RM2, the own rate of return on M2. RM2 is a weighted average of the rates payable on components of M2. h is the estimated coefficient that appears on the lagged level of the variable in question and the 5% critical value of the t statistics is 3.45 [Fuller (1976), Table 8.5.2)]. Q(sl) is the Ljung-Box Q-statistic based on 36 autocorrelations of the residual and sl is the significance level.

The long-run real M2 balances predicted by the cointegrating regression are shown in Charts 1 and 2 along with actual real M2 balances. Chart 1 uses real personal income and Chart 2 real GNP in the relevant cointegrating regression. As can be seen, there are differences between actual and estimated long-run real M2 balances but these differences appear stationary.

The results on unit roots presented above imply that levels of the variables entering the M2 demand regression (3) and velocity regression (2) are nonstationary but cointegrated. The parameter estimates of the regressions (3) and (2) presented in Table VI are therefore consistent. The coefficient that is estimated on real income (measured either by real personal income or by real GNP) is unity, suggesting that the income elasticity of money demand is unity. The long-run value of the coefficient estimated on the market rate of interest in real M2 demand regression is approximately –1. This estimate implies that when the market rate of interest rises by 100 basis points, real demand for M2 balances rises by 1 percent in the long run.

Table VI

TEST STATISTICS FOR COINTEGRATION OF REAL M2 AND M2 VELOCITY

Semi-Log Specification

1. Cointegrating Regression: $\ln(M2/p)_t = -.6 + 1.0 \ln rpy_t - 1.2 R_t + \hat{u}_t$

   Augmented Dickey-Fuller Regression: $\Delta\hat{u}_t = h\,\hat{u}_{t-1} + \sum_{s=1}^{n} \Delta\hat{u}_{t-s}$

   Lag length n:4 Estimated $\hat{h} = -.11$ Test statistic for $\hat{h} = 0$: -2.6 Q(sl) = 30.6(.58)

   5% critical value for $\hat{h}$: 3.6 [Engle and Yoo (1987), Table 3]

2. Cointegrating Regression: $\ln(M2/p2)_t = -5.9 + 1.1 \ln ry_t - 1.1 R_t + \hat{u}_t$

   Augmented Dickey-Fuller Regression: $\Delta\hat{u}_t = h\,\hat{u}_{t-1} + \sum_{s=1}^{n} \Delta\hat{u}_{t-s}$

   Lag length n:0 Estimated $\hat{h} = -.20$ Test statistic for $\hat{h} = 0$: -4.1 Q(sl) = 36.2 (.45)

   5% critical value for $\hat{h}$: 3.9 [Engle and Yoo (1987), Table 2]

3. Cointegrating Regression: $\ln(GPY/M2)_t = .2 + .78 R_t + \hat{e}_t$

   Augmented Dickey-Fuller Regression: $\Delta\hat{e}_t = h\,\hat{e}_{t-1} + \sum_{s=1}^{n} \Delta\hat{e}_{t-s}$

   Lag length n:4 Estimated $\hat{h} = -.10$ Test statistic for $\hat{h} = 0$: -3.13 Q(sl) = 29.0 (.66)

   5% critical value for $\hat{h}$: 3.17 [Engle and Yoo (1987), Table 2]

4. Cointegrating Regression: $\ln(GNP/M2)_t = .5 + .24 R_t + \hat{e}_t$

   Augmented Dickey-Fuller Regression: $\Delta\hat{e}_t = h\,\hat{e}_{t-1} + \sum_{s=1}^{n} \Delta\hat{e}_{t-s}$

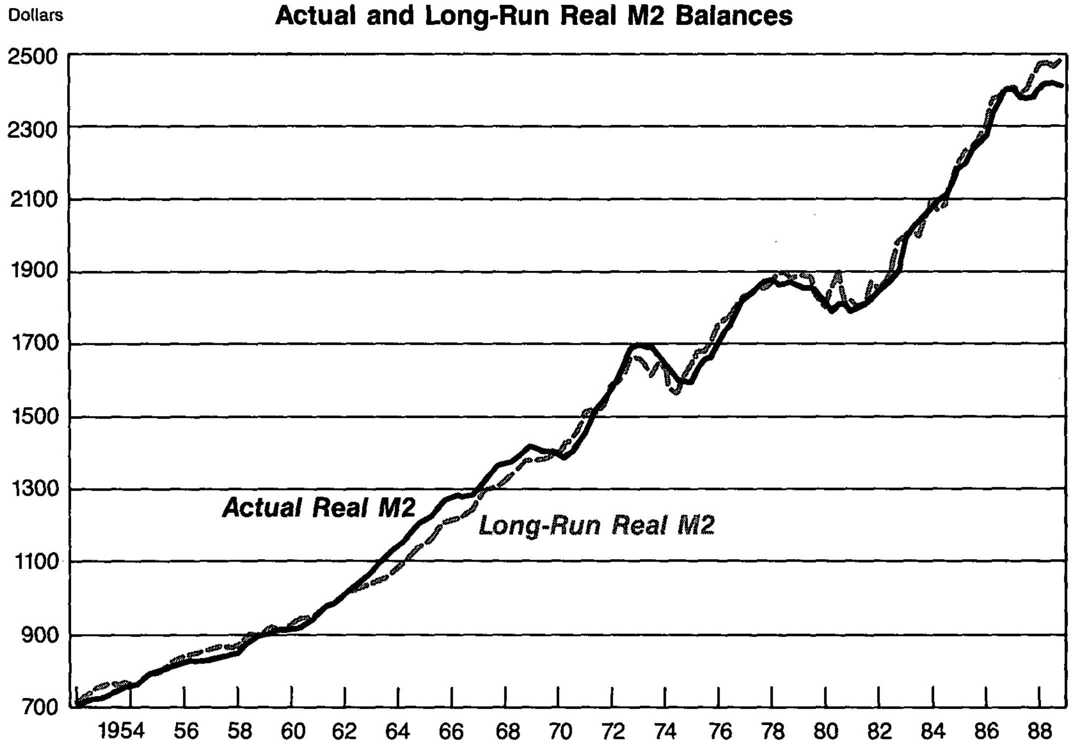
   Lag length n:4 Estimated $\hat{h} = -.10$ Test statistic for $\hat{h} = 0$: -3.21 Q(sl) = 4.7 (.10)

   5% critical value for $\hat{h}$: 3.17 [Engle and Yoo (1987), Table 2]

Notes: The cointegrating regressions are estimated over the period 1952Q1 to 1988Q4. p is the deflator for consumption expenditures; p2, the implicit GNP deflator; GNP, nominal GNP; and GPY, nominal personal income. See Note in Table V for definition of other variables.

Chart 1

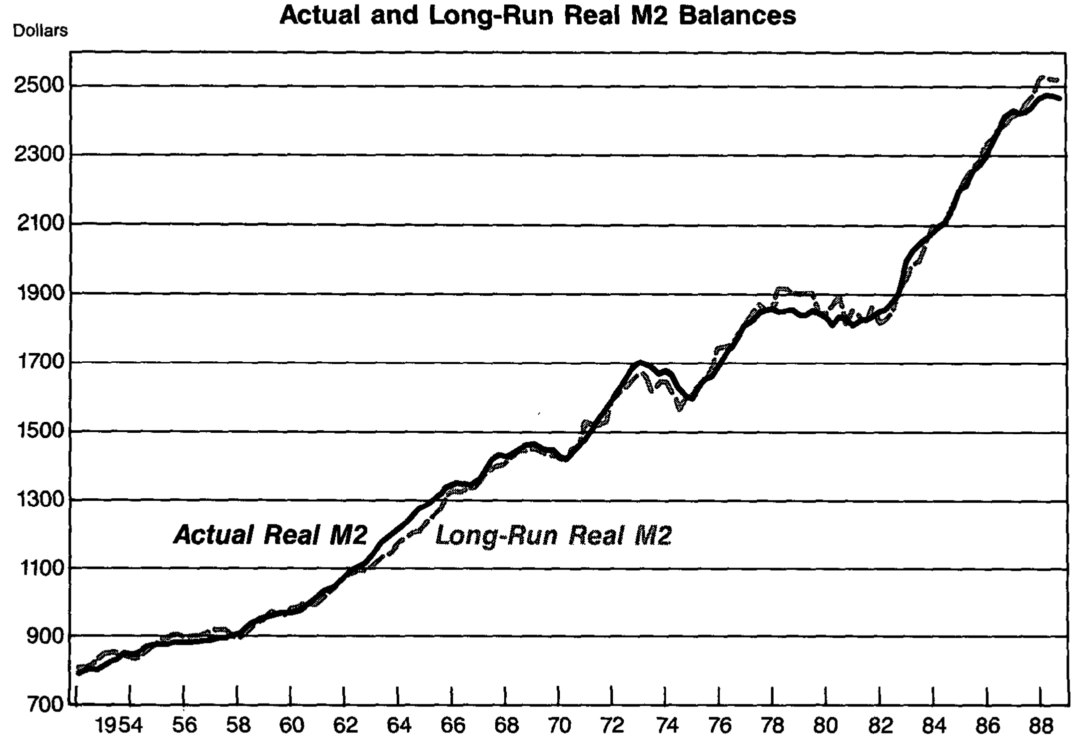
Actual and Long-Run Real M2 Balances



Note: *Long run is the value predicted from a regression of real M2 on real personal income and the commercial paper rate.*

Chart 2

Actual and Long-Run Real M2 Balances



Note: *Long run is the value predicted from a regression of real M2 on real GNP and the commercial paper rate.*

M2 AND MONETARY POLICY

Robert L. Hetzel

I. INTRODUCTION

Consistent with its mandate in the Humphrey-Hawkins Act of 1978, the Federal Reserve System each year sets a calendar-year target for the monetary aggregate M2. The M2 target is in the form of a cone with a base equal to the realized value of M2 in the fourth quarter of the previous year. In this form, the target does not fix the trend rate of growth of M2. Also, the level of the target changes as a consequence of base drift. That is, the level of a new target is changed each year by the amount of the previous year's target miss, where the miss is measured as the deviation in the fourth quarter between realized M2 and the midpoint of the target cone [Broaddus and Goodfriend (1984)].

This paper examines the effect of specifying the M2 target as a multiyear trend line. Such a target would determine the trend rate of growth of M2 and would eliminate random drift over time in M2.[1] If the trend line were set to rise by three percent each year, this form of M2 target would embody a proposal originally made by Milton Friedman (1960). What would an operationally significant, multiyear target for M2 in the form of a trend line rising at three percent per year imply about variables of fundamental concern, in particular, the dollar income of the public and the price level? The answer depends upon the behavior of the public's demand for real M2, that is, its demand for the purchasing power represented by M2. This assertion can be explained by reference to the quantity theory of money.

The quantity theory can be summarized in the formula $M = k \cdot I$, where M is money, k is the ratio the public maintains between its money balances and its dollar income, and I is dollar income. The quantity theory gives this formula economic content with the assumption that the behavioral relationship governing the money stock is largely independent from the behavioral relationships governing real variables.[2] The variable k, the ratio the public desires to maintain between its money balances and its income, is one way of expressing the public's demand for real money balances. The quantity theory assumes that over a significant period of time this real variable is determined in a way that is largely independent from the behavior of money (M). If the Fed constrains M2 (M) to adhere over time to a given target path, it follows that the behavior of dollar income (I) will be determined by the behavior of k.

Alternatively, the quantity equation can be expressed as $M = (k \cdot Q) \cdot P$. (In the formula above, substitute $P \cdot Q$ for I. The product of the price level, P, and real income, Q, equals dollar income, I.) The product $k \cdot Q$ is the amount of its real income the public desires to maintain in the form of real money balances. Both k and real income (Q) are real variables, and, over significantly long periods of time, are assumed to be determined in a fundamentally different way than the nominal variable M. If the Fed constrains M2 (M) to adhere over time to a given target path, it follows that the behavior of the price level (P) will be determined by $k \cdot Q$.

The paper examines the behavior of the public's demand for real M2. This behavior is shown to have changed very little over long periods of time, even with substantial financial innovation in the 1980s. Moreover, random disturbances to the public's demand for real M2 have tended to be offsetting over time. It follows that an M2 target in the form of a trend line that remains fixed over time can make the trend rate of growth in dollar income equal to the trend rate of growth in real income. The trend rate of inflation, consequently, can be made to equal zero. It also follows that such a target can eliminate over long periods of time much of the random drift currently exhibited by the price level.

[1] The proposed rule would require the Fed to establish some form of a feedback rule running from M2 to its policy variable. A decision would need to be made about the extent of the change in the policy variable that would be triggered by deviations of M2 from the targeted trend line. This decision raises issues treated in the literature under the heading of the optimal amount of interest rate smoothing. [See Poole (1970).] These issues are not discussed here. Regardless of the way in which this aspect of policy is determined, random fluctuations in M2 would not affect the target path. The operating procedures actually chosen would, periodically, make M2 coincide with a fixed trend line.

[2] Real variables are expressed in terms of physical quantities or rates of exchange between physical quantities (relative prices). Dollar (nominal) variables are expressed in terms of current dollars.

The paper also examines the variability of the public's demand for real M2. Estimated money demand functions divide this variability into random and systematic components. Although the random changes to M2 demand tend to average out over time, they can be large for individual years. Also, the systematic changes in M2 demand due to changes in the cost of holding M2 are important over periods of a year or more. For these reasons, there is only a low correlation between M2 and income over periods of a year. Consequently, the proposed M2 target would not reduce significantly yearly fluctuations in income. Its value would lie in eliminating the tendency for the price level to rise in a sustained way.

II.
A LONG-RUN PERSPECTIVE ON M2 VELOCITY

M2 velocity is dollar income divided by M2 (the inverse of the variable k). In order to understand the implications of M2 targeting, it is important to know whether M2 velocity is stationary or nonstationary. A stationary series gravitates over time around a fixed value. A nonstationary series wanders aimlessly through time without any fixed reference point. The data indicate that M2 velocity is a stationary series.

Figure 1 shows M2 velocity (GNP divided by M2) starting in 1914.[3] The horizontal axis is drawn through the value of velocity in 1914 (1.6). M2 velocity exhibits greater variation before 1950, which may be due to the greater magnitude of shocks impinging on the economy. Over the entire period, velocity appears to be stationary. That is, velocity periodically returns to the horizontal axis.

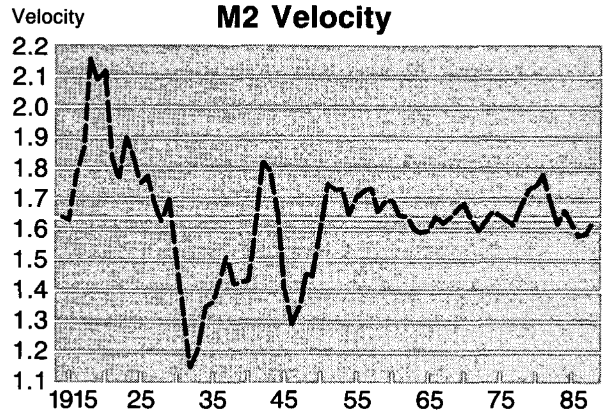
A general time-series model for M2 velocity is

$$(1)\quad V_t - m = c_1(V_{t-1} - m) + \epsilon_t.$$

That is, the current deviation of velocity (V) from its mean (m) equals some fraction of last period's deviation from the mean plus a random error, ϵ_t. Stationarity of velocity implies $c_1 < 1$. In this case, a deviation of velocity from its mean value tends to be reduced. Nonstationarity of velocity corresponds to the special case where $c_1 = 1$. In this case, the model becomes

Figure 1

M2 Velocity



Notes: M2 velocity is GNP divided by M2. From 1914 to 1929, GNP is from Balke and Gordon (1989). From 1930 on, GNP is from the Commerce Department. From 1914 to 1958, M2 is from Friedman and Schwartz (1970). Over this period, M2 is the latters' M4 series, with S&L shares interpolated when necessary. From 1959 to present, M2 is from the Board of Governors.

$$(2)\quad V_t = V_{t-1} + \epsilon_t.$$

A nonstationary series wanders randomly over time. As shown in (2), if velocity is nonstationary, the best prediction of current velocity will simply be last period's velocity, since ϵ_t by assumption is random noise.

The hypothesis of nonstationarity then can be tested by fitting the following regression:

$$(3)\quad \ln(V_t - \hat{m}) = c_1 \ln(V_{t-1} - \hat{m}) + \epsilon_t.$$

(ln is logarithm. The use of logarithms expresses velocity in (3) as a percentage deviation from its estimated mean value $\hat{m}$.) The hypothesis of nonstationarity is embodied in the null hypothesis $c_1 = 1$. The alternative hypothesis of stationarity is $c_1 < 1$.[4]

Table I displays the results of estimating regression (3) using annual average data. The lagged term, $\Delta \ln(V_{t-1} - \hat{m})$, was included because of the need to remove serial correlation from the errors. (Δ is the first-difference operator.) Because of the change in the variability of M2 velocity around 1950, the test is performed starting in 1950. The OLS t-test of the null hypothesis $c_1 = 1$ yields a statistic of -4.8

[3] Figure 1 uses GNP in the calculation of velocity since Balke and Gordon (1989) make GNP, but not income, available for a long period of time. In the remainder of the paper, velocity is defined as personal income divided by M2. Personal income is used because it worked somewhat better than GNP in the money demand regressions reported in Tables II and III.

[4] An alternative way to test for nonstationarity is to run the regression $(V_t - V_{t-1}) = c_0 + c_1 V_{t-1} + \epsilon_t$. The hypothesis of nonstationarity is then the null hypothesis that $c_0 = c_1 = 0$. With $c_0 = c_1 = 0$, the regression corresponds to model (2). The relevant test statistic is an F statistic, whose distribution is given in Dickey and Fuller (1981). This regression was run in logs and with one lagged first difference of velocity to eliminate serial correlation in the residuals. The test in this form yields the same result as the test in the form reported in Table I.

Table I

VELOCITY AUTOREGRESSION, 1950 TO 1988

$$\ln V_t = \underset{(.083)}{.60} \ln V_{t-1} + \underset{(.127)}{.36} \Delta \ln V_{t-1} + \hat{\epsilon}_t$$

CRSQ = .64 SEE = .023 DW = 1.7 DF = 37

Notes: Observations are annual averages of the ratio of personal income to M2, divided by the average value of these observations from 1950 to 1988. ln is the logarithm. Δ is the first-difference operator. CRSQ is the corrected R-squared; SEE standard error of estimate; DW the Durbin-Watson statistic. DF is degrees of freedom. Standard errors in parentheses. Estimation is by OLS.

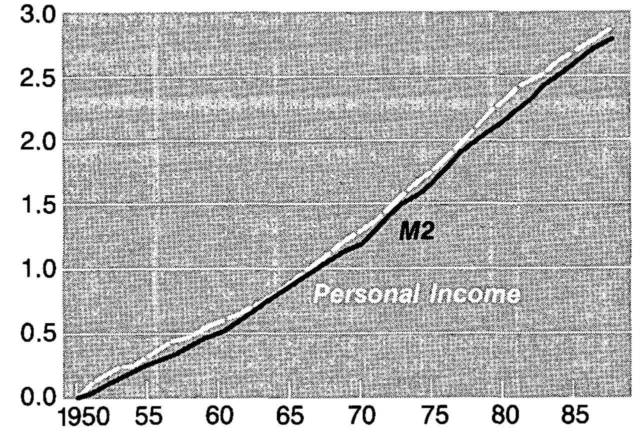
[(.60 − 1)/.083]. Fuller (1976, Table 8.5.2) gives −3.75 as the critical value for a test at the 1 percent significance level of the null hypothesis that $c_1 = 1$. The hypothesis that c_1 equals one can be rejected at the 1 percent level of significance. M2 velocity appears to be stationary.[5]

Stationarity of M2 velocity means that M2 and dollar income move together over time. Figure 2 shows annual observations of M2 and personal income from 1950 to 1988. Each series was put in index number form by dividing its values by the series' 1950 value. Logarithmic values are plotted, so each series starts in 1950 with a common base of zero. Although the divergence between the M2 and the income series for particular years is significant, the divergence between the two series does not grow over time. It follows that an operationally significant M2 target in the form of a trend line would cause dollar income to fluctuate around a fixed trend line.

Assuming that the proposed M2 target made income fluctuate around a fixed trend line, how large would these income fluctuations be? In answering this question, it is useful to examine M2 demand functions, which split variability in M2 demand into systematic and random components. The effect of an M2 target in the form of a trend line can then be discussed with respect to each kind of variability[6].

Figure 2

M2 and Personal Income



Notes: Observations are annual values of the natural logarithm of an index number that uses the year 1950 as a base value.

III. M2 DEMAND FUNCTIONS

In order to understand the variations in velocity shown in Figure 1, it is necessary to take account of changes in the cost of holding M2. This point is illustrated by Figures 3 and 4. Figure 3 shows M2 velocity (personal income divided by M2) and a measure of the interest foregone by holding M2 rather than a money market instrument. Specifically, the money market opportunity cost of holding M2 is measure of the interest foregone by holding M2 rather than a money market instrument. Specifically, the money market opportunity cost of holding M2 is measured as the interest rate on commercial paper minus a weighted average of the explicit rates of interest paid on the components of M2. When money market rates rise relative to the rates paid on the components of M2 like time and savings deposits, it becomes more costly to hold M2. The public then holds fewer M2 balances relative to its income and velocity therefore rises. Conversely, when it becomes less costly to hold M2, velocity falls.

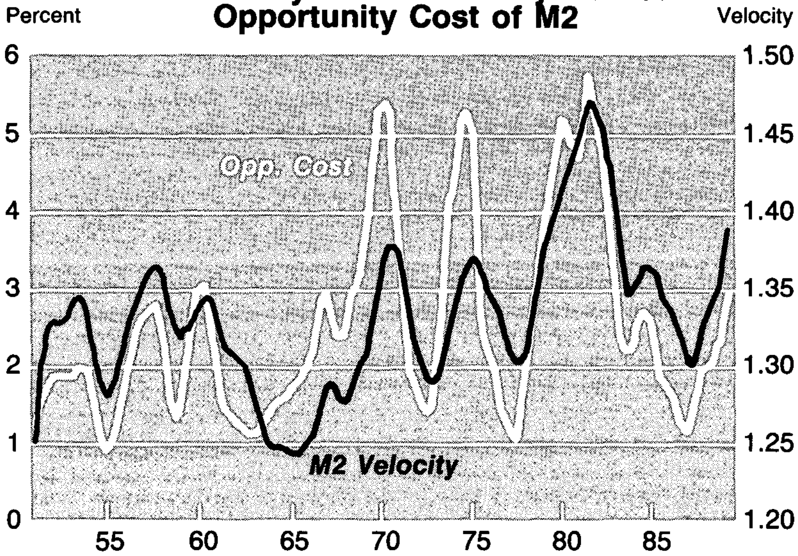
Figure 4 shows M2 velocity and the rate of inflation, which is used as a proxy for the cost of

[5] The test for nonstationarity of M2 velocity was also performed for the period from 1914 through 1988. Velocity was defined as the ratio of GNP to M2 and the Balke-Gordon (1989) GNP data were used from 1914 through 1929. Thereafter, Commerce Department data were used. M2 velocity was first expressed as a deviation from its mean value over this period. The velocity series was then normalized so that its variance was the same before and after 1950. The series from 1914 through 1949, expressed as deviations from the mean, was divided by its standard deviation over this period. The velocity series from 1950 through 1988 was adjusted similarly, and the resulting series were combined. Using this series, a regression was then run like the one shown in Table I. The hypothesis of nonstationarity, as before, was tested with the null hypothesis that the coefficient on lagged velocity is one. The hypothesis of nonstationarity can almost, but not quite, be rejected for the period 1914 through 1988 at the 1 percent level of significance.

[6] The magnitude of fluctuations in income would also depend upon the aspect of policy referred to in footnote 1, that is, whether the degree of interest rate smoothing chosen is optimal. The optimal amount of smoothing increases with the importance of random shocks to money demand relative to random shocks to real aggregate demand [Poole (1970)].

Figure 3

M2 Velocity and the Money Market Opportunity Cost of M2



Notes: Velocity is personal income divided by M2. The money market opportunity cost of M2 is the 4-6 month commercial paper rate minus a weighted-average of the explicit rates of interest paid on the components of M2. Observations are four-quarter moving averages of the contemporaneous value and three lagged values. Tick marks above years correspond to first quarter of year.

holding M2 rather than physical assets.[7] When inflation rises, it becomes more costly to hold M2, and velocity rises. Conversely, when inflation falls, velocity falls. Figure 4 also shows that changes in inflation tend to lead changes in velocity. Apparently, when inflation changes, significant time is required for the public to substitute between M2 and physical assets.

Figures 3 and 4 suggest the following regression equation to explain the public's demand for real M2.

$$(4)\quad \ln \frac{M_t}{P_t \cdot N_t} = c_0 + c_1 \ln \frac{I_t}{P_t \cdot N_t} - c_2(R_t - RM_t) - c_3\, \Delta \ln P_t + \mu_t$$

M is M2, P the price level, N population, I income, R the interest rate in the money market, RM the own rate of return on M2, and μ an error term. The natural logarithm is ln. The left-hand variable is (the log of) real per capita M2. The right-hand variables are a constant, (the log of) real per capita income, the difference between a money market rate of interest and the weighted average of the explicit rates paid on the components of M2, and the rate of inflation ($\Delta \ln P_t$, which is the difference in the log of the price level in periods t and t-1).

This regression was fit for the years 1950 through 1988 with a contemporaneous value and one lagged value on the right-hand variables. A simpler regression without distributed lags on the right-hand variables, however, yielded values for the estimated coefficients very close to the values of the sum of the estimated coefficients in the first regression. The latter, simpler regression, is shown in Table II. It includes one contemporaneous term for real income and the money market opportunity cost of holding M2 and one lagged term, but no contemporaneous term, for inflation.

The regression results shown in Table II indicate that an increase of one percentage point in the money market opportunity cost of holding M2 produces a decrease of 1.33 percent in real M2 demand. They also indicate that an increase in the inflation rate of one percentage point produces, with a lag of one year, a decrease of .79 percent in real M2 demand.

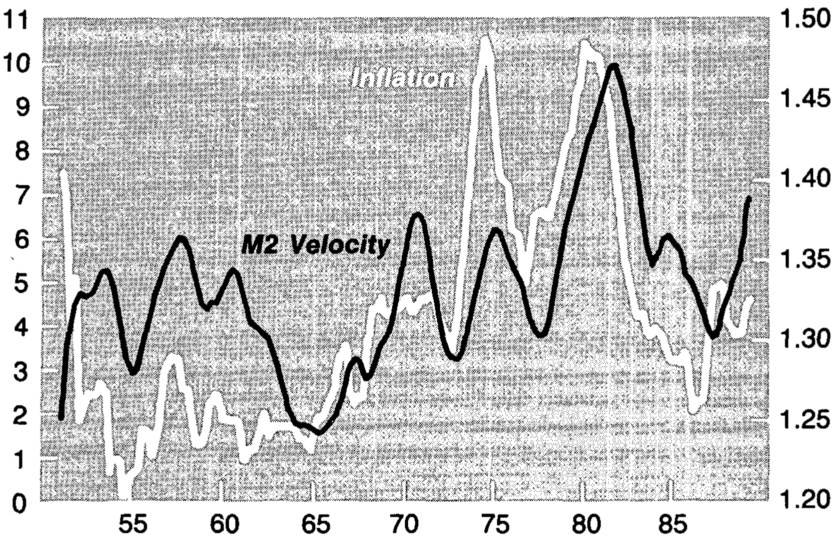
The standard error of estimate (SEE in Table II) is one measure of the average annual variation in real M2 demand due to random disturbances unrelated to changes in real income and in the cost of holding M2. In percent, it is 2.3. (The low value of the Durbin-Watson statistic shows that there is a significant amount of persistence in these random disturbances.) The largest annual random disturbance to the public's real M2 demand was an overprediction of −3.7 percent, which occurred in 1951. There is then considerable random annual variation in real M2 demand.

Estimation using data in level form, as in Table II, could produce a good fit spuriously. The regression could fit a trend in the left-hand variable, real M2, to a trend in one of the right-hand variables, especially real income, even though these trends are unrelated economically [Granger and Newbold (1974)]. The low Durbin-Watson statistic of these regressions (indicating high first-order serial correlation of the residuals) suggests the possibility that the regression is explaining only the trend of real M2,

[7] The nominal return to holding physical assets is the sum of the rental rate on these assets plus the change in their price expected by the public. Neither of these variables is observable. The proxy used for this return, the rate of inflation, does not capture the rental rate on physical assets. In addition, actual inflation is not necessarily a good measure of the public's expectation of the change in prices on physical assets. Despite these drawbacks, Figure 4 does show a positive correlation between M2 velocity and inflation.

Figure 4

M2 Velocity and Inflation



Notes: Velocity is personal income divided by M2. Observations are four-quarter moving averages of the contemporaneous value and three lagged values. Inflation is four-quarter percentage changes in the implicit consumption expenditures price deflator. Tick marks above years correspond to first quarter of year.

not its annual variation. Differencing the variables, by removing trends in the data, eliminates this potential problem. Differencing, however, removes common trends that may in fact be important for explaining economic relationships. There is no clear criterion for choosing between regressions using data in level form and in first-differenced form.

Fortunately, the absence of deterioration in fit in regressions estimated using differences indicates that the spurious regression phenomenon mentioned above is not a problem. Also, the estimated coefficients are similar in regressions using data in level form and in first-differenced form. This similarity indicates that differencing does not produce an unacceptable loss of information. Table III reports regression results over the years 1950 to 1988 using differences.[8] Percentage changes in real per capita M2 are regressed on percentage changes in real per capita income, changes in the money market opportunity cost of holding M2, and changes in the rate of inflation.[9] The right-hand variables are entered with a contemporaneous term and one lagged term.[10]

Table II

REAL M2 DEMAND REGRESSION, 1950 TO 1988

$$\ln \frac{M_t}{P_t \cdot N_t} = \underset{(4.1)}{-.20} + \underset{(55.2)}{1.01} \ln \frac{I_t}{P_t \cdot N_t} - \underset{(4.0)}{1.35} (R_t - RM_t) - \underset{(3.7)}{.73} \Delta \ln P_{t-1} + \hat{\mu}_t$$

CRSQ = .99 SEE = .023 DW = .60 DF = 35

Notes: M is M2; P the personal consumption expenditures deflator; N population of the U.S.; I personal income; R the 4-6 month commercial paper rate expressed as a decimal; RM the own rate of return on M2. Data are annual averages. ln is the natural logarithm. Δ is the first-difference operator. CRSQ is the corrected R-squared; SEE the standard error of estimate; DW the Durbin-Watson statistic. DF is degrees of freedom. Absolute value of t statistics in parentheses. Estimation is by OLS. The right-hand variables include one contemporaneous term for real income; one contemporaneous term for the money market opportunity cost of holding M2; and one lagged term, but no contemporaneous term, for inflation.

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[8] A regression was estimated using differenced data and one contemporaneous and lagged value on the right-hand variables, but with the calculated rate of return on M2 entered as a separate variable, rather than in the form of a difference with the commercial paper rate. That is, the own rate of return on M2 was entered separately from the rates of return on the substitutes for M2, money market instruments and physical assets. This regression yielded almost the same estimates of the coefficients on the real income and inflation variables as shown in Table III. The estimates of the coefficients on the paper rate and on the own rate of return on M2 were practically of the same magnitude, but with a negative coefficient on the paper rate and a positive coefficient on the M2 own rate. This unconstrained regression, then, suggested the essentially identical regression of Table III, where the paper rate and the M2 own rate are entered as a difference. Entering the opportunity cost variable for physical capital as the difference between the inflation rate and the own rate of return on M2 resulted in little change for regressions using first differences, but produced a deterioration of fit for regressions in level form.

The regressions shown in Tables II and III are similar to the regressions that Friedman and Schwartz (1982) estimate in their Table 6.14. They calculate the money market opportunity cost variable for M2 differently, however. (Essentially, they assume that banks could costlessly evade the prohibition of payment of interest on demand deposits and Reg. Q.) They also prefer the percentage change in GNP, rather than inflation, as the opportunity cost variable for physical capital. Use of the percentage change in GNP, rather than inflation, in the regressions shown in this paper resulted in approximately the same fit for regressions run with differenced data. The fit deteriorated for regressions run with data in level form, however.

[9] Δln, a first difference in logarithms, yields a continuously compounded percentage change. Δ is a simple first difference.

[10] The first differences of the data are multiplied by the filter $(1 - .16L - .25L^2)$,

Table III

CHANGE IN REAL M2 DEMAND REGRESSION, 1950 TO 1988

$$\Delta \ln \frac{M_t}{P_t \cdot N_t} = \underset{(7.7)}{.84} \, \Delta \ln \frac{I_t}{P_t \cdot N_t} - \underset{(7.9)}{2.12} \, \Delta(R_t - RM_t) - \underset{(5.4)}{1.01} \, \Delta(\ln P_t - \ln P_{t-1}) + \hat{v}_t$$

CRSQ = .85 SEE = .012 DW = 2.0 DF = 33

Notes: Δ is the first-difference operator. The right-hand variables include a contemporaneous term and one lagged term. The sum of the estimated coefficients (and absolute value of its t statistic) is shown. The estimated coefficients on the contemporaneous and lagged terms (absolute value of t statistics in parentheses) are for $\Delta \ln (I_t/P_t \cdot N_t)$, .33 (3.2) and .51 (4.9); for $\Delta(R_t - RM_t)$, −.87 (4.9) and −1.25 (6.1); and for $\Delta(\ln P_t - \ln P_{t-1})$, −.62 (5.1) and −.39 (3.6). The first differences of the data are multiplied by the filter $(1 - .17L - .26L^2)$, where L is the lag operator.

The magnitude of the coefficients estimated on the opportunity cost variables rises somewhat in comparison to the regression using data in level form. Differencing eliminates the upward trend over the 1950 to 1988 period in the money market opportunity cost of holding M2 and in inflation. The upward trend in these variables correlates with the upward trend in real M2 and appears to have biased downward the estimates of the coefficients on these variables reported in Table II. Increases of one percentage point in the money market opportunity cost of holding M2 and in the inflation rate are now estimated to reduce real M2 demand by 2.13 and 1.04 percent, respectively.

Do the random disturbances to the public's demand for real M2 (the μ_t of a regression like the one estimated in Table II) average out over time or cumulate? Alternatively, does the left-hand variable in money demand regressions, real M2, move together or diverge over time from the right-hand variable, real income. The relevant statistical test is whether the disturbances in an M2 demand regression are stationary or nonstationary. The test is performed as above in the test of the stationarity of velocity. Nonstationarity of disturbances to money demand implies that the best prediction of the current value of a disturbance (μ_t) is the prior disturbance (μ_{t-1}). In the regression equation (5), nonstationarity implies that $c_1 = 1$ and ξ_t is a white noise error.

(5) $\mu_t = c_1\mu_{t-1} + \xi_t$

The estimated money demand errors used to fit (5) are taken from a money demand regression like the one shown in Table II, which uses annual observations in level form. The regression included a contemporaneous and one lagged value for each right-hand variable. The contemporaneous disturbance estimated from this regression is regressed on its own lagged value. See Table IV. (No lagged first differences were needed in order to eliminate serial correlation in the errors.) The null hypothesis of nonstationarity is that the coefficient on the lagged term is one.

The OLS t-test of the null hypothesis that the true value of the coefficient on $\hat{\mu}_{t-1}$ equals one yields a statistic of −3.8 [(.44 − 1)/.147]. Fuller (1976, Table 8.5.2) gives −3.75 as the critical value for a test of the null hypothesis at the 5 percent significance level. The null hypothesis of nonstationarity can be rejected at the 5 percent level of significance. [Also, see Mehra (1989).] Random disturbances to real M2 demand tend to average out over time.

Because real M2 and real income both possess strong positive trends, neither are stationary variables. Stationarity of the disturbances estimated from the M2 demand regression equation implies, however, that the difference between real M2 (the left-hand variable of the regression) and real income (a right-hand variable) is stationary. Real M2 $(\frac{M}{P})$ and real income (Q) move together over time.

Because real M2 $(\frac{M}{P})$ and real income (Q) move together over time, it follows that money per unit

Table IV

AUTOREGRESSION OF M2 DEMAND ERRORS 1951 TO 1988

$$\hat{\mu}_t = \underset{(.147)}{.44} \, \hat{\mu}_{t-1} + \hat{\xi}_t$$

CRSQ = .20 SEE = .018 DW = 2.0 DF = 37

Notes: The $\hat{\mu}_t$ is the estimated error from a regression in the form shown in Table II. The regression used to generate the errors included a contemporaneous and one lagged term on the right-hand variables. The standard error is in parentheses.

where L is the lag operator. That is, each data point is a first difference minus .16 times the difference one period prior and minus .25 times the difference two periods prior. This filter removed residual autocorrelation in the errors left after first differencing. The coefficients used in the filter are derived from the fitted errors obtained in a regression like that of Table III, except using simple first differences. The contemporaneous fitted error from this regression was regressed on its two prior lagged values. The estimated coefficients on these lagged values are the values used in the filter.

of output ($\frac{M}{Q}$) and the price level (P) move together over time. The quantity equation can be written as $\frac{M}{P}$ = k•Q. Stationarity of disturbances to M2 demand is a reflection of the stationarity of M2 velocity, or its inverse, k. This stationarity implies that $\frac{M}{P}$ and Q move together over time. When the quantity equation is rearranged as $\frac{M}{Q}$ = k•P, it is seen that stationarity of M2 velocity also implies that money per unit of output ($\frac{M}{Q}$) and the price level (P) move together over time.

If each of the Series in Figure 2 is divided by real income (Q), the graph would plot M2 per unit of output ($\frac{M}{Q}$) and the price level (P).[11] Like the series shown in Figure 2, these transformed series do not diverge over time. A target for M2 (M) in the form of a given trend line then will tie down the price level (P), apart from random permanent disturbances to real income (Q). These disturbances affect the denominator of money per unit of output ($\frac{M}{Q}$) and will affect the price level (P) permanently. Such disturbances cause the price level to drift away over time from any given base value. Such drift, however, is small relative to the drift in the price level caused by the current drift in M2. A trend-line target for M2 fixed over time would largely eliminate the present amount of drift in prices. This statement is illustrated below.

Note first, however, that the regression analysis of Table II yields an estimate of the income elasticity of demand for real M2 (the estimated value of c_1) of one. It follows that the trend rate of growth of real M2 and of real income are the same. This fact is shown in Figure 1 by the trendlessness of M2 velocity. The quantity equation can be written as V = Q/(M/P). The trend rate of rise in Q and M/P is the same. If a trend-line target for M2 rose at the same rate as the trend rate of growth in real income, say, three percent per year, the trend rate of rise in the price level would be zero.[12] On average, the increase in the demand for real M2 would be supplied by the increase in M2. On average, there would be no need for the price level to change.

[11] This form of Figure 2 has long been used by quantity theorists. See, for example, Friedman (1958 and 1987). Humphrey (1989) provides a history of the graph.

[12] Over the period 1950 to 1988, the trend rate of growth of real GNP was almost exactly 3 percent.

Consider now the Friedman proposal that M2 be made to grow at 3 percent per year. As noted in the introduction, the quantity equation can be written as M = (k•Q)•P. In percentage change form, and with k equal to a constant over a long period of time, this formula implies that the trend rate of growth of money (M) will equal the trend rate of growth of real income (Q) plus the trend rate of growth of prices (P). Assuming that the trend rate of growth of real income is three percent, it follows that the trend rate of growth of prices will equal the trend rate of growth of money minus three percent.

This last formula was used to predict the change in the price level since 1950. The price level (consumption expenditures deflator) and M2 were expressed as index numbers with a base of 100 in 1950. The figure for the percentage excess of M2 over a trend line rising at three percent per year was used as the prediction of the percentage change in the price level from its 1950 base. The value of the index number for the price level in 1988 was predicted to be 517, while its actual value was 475. The actual value of the price level then was 8.5 percent below the predicted value. It follows that if procedures had been in place since 1950 to constrain M2 to grow around a trend line rising at three percent per year, the price level in 1988 would have fallen from 100 in 1950 to 91.5, a decline of 8.5 percent. Instead, the price level rose to 475. An operationally significant trend-line target for M2 will eliminate most of the drift over time in the price level.

IV. M2 DEMAND AND FINANCIAL INNOVATION IN THE 1980s

The average magnitude of the estimated errors of the regressions in Tables II and III is no larger in the 1980s than in other periods. Financial innovation has not affected the stability of the M2 demand function. One reason is that the definition of M2 has imposed considerable continuity on the kinds of financial instruments included in M2. M2 is composed of transactions instruments and savings instruments available in small denominations.[13] It excludes money market instruments, which are issued in large

[13] The exception is overnight Eurodollars and overnight repurchase agreements. These instruments, which are good substitutes for corporate demand deposits, do not comprise a significant fraction of M2.

There is a quirk in the definition of M2 that reduces its economic continuity over time. M2 includes time deposits less than $100,000. With inflation, over time, the definition of M2 includes continually fewer time deposits representing a large amount of purchasing power. The $100,000 value used to exclude large time deposits should be indexed to change with the inflation rate.

denominations, except to the extent that such instruments are made available in small denominations through money market mutual funds. Figure 5 shows the composition of M2 over time.

To understand why financial innovation in the 1980s altered the character of the public's demand for M1, but not M2, one must understand how this innovation altered the substitutions among savings instruments prompted by changes in market rates. The nationwide introduction of the NOW account in 1981 changed the character of these substitutions and, in the process, changed the character of M1. [See Hetzel and Mehra (1989) and Mehra (1989).] Because NOW accounts pay interest, they are used as a savings instrument, as well as an instrument for effecting transactions.[14] Both demand deposits and NOW accounts offer check writing privileges. NOW accounts, in contrast to demand deposits, however, are good substitutes for the other savings instruments in M2.

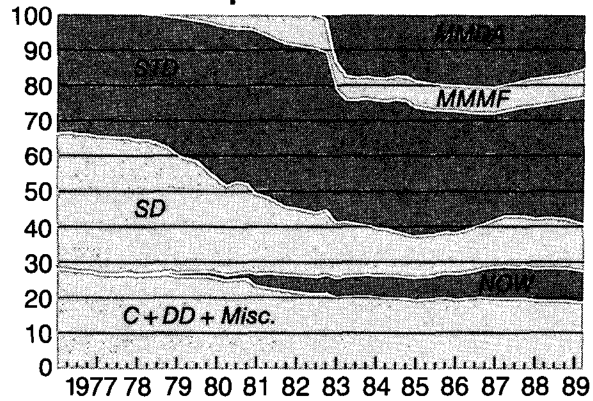
The instruments in M2 used as savings vehicles are NOWs, savings deposits, small time deposits, money market deposit accounts (MMDAs), and money market mutual fund shares (MMMFs). The rates paid on small time deposits, on MMDAs, and on MMMFs change promptly with changes in money market interest rates. In contrast, the rates paid on NOWs and savings deposits change only slowly as money market rates of interest change. Figure 6 plots a money market rate, the commercial paper rate. It also plots the difference between the paper rate and a weighted average of the rates paid on small time deposits, MMMFs, and MMDAs, as well as the difference between the paper rate and a weighted average of the rates paid on NOWs and savings deposits. When market rates fall, the attractiveness of small time deposits, MMMFs, and MMDAs changes only slightly. The rates offered on these deposits fall in line with market rates, so the difference between market rates and the rates they offer changes only slightly. In contrast, when market rates fall, NOWs and savings deposits become more attractive. Because the rates offered on these deposits change only slowly, the difference between market rates and the rates they offer narrows.[15]

Consequently, when market rates fall, individuals take funds out of small time deposits, MMDAs, and

[14] Prior to the introduction of NOWs, banks paid implicit interest on consumer demand deposits by offering check clearing services below cost. This practice made the average return paid by banks on demand deposits positive. An individual could increase the implicit yield on his demand deposits by writing more checks on a given balance. He could not, however, increase the return offered on his demand deposits by holding additional deposits. The marginal return on demand deposits was zero. With the introduction of NOWs, the marginal return to holding a checkable deposit in this form increased from zero to 5.25 percent, the ceiling rate under Regulation Q. Because a marginal rate of 5.25 percent was often close to the level of money market rates, individuals began to use NOWs as an instrument for saving in small denominations.

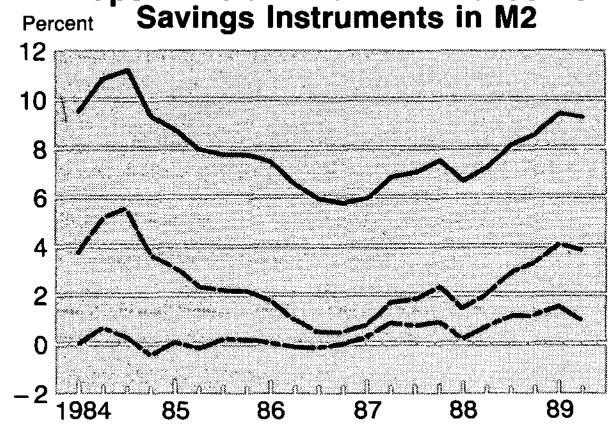
[15] After 1987, the weighted average of rates paid on small time deposits, MMDAs, and MMMFs does not change quite as quickly as market rates. The reason is that changes in MMDA rates are becoming less sensitive to changes in money market rates. Increasingly, banks are competing for interest-sensitive funds solely through small time deposits and through "tiering." Tiering is the practice of offering a rate of interest that is kept competitive with money market rates only on deposits that require a large minimum balance.

Figure 5
Components of M2



Notes: Percentage of M2 by component. C is currency; DD demand deposits; NOW other checkable deposits, chiefly NOW accounts; SD savings deposits; STD small time deposits; MMMF money market mutual funds of noninstitutional investors; and MMDA money market deposit accounts. Misc. is overnight RPs, overnight Eurodollars, and travelers checks.

Figure 6
Paper Rate and Rate Differential for Savings Instruments in M2



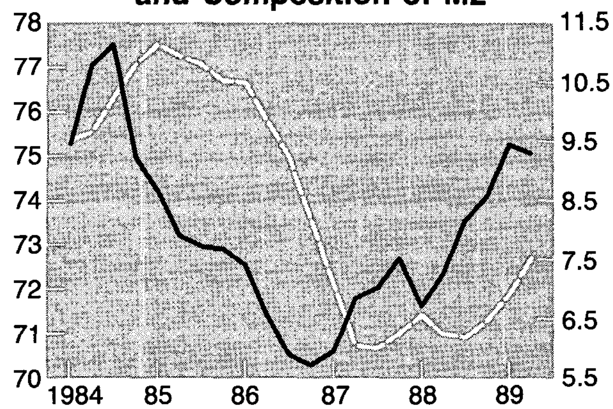
Notes: Top line is 4-6 month commercial paper rate. Middle line is difference between paper rate and a weighted average of rates paid on NOWs and savings deposits. Bottom line is difference between paper rate and a weighted average of rates paid on MMDAs, MMMFs, and small time deposits.

MMMFs and place them in NOWs and savings deposits. When market rates rise, they reverse this transfer. Figure 7 shows that, when market rates fall, the share of savings-related deposits in M2 made up of small time deposits, MMMFs, and MMDAs decreases, while the share of NOWs and savings deposits increases. When market rates rise, this change in shares is reversed.

These substitutions among instruments used as savings vehicles have affected the behavior of M1. When market rates fell in late summer 1982 and again in fall 1984, the rates paid on small time deposits, MMMFs, and MMDAs (MMDAs were in existence in 1984, but not 1982) fell much more than did the rate paid on NOWs. Consequently, the public substituted out of small time deposits, MMMFs, and MMDAs into NOWs. Because small time deposits, MMMFs, and MMDAs are not included in M1, this substitution increased the rate of growth of M1. All these deposits, however, are included in M2, so the behavior of M2 was unaffected. In sum, the deregulation and financial innovation of the 1980s has altered the character of the public's demand for M1, but not M2.

Figure 7

Interest Rate and Composition of M2



Notes: Solid line is the 4-6 month commercial paper rate. Dashed line shows the fraction of consumer savings-related deposits in M2 with interest rates sensitive to market rates: (STD + MMMF + MMDA) / (OCD + SD + STD + MMMF + MMDA). See Figure 5 for definition of mnemonics. Tick marks indicate first quarter of year.

V. THE RECENT BEHAVIOR OF M2 AND INCOME

The quantity equation can be written as I = M·V, that is, dollar income equals money times the velocity of money. M2 velocity is a function of the money market opportunity cost of holding M2 [(R – RM)] and of the rate of inflation [Inf]. Expressing the preceding equation in percentage change form (using Δln) and making changes in velocity a function of changes in the money market opportunity cost of holding M2 [Δ(R – RM)] and of changes in the rate of inflation [ΔInf] yields

$$(6) \quad \Delta \ln I = \Delta \ln M + \Delta \ln V[\Delta(R - RM), \Delta Inf].$$

That is, the percentage change in income (Δln I) equals the percentage change in money (Δln M) plus the percentage change in velocity (Δln V), which depends upon changes in the money market opportunity cost of holding M2 and in the rate of inflation. Below, the right side of this equation is used to predict the growth of dollar income over the recent past.

Table V displays the M2 determinants of growth in dollar income, summarized by the rate of growth of M2 and by estimated changes in M2 velocity deriving from changes in the cost of holding M2. Column 1 shows actual year-over-year percentage changes in personal income (%ΔI). Column 2 shows an estimate for this figure (Est. %ΔI) derived from the sum of the percentage change in M2 (%ΔM2) and of the percentage change in velocity attributed to changes in the cost of holding M2 (Est. %ΔV). (Column 2 is the sum of Columns 3 and 4.) Column 3 shows actual year-over-year percentage changes in M2 (%ΔM2). Column 4 shows the estimated, combined effect on changes in M2 velocity of changes in the money market opportunity cost of holding M2 and of changes in inflation. (Column 4 is the sum of Columns 5 and 6.)

Column 5 is an estimate of the change in M2 velocity produced by changes in the money market opportunity cost of holding M2, $\Delta(R_t - RM_t)$. For each year, the contemporaneous and prior year's values of $\Delta(R_t - RM_t)$ are multiplied by the appropriate coefficient estimated in the regression shown in Table III, and the sum of these two terms is reported in Column 5. Column 6 is an estimate of the change in M2 velocity produced by changes in the rate of inflation, $\Delta(\ln P_t - \ln P_{t-1})$. For each year, the contemporaneous and prior year's values of $\Delta(\ln P_t - \ln P_{t-1})$ are multiplied by the appropriate coefficient estimated in the regression equation shown in Table III, and the sum of these two terms is reported in Column 6.

Table V brings out, for the recent past, the importance of changes in the cost of holding M2 for the relationship between M2 and income. The magnitude of the figures in Column 4 shows that velocity changes due to changes in the cost of holding real M2 have been important determinants of changes in income. Since 1978, M2 growth has been fairly steady at around 8 percent. (The major exceptions are 1983, when M2 growth was augmented by the

Table V

MONETARY DETERMINANTS OF INCOME GROWTH

	(1) %ΔI	(2) Est. %ΔI	(3) %ΔM2	(4) Est. %ΔV	(5) %V[Δ(R – RM)]	(6) %V[ΔInf]
1977	10.2	10.3	11.9	–1.6	–1.2	–.4
1978	12.0	10.6	8.2	2.3	1.7	.7
1979	11.5	12.7	7.9	4.8	3.4	1.4
1980	10.5	11.1	7.7	3.3	1.7	1.6
1981	11.0	8.9	9.0	–.1	.2	–.3
1982	5.8	5.3	8.9	–3.5	–.9	–2.6
1983	6.1	6.6	11.8	–5.0	–2.8	–2.2
1984	9.1	5.6	7.7	–2.1	–1.3	–.8
1985	6.7	8.1	8.6	–.5	–.1	–.4
1986	5.9	5.6	8.0	–2.4	–1.7	–.7
1987	6.9	7.4	6.4	1.0	0.0	1.0
1988	7.3	6.8	5.0	1.8	1.4	0.4

Notes: Col (1): %ΔI is the percentage change in personal income calculated using annual average data. *Col (2): Est %ΔI is the* estimated percentage change in income calculated as the sum of columns (3) and (4), i.e., (2) = (3) + (4). Col (3): %ΔM2 is the percentage change in M2 calculated using annual average data.

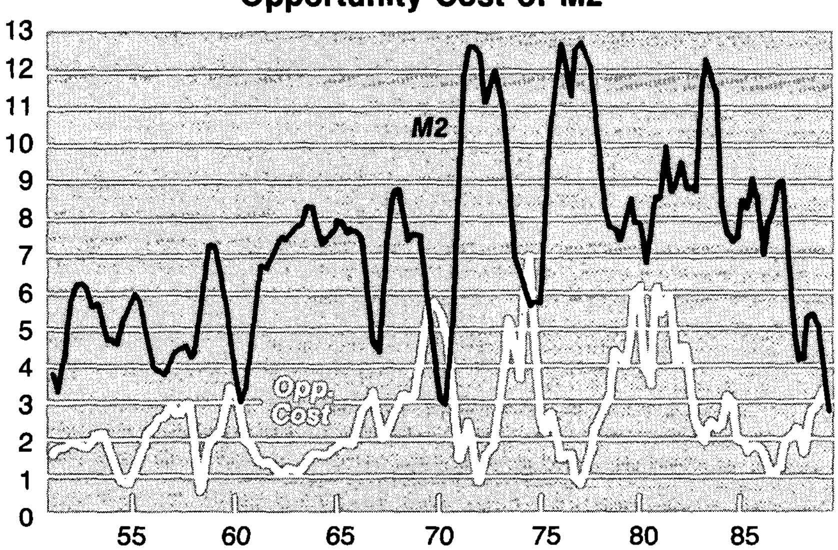
Col (4): Est %ΔV is the estimated *percentage change* in M2 velocity calculated as the sum of the estimated impact on velocity of changes in the money market opportunity cost of M2, Δ(R – RM), from column (5) and the estimated impact on velocity of changes in inflation, *ΔInf, from column* (6), i.e., (4) = (5) + (6).

Col (5): %V[Δ(R – RM)] is the estimated impact on velocity of the percentage point change in the annual average money market opportunity cost of holding M2: the 4-6 month commercial paper rate minus a weighted average of the rates paid on M2. The values in column (5) show the sum of the estimated impact on velocity of the contemporaneous and lagged values of Δ(R – RM) using the regression coefficients from Table III. For year t, these values are $.87\ \Delta(R_t - RM_t) + 1.25\ \Delta(R_{t-1} - RM_{t-1})$.

Col (6): %V[ΔInf] is the estimated impact on velocity of the percentage point change in the annual average rate of inflation, measured by the personal consumption expenditures deflator. The values in column (6) show the sum of the estimated impact on velocity of the contemporaneous and lagged values of $\Delta[\ln P_t - \ln P_{t-1}]$ using the regression coefficients from Table III: $.62\ \Delta(\ln P_t - \ln P_{t-1}) + .39\ \Delta(\ln P_{t-1} - \ln P_{t-2})$.

Figure 8

Growth of M2 and the Money Market Opportunity Cost of M2



Notes: Quarterly observations of four-quarter percentage changes in M2. The money market opportunity cost of M2 is the 4-6 month commercial paper rate minus a weighted-average of the explicit rates of interest paid on the components of M2. Tick marks above years correspond to first quarter of year.

introduction of MMDAs, and 1988, when M2 growth slowed.) Since 1978, changes in the thrust of monetary policy have derived more from changes in the cost of holding M2, than from changes in the growth of M2.

This last fact is apparent from Figure 8, which shows the rate of growth of M2 and the money market opportunity cost of holding M2. The initial contractionary effects of the reduction in the rate of growth of M2 that began in 1977 were more than offset by the increase in the money market opportunity cost of holding M2. Monetary policy, therefore, remained expansionary in the last part of the 1970s. In the 1980s, despite steady growth in M2, monetary policy became contractionary because of the fall in the money market opportunity cost of holding M2.

Table V illustrates that even over periods of time as long as one or two years the relationship between changes in income and in M2 can be quite loose. For this reason, M2 is not particularly useful as an intermediate target in procedures designed to control movements in income over periods as short as a year. Nor is it very useful as an information variable for inferring the contemporaneous behavior of income. M2 velocity is predictable over significant periods of time, however, as was shown earlier in the article. An M2 target can be used as part of a procedure for controlling income and prices over a long period of time.

VI. POLICY IMPLICATIONS

Prior to the 1980s, most economists considered M1 to be the most useful monetary aggregate for monetary policy.[16] It was easy then to use M1 as a predictor of income because of the insensitivity of M1 demand to interest rates. M1 also corresponded to the a priori definition of money as a medium of exchange. The deregulation and financial innovation of the 1980s, however, have altered the characteristics of the public's M1 demand function. M1 now is an instrument for saving as well as for effecting transactions. Asset substitutions between NOWs and savings instruments not included in M1 have caused large fluctuations in M1 demand in the 1980s. In contrast, M2 is defined broadly enough to eliminate the asset substitutions that have changed the character of the M1 demand function.

In order to ensure satisfactory behavior of the price level, monetary policy must provide for control of the money stock. A definition of money useful for monetary policy is one that provides a predictable relationship with the price level. The long-run predictability of M2 velocity makes M2 a useful definition of money for monetary policy. Brunner and Meltzer (1971) much earlier described aptly the reasons for using M2 now in the formulation of monetary policy.

> The recognition of the central role of a medium of exchange does not imply that the collection of assets that serve as medium of exchange is most appropriate for explaining movements of the general price level. A definition embracing a larger collection of assets is appropriate if there are close substitutes for the medium of exchange on the supply side. In this case, slight changes in relative prices reallocate [wealth] between the medium of exchange and other assets, so the collection of assets most useful for explaining the general price level differs from the assets that serve as medium of exchange [p. 803].

M2 velocity is stationary. Over time, the values taken on by velocity gravitate around a fixed base. Because M2 velocity is stationary, an operationally significant M2 target in the form of a trend line would cause dollar income to grow around a trend line. M2 velocity exhibits no trend. On average, real income and real M2 grow at the same rate. It follows that M2 growth equal on average to the trend rate of growth of real income will make the trend rate of inflation equal to zero.

[16] Milton Friedman, who emphasizes M2, is an obvious exception.

References

Balke, Nathan S., and Robert J. Gordon. "The Estimation of Prewar Gross National Product: Methodology and New Evidence." *Journal of Political Economy* 97 (February 1989): 38-92.

Broaddus, Alfred, and Marvin Goodfriend. "Base Drift and the Longer Run Growth of M1: Experience from a Decade of Monetary Targeting." Federal Reserve Bank of Richmond *Economic Review* 70 (November/December 1984): 3-14.

Brunner, Karl, and Allan Meltzer. "The Uses of Money: Money in the Theory of an Exchange Economy." *American Economic Review* 61 (December 1971): 784-805.

Dickey, David A., and Wayne A. Fuller. "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root." *Econometrica* 49 (July 1981): 1057-72.

Friedman, Milton. "The Supply of Money and Changes in Prices and Output." In *The Relationship of Prices to Economic Stability and Growth*, 85th Cong., 2nd sess., Joint Economic Committee Print, 1958. Reprinted in Milton Friedman. *The Optimum Quantity of Money and Other Essays*. Chicago: Aldine Publishing Co., 1969, pp. 171-87.

————. *A Program for Monetary Stability*. New York: Fordham University Press, 1960.

————. "Monetary History, Not Dogma." *The Wall Street Journal*, February 12, 1987, Op-Ed page.

Friedman, Milton, and Anna J. Schwartz. *Monetary Statistics of the United States*. New York: National Bureau of Economic Research, 1970.

————. *Monetary Trends in the United States and the United Kingdom*. Chicago: The University of Chicago Press, 1982.

Fuller, Wayne A. *Introduction to Statistical Time Series*. New York: John Wiley & Sons, 1976.

Granger, C. W. J., and P. Newbold. "Spurious Regressions in Econometrics." *Journal of Econometrics* 2 (July 1974): 111-20.

Hetzel, Robert L. "The Monetary Responsibilites of a Central Bank." Federal Reserve Bank of Richmond *Economic Review* 74 (September/October 1988): 19-31.

Hetzel, Robert L., and Yash Mehra. "The Behavior of Money Demand in the 1980s." *Journal of Money, Credit, and Banking* 21 (November 1989), forthcoming.

Humphrey, Thomas M. "Precursors of the P-Star Model." Federal Reserve Bank of Richmond *Economic Review* 75 (July/August 1989): 3-9.

Mehra, Yash. "Some Further Results on the Source of Shift in M1 Demand in the 1980s." Federal Reserve Bank of Richmond *Economic Review* 75 (September/October 1989): 3-13.

Poole, William. "Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model." *Quarterly Journal of Economics* 84 (May 1970): 197-216.

APPENDIX

CONSTRUCTION OF A RATE OF RETURN SERIES FOR M2 AND CONSTRUCTION OF M2 PRIOR TO 1959*

1. Introduction

This appendix explains the construction of the rate of return series for M2. This series is constructed as a weighted average of the explicit rates of return on the various components of M2. This appendix also explains the construction of an M2 series prior to 1959 consistent with the current definition of M2. As currently defined, the M2 series published by the Board of Governors is only available starting January 1959.

The monetary aggregates were redefined in 1980 ("The Redefined Monetary Aggregates," *Federal Reserve Bulletin*, February 1980, pp. 97-114). Prior to 1980, M2 was defined as M1 plus time and savings deposits at commercial banks, minus negotiable CDs $100,000 or greater at weekly reporting banks. Since 1980, M2 has been defined as M1 plus overnight RPs issued at commercial banks, overnight Eurodollar deposits held by U.S. residents at branches of U.S. banks worldwide, money market mutual fund shares, savings deposits at *all* depository institutions, and time deposits at *all* depository institutions issued in denominations less than $100,000, minus a consolidation component.

Section 2 describes the construction of the M2 series prior to 1959Q1. Table AI of Section 2 lists the mnemonics and sources for the components of M2 that enter into formulas (2) and (3) for calculating the rate of return on M2 prior to 1959Q1. Section 3 (Table AII) lists the mnemonics and sources for the components of M2 that enter into formula (4) for calculating the rate of return on M2 from 1959Q1 on. Section 4 (Tables AIII and AIV) lists the mnemonics and sources for the interest rates paid on the components of M2. Section 5 shows the formulas used to construct the rate of return series on M2.

2. M2 Prior to 1959Q1

Data on the components of M2 prior to 1959Q1 are from Milton Friedman and Anna Schwartz (*Monetary Statistics of the United States*, New York: National Bureau of Economic Research, 1970, Table 1, pp. 4-53). Basically, for the period before 1959Q1, the M2 series used is the aggregate M4 reported in Table 1 of Friedman and Schwartz. Prior to 1950Q1, end-of-year observations on S&L shares were interpolated to yield quarterly observations, and from 1950Q1 to 1955Q1, end-of-quarter observations on S&L shares were interpolated to yield quarterly-average observations. These quarterly-average estimates of S&L shares were used in the construction of quarterly figures for M2 from the Friedman and Schwartz M4 series.

The M1 component of M2 prior to 1959 includes demand deposits of foreign commercial banks and institutions. These deposits were dropped from M1 as redefined in 1980, but had to be included in the observations prior to 1959 for lack of data.

* Robert LaRoche contributed to this appendix.

Table AI

COMPONENTS OF M2, PRIOR TO 1959Q1

Mnemonic	Description	Source
M1SA	M1, seasonally adjusted	F&S1 8
DCB	Time and savings deposits at commercial banks	F&S1 3
DSB	Deposits at mutual savings banks	F&S1 5
DPS	Deposits with postal savings system	F&S1 6
DTH	Deposits at S&Ls	F&S1 7
M2SA	M2, seasonally adjusted	F&S1 13

Notes: The number following F&S1 (Friedman and Schwartz, Table 1) refers to the column number of the data in F&S, Table 1. The series are seasonally adjusted.

3. M2 from 1959Q1 to Present

Data are from the Federal Reserve Board's Public Money Library (PML) and Friedman and Schwartz *Monetary Statistics*, Table 1.

Table AII

COMPONENTS OF M2, 1959Q1 TO PRESENT

Mnemonic	Description	Source
OCDC	Other checkable deposits at commercial banks (1974Q1-)	PML 125
OCDT	Other checkable deposits at thrift institutions (1970Q1-)	PML 147
M1NSA	M1, not seasonally adjusted (1959Q1-)	PML 198
SD	Savings deposits of all depository institutions (1959Q1-)	PML 470
STD	Small time deposits of all depository institutions (1959Q1-)	PML 475
DPS	Deposits with postal savings system (Ends 1967Q3)	F&S1 6
ONRP	Overnight repurchase agreements issued by commercial banks to other than depository institutions and MMMFs (1970Q1-)	PML 452
ONED	Overnight Eurodollar deposits issued by foreign branches of U.S. commercial banks to U.S. residents (1977Q1-)	PML 461
MMDAC	Money market deposit accounts at commercial banks (1982Q4-)	PML 239
MMDAT	Money market deposit accounts at thrift institutions (1982Q4-)	PML 345
MMF	General purpose and broker/dealer money market funds(1973Q1-)	PML 404
M2NSA	M2, not seasonally adjusted (1959Q1-)	PML 498

Notes: PML is the Federal Reserve Board's Public Money Library. The number following PML is the line number of the data series in this database. These series are not seasonally adjusted. DPS is taken from Friedman and Schwartz, Table 1, and is seasonally adjusted. The dates in parentheses show the periods for which each series is non-zero.

The other checkable deposits series, OCDC and OCDT, contain Super NOW accounts over the period of the latter's existence from 1983Q1 to 1986Q1.

4. Interest rates on components of M2

Data on rates of return before 1950Q1 are from Friedman and Schwartz *Monetary Statistics* (Table 9, pp. 173-4). The annual data were interpolated to obtain quarterly data.

Table AIII

RATES OF RETURN PRIOR TO 1950Q1

Mnemonic	Description	Source
RDCB	Rate on commercial bank time deposits	F&S9 1
RDSB	Rate on mutual savings bank deposits	F&S9 2
RDPS	Rate on deposits with postal savings system	F&S9 3
RDTH	Rate on savings and loan shares	F&S9 4

Notes: The number following F&S9 refers to the column number in Friedman and Schwartz, Table 9. Rates of return are expressed as simple annual rates.

Data on rates of return from 1950Q1 to present are from the Board's Quarterly Model (QM) database, from the Board's Macro Data Library (MDL), and from a database kept by the Monetary Studies Section at the Board. Monthly data are averaged in order to yield quarterly series.

Table AIV

RATES OF RETURN FROM 1950Q1 TO PRESENT

Mnemonic	Description	Source
ROCDE	Rate on other checkable deposits (1970Q2-)	*
RSAVEFF	Rate on savings deposits (1950Q1-)	QM
RSTDEFF	Rate on small time deposits (1959Q1-)	QM
RDPS	Rate on deposits with postal savings system (Ends 1967Q3)	F&S9 3
RONRP	Rate on overnight repurchase agreements (1972Q1-)	MDL
RONED	Rate on overnight Eurodollar deposits (1971Q1-)	MDL
RMMDACE	Rate on money market deposit accounts at commercial banks (1982Q4-)	*
RMMDATE	Rate on money market deposit accounts at thrift institutions (1982Q4-)	*
RMMFE	Rate on money market funds (1974Q3-)	*

Notes: QM refers to the Board's Quarterly Model database. MDL refers to the Board's Macro Data Library. RSAVEFF and RSTDEFF are the mnemonics used on the QM for the rate on savings deposits and the rate on small time deposits, respectively. The mnemonics on the MDL corresponding to RONRP and RONED are RMDLRRPM and &EDONM, respectively. Series with a "*" in the Source column are taken from a database kept by the Board's Monetary Studies Section and have the same mnemonics as the corresponding series on that database. The number following F&S9 refers to the column number in Friedman and Schwartz, Table 9. The dates in parentheses show the periods over which each series is non-zero.

With the exception of RONRP and RONED, the rate of return series kept on the Board's databases are expressed as effective annual rates. The former are expressed as simple annual rates as is the RDPS series, which is taken from F&S, Table 9. (All series are in the form in which they are found in the sources.)

The RSTDEFF series begins in 1959Q2. (The 1959Q1 value was set at 2.7, the 1959Q2 value.) Prior to 1959Q1, the RSAVEFF series is used in place of RSTDEFF.

ROCDE is a weighted average of the effective annual yields on OCDs at commercial banks and at thrift institutions. From 1983Q1 to 1986Q1, yields on Super NOWs are included in the average.

5. Calculation of rate of return for M2

This section calculates a weighted-average rate of return on M1 (RM1) and M2 (RM2) using rates on the components of these aggregates. Currency, travelers checks, and demand deposits enter in with a zero weight because they do not pay an explicit rate of return.

Calculation of RM1

(1) RM1 = (1/M1NSA) [(OCDC + OCDT) • ROCDE]

Notes: The RM1 series is zero until 1970Q2. The other checkable deposit series, OCDC and OCDT, contain Super NOWs over the period of their existence from 1983Q1 to 1986Q1.

Calculation of RM2

Prior to 1950Q1:

(2) RM2 = (1/M2SA) [DCB • RDCB + DPS • RDPS + DSB • RDSB + DTH • RDTH]

For 1950Q1 to 1958Q4:

(3) RM2 = (1/M2SA) [(DCB + DSB + DTH) • RSAVEFF + DPS • RDPS]

For 1959Q1 to present:

(4) RM2 = (1/M2NSA) [M1NSA • RM1 + SD • RSAVEFF + DPS • RDPS + STD • RSTDEFF
+ ONRP • RONRP + ONED • RONED + MMDAC • RMMDACE
+ MMDAT • RMMDATE + MMF • RMMFE]

Table AV

RATE OF RETURN FOR M2 (RM2)

Year	Quarter	RM2
1946	1	0.47
1946	2	0.47
1946	3	0.47
1946	4	0.48
1947	1	0.49
1947	2	0.49
1947	3	0.50
1947	4	0.50
1948	1	0.52
1948	2	0.53
1948	3	0.53
1948	4	0.53
1949	1	0.57
1949	2	0.57
1949	3	0.58
1949	4	0.58
1950	1	0.37
1950	2	0.38
1950	3	0.38
1950	4	0.39
1951	1	0.40
1951	2	0.41
1951	3	0.42
1951	4	0.43
1952	1	0.44
1952	2	0.46
1952	3	0.47
1952	4	0.48
1953	1	0.50
1953	2	0.51
1953	3	0.52
1953	4	0.54
1954	1	0.55
1954	2	0.57
1954	3	0.58
1954	4	0.59
1955	1	0.60
1955	2	0.62
1955	3	0.64
1955	4	0.67
1956	1	0.68
1956	2	0.71
1956	3	0.74
1956	4	0.77
1957	1	0.94
1957	2	0.99
1957	3	1.03
1957	4	1.05
1958	1	1.08
1958	2	1.11
1958	3	1.14
1958	4	1.16
1959	1	1.21
1959	2	1.25
1959	3	1.28
1959	4	1.31
1960	1	1.35
1960	2	1.39
1960	3	1.43
1960	4	1.45
1961	1	1.49
1961	2	1.52
1961	3	1.60
1961	4	1.64
1962	1	2.04
1962	2	2.13
1962	3	2.16
1962	4	2.16
1963	1	2.19
1963	2	2.22
1963	3	2.30
1963	4	2.30
1964	1	2.33
1964	2	2.35
1964	3	2.36
1964	4	2.37
1965	1	2.48
1965	2	2.50
1965	3	2.52
1965	4	2.58
1966	1	2.66
1966	2	2.69
1966	3	2.73
1966	4	2.69
1967	1	2.71
1967	2	2.74
1967	3	2.76
1967	4	2.75
1968	1	2.78
1968	2	2.80
1968	3	2.82
1968	4	2.81
1969	1	2.84
1969	2	2.85
1969	3	2.90
1969	4	2.86
1970	1	3.07
1970	2	3.16
1970	3	3.18
1970	4	3.18
1971	1	3.19
1971	2	3.15
1971	3	3.20
1971	4	3.23
1972	1	3.23
1972	2	3.23
1972	3	3.27
1972	4	3.33
1973	1	3.42
1973	2	3.67
1973	3	4.52
1973	4	4.55
1974	1	4.65
1974	2	4.57
1974	3	4.45
1974	4	4.32
1975	1	3.94
1975	2	3.81
1975	3	3.92
1975	4	3.87
1976	1	3.88
1976	2	3.93
1976	3	3.98
1976	4	4.05
1977	1	4.02
1977	2	4.07
1977	3	4.22
1977	4	4.29
1978	1	4.28
1978	2	4.32
1978	3	4.75
1978	4	5.35
1979	1	5.64
1979	2	5.67
1979	3	5.85
1979	4	6.90
1980	1	7.75
1980	2	6.71
1980	3	6.10
1980	4	8.09
1981	1	8.89
1981	2	9.26
1981	3	9.93
1981	4	8.66
1982	1	8.97
1982	2	8.78
1982	3	7.82
1982	4	6.35
1983	1	6.39
1983	2	6.48
1983	3	6.88
1983	4	6.88
1984	1	7.04
1984	2	7.47
1984	3	7.97
1984	4	7.27
1985	1	6.63
1985	2	6.23
1985	3	5.87
1985	4	5.87
1986	1	5.78
1986	2	5.29
1986	3	4.88
1986	4	4.63
1987	1	4.62
1987	2	4.76
1987	3	4.93
1987	4	5.13
1988	1	5.10
1988	2	5.10
1988	3	5.38
1988	4	5.64
1989	1	6.10
1989	2	6.40

THE CHANGING LABOR FORCE: SOME PROVOCATIVE FINDINGS

William E. Cullison

A labor force participation rate is defined as the percentage of the population in the labor force. The labor force, in turn, is defined as the sum of the numbers of employed and unemployed persons. The total labor force includes armed forces personnel, while the civilian labor force does not. The Bureau of Labor Statistics (BLS) publishes labor force participation rates for various age, sex, and racial groupings.

This article examines changes in the labor force participation rates in various sex and age groups since 1950, with particular emphasis on developments since 1976. It also studies long-term trends in labor force participation by major age/sex group after mid-1981 and tests labor force participation rates to see whether they have varied with real GNP, inflation, and/or unemployment since 1976.

The data show that while female participation rates have been rising rapidly since 1950, male participation rates have been falling, and falling especially rapidly for males 55 years and older since 1970. The popular press has widely reported the increase in female labor force participation, attributing it to the "feminist revolution," among other things. But the press has largely ignored the decline in male labor force participation.[1]

The results of a regression analysis of the trends in the data provide evidence on several key issues. These are: (1) the effects of the Reagan administration's tax policies on worker behavior in the 1980s, (2) whether any significant part of the labor force is composed of secondary workers who participate only when times get hard such that extra earnings are needed to maintain the family's income (the so-called "additional worker" effect), and (3) whether any significant portion of workers become discouraged and drop out of the labor force in hard times when jobs are difficult to find.

The analysis concludes that the Reagan administration's reductions of marginal income tax rates after mid-1981 had no apparent influence on labor force participation. Other findings cast doubt on the extent of a discouraged worker effect on labor force participation but provide evidence consistent with an additional worker effect. The results of the analysis also suggest some surprising possible effects of the female work revolution on female and male labor force participation. Before these issues can be discussed, however, it is necessary to present the data and the regression analysis.

I. TRENDS IN LABOR FORCE PARTICIPATION SINCE 1950

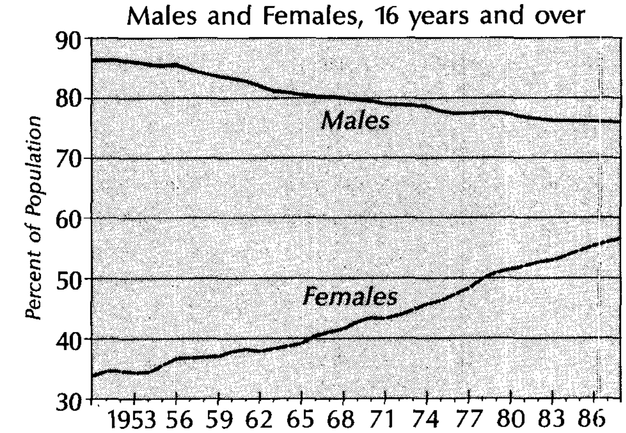
Chart 1 depicts civilian participation rates for males and females 16 and over for the 1950 to 1988 time period. Almost 34 percent of the 16 and over female population was in the labor force in 1950, but by 1988 the percentage had increased to 56.6. In contrast, 86.2 percent of the 16 and over male population was in the labor force in 1950, but that percentage had declined to 76.2 by 1988.

The chart thus summarizes the striking changes in the composition of the labor force in the past 38

Chart 1

CIVILIAN PARTICIPATION RATES

Males and Females, 16 years and over



[1] The economics literature, on the other hand, is replete with studies that recognize and attempt to explain the declining labor force participation of older males. See, for example, the survey articles by Killingsworth and Heckman [1], Lazear [2], and Pencavel [3], in the *Handbook of Labor Economics*.

years, which in numbers of persons affected might best be characterized as follows. If the population in 1988 had the same labor force participation by sex that it had in 1950, the labor force would include 8.9 million more males and 22 million fewer females.

Charts 2 and 3 illustrate the changes in labor force participation for females and males in the 20-24, 25-54, 55-64, and 65 and over age groups. Chart 2 shows that females in the prime 20-24 and 25-54 age groups have been the major source of female labor force growth, with the overall participation rate of 20-54 females rising from approximately 40 percent in 1950 to almost 73 percent in 1988. The participation rate of females in the 55-64 age category also rose over 15 percentage points from 1950 to 1970, but since 1970 participation rates in that age group have seemed to stabilize. Female labor force participation in the 65 and over category, on the other hand, remained stable from 1950 to 1970, but it began to decline very slightly after 1970.

Chart 3 illustrates the changes in male labor force participation by age group. In contrast to female labor force participation, where most of the change in participation is in the prime 20-54 age group, the change in the male labor force participation is mostly in the 55 and over age group. In 1950, for example, almost 87 percent of the males in the 55-64 age group were in the labor force, but by 1988 the participation rate had dropped to 67 percent. Also, almost 46 percent of males over 65 were in the labor force in 1950, but only 16.5 percent in 1988.

The decline in labor force participation of older males illustrated by Chart 3 has spawned a number of studies in the professional economics literature that attempt to explain the changes in male retirements. Some of the studies are concerned about the general effects of earnings on the retirement decision, but most examine the changes over time in governmental social security and private pension programs. The results of the studies are somewhat inconclusive, however, for different economists have focused upon different causal factors. These factors include current earnings, lifetime earnings profiles, education levels, wealth, wages in alternative jobs, social security benefits, earnings tests, pension levels, pension payment schedules, and individual savings. A good survey of the retirement studies is provided by Edward Lazear [2].

Differences in Trends of Labor Force Participation Rates After 1981:2.

To examine changes in labor force participation before and after the enactment of the Economic Recovery Tax Act (ERTA) of 1981, the participation rates for the various age/sex groupings were examined using quarterly data over 1976-88. In particular, the participation rates of the ten age/sex groups were regressed on two variables—a simple time trend, and a time trend multiplied by a dummy variable that took a zero value until 1981:1 and a value of one after 1981:1.

The results of these regressions are shown in the accompanying table. Significant serial correlation of the data was found, so the regressions are reported with the Cochrane-Orcutt correction. The coefficients and t statistics listed in the column labeled "Trend 2" indicate the extent of the change in trend after 1981:1.[2]

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[2] Trend 2 is the straight time trend multiplied by the dummy variable that takes a zero value before 1981:2 and a value of one after 1981:1.

Chart 2

FEMALE PARTICIPATION RATES

Civilian Labor Force, by Age Group

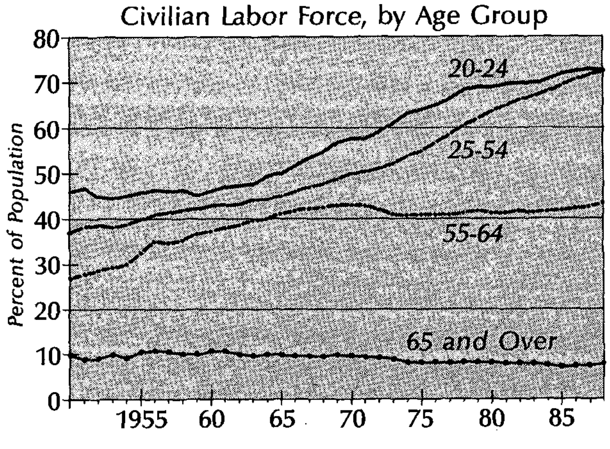
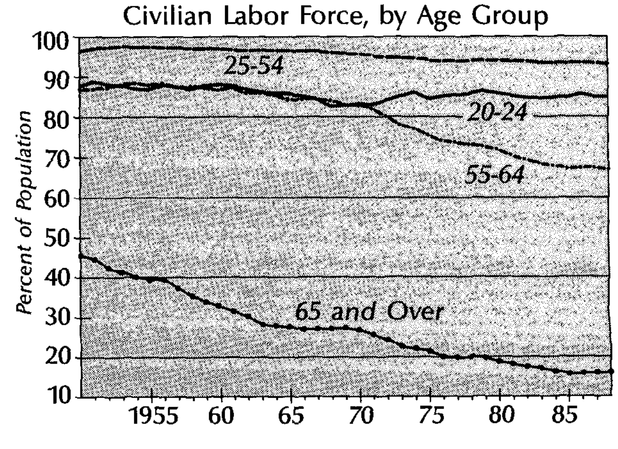


Chart 3

MALE PARTICIPATION RATES

Civilian Labor Force, by Age Group



REGRESSIONS OF PARTICIPATION RATES ON TREND AND A TREND DUMMY
(With Cochrane-Orcutt Correction for Serial Correlation)[a]
Quarterly from 1976:1 to 1988:4

Sex-Age Group	R^2	Durbin-Watson	Constant	Trend 1 (1950 = 1)	Trend 2 (1981:2 BREAK)	Rho-AR1
FEMALES:						
16-19	0.68	2.19	45.64 (10.67)	0.0597 (1.71)	−0.0121 (1.96)	0.6845 (7.09)
20-24	0.96	2.33	52.37 (17.93)	0.1369 (5.87)	−0.0040 (1.08)	0.7514 (9.27)
25-54	0.998	2.27	28.36 (8.69)	0.2922 (12.33)	−0.0033 (1.66)	0.8984 (28.75)
25-54[b]	0.998	2.22	21.36 (10.08)	0.3310 (22.87)	−0.0027 (1.41)	0.7947 (13.46)
55-64	0.78	1.77	33.52 (20.96)	0.0660 (4.90)	−0.0045 (1.73)	0.5433 (4.08)
65 and over	0.69	1.84	8.95 (9.46)	−0.0073 (0.92)	−0.00161 (1.07)	0.5910 (4.55)
MALES:						
16-19	0.91	2.19	68.07 (14.32)	−0.0636 (1.68)	−0.0142 (2.41)	0.7617 (8.50)
20-24	0.45	2.08	84.15 (53.94)	0.0146 (1.10)	−0.0076 (2.75)	0.3717 (2.79)
25-54	0.65	2.05	95.25 (193.40)	−0.0086 (2.04)	−0.0013 (1.48)	0.2501 (1.91)
25-54[c]	0.69	2.03	95.16 (215.20)	−0.0075 (1.96)	−0.0015 (1.92)	0.1821 (1.35)
55-64	0.98	2.10	88.65 (61.90)	−0.1348 (11.10)	−0.0081 (3.31)	0.4717 (3.69)
65 and over	0.97	2.01	27.45 (6.70)	−0.0704 (2.36)	−0.0031 (1.20)	0.8943 (13.49)

[a] The numbers in parentheses are *t* statistics.

[b] A measure of the so-called "misery index" (the percentage change in the CPI from eight quarters before plus the unemployment rate) is included in this equation. The coefficient on the "misery" rate equals 0.1074; the *t* value is 2.98.

[c] The percentage change in real GNP lagged one quarter is included in this equation. The coefficient on the change in GNP is −0.0129; the *t* value is −2.31.

The table shows that the coefficients for the Trend 2 variable are negative for *all* ten age/sex groups. One can therefore conclude that there was no significant upward surge of the trend rate of labor force participation after 1981 in any age/sex group studied.

The coefficient on Trend 2 was *significantly* negative (at the 95 percent confidence level), however, only for three male age groups—16-19, 20-24, and 55-64. This finding indicates that after 1981 relatively more 16-24 year-old and 55-64 year-old men began either (1) to quit their jobs (or discontinue their job searches) and drop out of the labor force or (2) to refrain from entering the labor force at all. In the case of 16-19 and 55-64 year olds, the post-1981 change merely accentuated an existing trend toward lessened labor force participation.

The male 20-24 age group, however, had exhibited a trend of increasing labor force participation before 1981, being the *only* male labor force group that tended to increase its participation rate over the 1950-81 period. After the post-1981 trend correction is made, the net trend coefficient for the 20-24 year group remains positive, but its value is halved.

How Differences in Economic Conditions Affect Participation Rates

A regression equation containing the two trends and the percentage change in real GNP as independent variables was also estimated for each of the ten age/sex groups. The objective was to determine whether the participation rates were sensitive to overall economic conditions. One frequently hears that the labor force tends to decline in times of economic contraction and to rise in times of expansion. For this claim to be consistent with the data, participation rates must vary *directly* with the rate of change in real GNP. As it turns out, they do not.

The coefficient on the change in GNP was significantly different from zero only for the regression with male 25-54 participation rates as the dependent variable. The results of that regression[3] are reported in the table as the second equation for that age/sex group. As the table shows, however, male 25-54 labor force participation varied *inversely* with the change in real GNP. The implications, thus, are that 25-54 males participate relatively more in the labor force in times of economic contraction and relatively less in times of economic expansion, and that the state of the economy has little effect on the labor market participation of any other age/sex group. It is worth mentioning that the coefficient on the Trend 2 remained negative in the equations that included the change in real GNP.

Finally, to examine the notion that increases in inflation and unemployment might induce secondary workers to join the labor force in order to maintain the family's existing standard of living, a set of regressions was run with the two trends and a measure of the so-called "misery index."[4] The coefficient on the misery index variable was significantly different from zero (at the 95 percent level) only for participation rates of females in the 25-54 age group. That equation is reported in the table as the second equation for females 25-54.

Two additional sets of regressions were also run: one using the unemployment rate as the third independent variable, and the other using the percent change in the Consumer Price Index (CPI). The coefficient on the unemployment rate was not significantly different from zero in any regression, but the coefficient on the change in the CPI was significantly different from zero in one regression, that of females aged 25-54. Since the t value for the CPI change was lower than the t statistic on the "misery" coefficient, the table reports only the result of the regression using the misery index as an argument. It is again worth mentioning that the regression estimates of the coefficients on the Trend 2 variable remained negative in all cases.

II. IMPLICATIONS FOR SUPPLY-SIDE TAX POLICIES

The early rhetoric accompanying the supply-side tax policies of the Reagan administration stated that, among other things, lower marginal tax rates would provide incentives for persons to work harder. As President Reagan put it in his first *Economic Report* (1982),

> . . . the first part of the year we work for ourselves. We begin working for the government only when our income reaches taxable levels. After that, the more we earn, the more we work for the government, until rising tax rates on each dollar of extra income discourage many people from further work effort or from further saving and investment. . . . We have set in place a fundamental reorientation of our tax laws. . . . The reduction in marginal rates for all taxpayers, making Individual Retirement Accounts available to all workers, cutting the top tax bracket from 70 percent to 50 percent, and reduction of the "marriage penalty" will have a powerful impact on the incentives for all Americans to work, save, and invest [4, pp. 6-7].

In his last *Economic Report* (1989), President Reagan summarized his administration's accomplishments as follows:

> And by reducing taxes and regulatory bureaucracy, we have unleashed the creative genius of ordinary Americans and ushered in an unparalleled period of peacetime prosperity. . . . Our New Beginning has restored personal incentives through a series of tax reforms and tax cuts. These reforms have reduced the top Federal marginal income tax rate to less than one-half the level that prevailed when we took office and decreased tax liabilities at all income levels [5, pp. 3, 7].

In the *Annual Report of the Council of Economic Advisers*, which is published with the President's *Economic Report*, Reagan's Council of Economic Advisers stated:

> The Economic Recovery Tax Act of 1981 [ERTA] reduced the top marginal tax rate for individual income from 70 to 50 percent. It reduced marginal tax rates on given levels of nominal income for all tax brackets while indexing personal exemptions, the standard deduction, and the tax brackets in 1985 to prevent bracket creep. . . . The act significantly reduced the average burden of taxation for American families compared with what it would have been

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[3] Three sets of regressions were calculated—one with the current change in real GNP, one with the change in real GNP lagged one quarter, and one with the change in real GNP lagged two quarters—for all age/sex groups. Males 25-54 were the only group to be significantly affected by the change in real GNP (at the 95 percent level). The t value of the coefficient for the GNP variable was highest for real GNP lagged one quarter, so the results of that regression are reported in the table.

[4] The misery index is generally defined as the sum of the inflation rate and the unemployment rate. For this estimation, it was specifically defined as the sum of the annual rate of change in the Consumer Price Index (CPI) from eight quarters earlier and the civilian unemployment rate.

without a change in the tax law. . . . The cuts in marginal tax rates acted to increase the incentives to work and to invest [5, pp. 86-7].

After evaluating the effects of the Tax Equity and Fiscal Responsibiity Act of 1982 (TEFRA) and the Tax Reform Act of 1986 (TRA) on the changes in marginal tax rates initiated by ERTA, the Council's *Annual Report* observed that income tax savings (for median income families of four) remained substantial, even in 1988, over what they would have been under the tax law in existence in 1980. The report concluded:

The reductions in marginal tax on labor income encourage labor force participation, particularly of second earners. Because TRA reduced the difference between gross wages and net wages at the margin, it provides workers with an incentive to increase their work effort [5, p. 90].

Finally, a great deal of publicity was given in the early 1980s to the Laffer curve. The Laffer curve was based on a simple truism—that at lower levels of income taxation, raises in tax rates yield more total tax revenue, but that if tax rates continue to rise individuals eventually lose incentives to work and invest, so total tax receipts eventually decline. Thus, at a 100 percent tax rate, total tax receipts would be zero. From a political point of view, the Laffer curve provided a rationale for reducing taxes without reducing government spending, provided of course that one assumed that income tax rates already were so high that the economy was operating on the downward sloping side of the curve.

The foregoing quotations and the Laffer curve rationale for tax reduction imply that lower marginal tax rates will induce individuals to work, save, and invest. If this implication is correct, one would expect labor force participation rates to rise after tax rate relief.

In fact, however, no evidence of an increase in the trend rate of labor force participation was found. As the table shows, there was no significant upward movement in the trend rate of labor force participation in any of the ten age/sex groups studied after the first half of 1981, even after adjusting for changes in economic conditions.[5]

Why did no such effect show up? One reason may be that the incentives were not large enough. At the same time that the income tax rates were being reduced, for example, the payroll taxes (contributions for social security, etc.) were rising. A 1987 study by the Congressional Budget Office (CBO), for example, concluded that the effective tax rates for overall federal taxes were slightly higher under 1988 tax laws than they were under 1977 tax laws for all but the highest decile of income earners.[6] The CBO illustration showing the different effective tax rates by population decile is reproduced here as Figure 1.

Chart 4 shows personal taxes and social security contributions as percentages of personal income before tax deductions.[7] This chart does show a modest reduction in average taxes after 1981.

That trends in labor force participation rates did not increase after 1981 implies either (1) that there were no significant reductions in marginal tax rates in the 1980s or (2) that the reductions in tax rates had no significant effect on labor force participation. The first possibility is contrary to the spirit of the 1989 *Economic Report of the President*. The second is contrary to the supply-side predictions of the early 1980s.

III.
OTHER IMPLICATIONS OF THE DATA

Discouraged Workers

Some analysts argue that individuals will drop out of the labor force if they become too discouraged about their job prospects. Workers therefore would be expected to increase their labor force participation in periods of economic expansion and decrease it in times of economic contraction.

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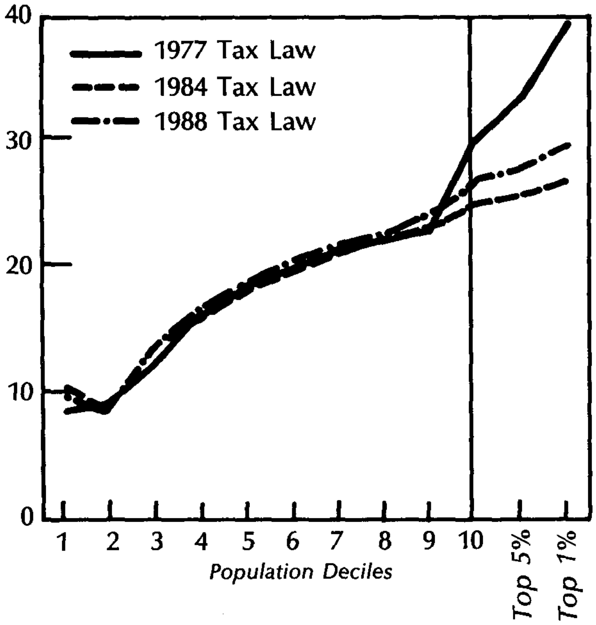
[5] Of course, some workers may have responded by taking second jobs; a phenomena that would not show up in the participation rate data. Data on multiple job holding were gathered from the May supplement to the Census's Current Population Survey until 1980, when the supplement was discontinued. Special questions included in the May 1985 CPS, however, asked about multiple job holding, so data are available for 1985. By interpolation a quarterly series on multiple jobholders was estimated for males and females 16 and over for the 1970-85 time period. The estimates were then added to the civilian labor forces and new estimates of participation rates were devised that, in effect, counted the multiple jobholders as participating twice. Regressions were run on the revised participation rates over the 1970:2 to 1985:2 and 1976:1 to 1985:2 periods, again with the trend and trend dummy variables as arguments. It was found that adding the multiple jobholders made no difference to the regression results, and again all of the coefficients on "Trend 2" were negative.

[6] The data utilized in the CBO study, however, are not wholly appropriate for analyzing changes in tax incentives on labor force participation. The CBO procedure allocated both employer and employee contributions to Social Sećurity as well as the family's share of the corporate income tax to each decile's effective tax rate.

[7] Personal income as defined by the Bureau of Economic Analysis includes transfer payments *net* of personal contributions for social insurance. To get an appropriate before-tax personal income measure to be used as the denominator for the series in Chart 4, personal contributions for social insurance were added to the BEA's personal income figure. Thus, the before-tax personal income statistic used includes transfer payments *gross* of social insurance contributions.

Figure 1

EFFECTIVE FEDERAL TAX RATES BY POPULATION DECILE



Note: Families are ranked by income size (1 being the lowest) Family income includes the family's share of the corporate income tax which is allocated to capital income. The lowest decile excludes families with zero or negative incomes. The effective tax rate is the ratio of taxes to family income in each income class.

Source: United States, Congressional Budget Office, "The Changing Distribution of Federal Taxes: 1975-1990," October 1987, Summary Figure 1, p. xv.

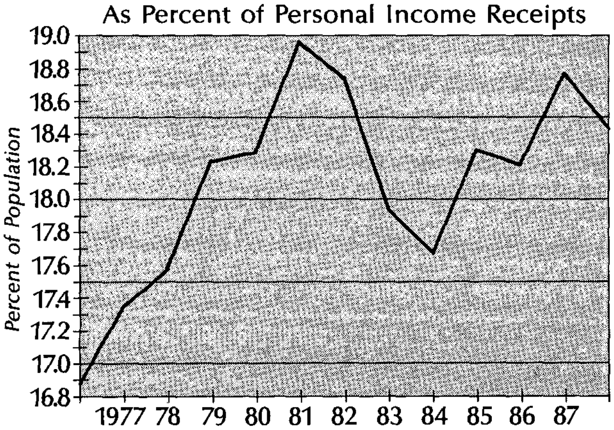
The data, however, show that since 1976 the only participation rates that were significantly related to changes in real GNP were those of males in the 25-54 age group, and that those participation rates were not related to GNP growth in the way predicted by the discouraged worker hypothesis. As the table shows, the coefficient on the change in real GNP lagged one quarter bears a negative sign.[8] Thus, the analysis implies that a decline in the rate of growth in real GNP, other things equal, will induce a rise in the rate of labor force participation of age 25-54 males, which is exactly opposite to the sort of behavior predicted by the discouraged worker effect.

This inverse relation between real GNP growth and male 25-54 participation rates is consistent with either (1) the backward-bending supply curve of labor, according to which workers opt for more leisure and therefore drop out of the labor market when their incomes rise and come back in when their incomes fall, or (2) a variant of the backward-bending supply curve, the additional worker effect.

Chart 4

PERSONAL TAXES & S.S. CONTRIBUTIONS

As Percent of Personal Income Receipts



Additional Workers

Underlying the additional worker effect is the concept that secondary workers (nonbreadwinners) enter the labor force in times of adversity to enable the the family to maintain its standard of living. As noted above, the labor force participation rate behavior of age 25-54 males, who increase their participation as the economy expands and reduce it as the economy contracts, would be consistent with the additional worker hypothesis if those workers were indeed secondary workers. If male 25-54 participation rates were dominated by the additional worker effect, however, the regression of them on the misery index, the CPI, or the unemployment rate should also have been significant. It was not.

Evidence of the additional worker effect is found, however, in the regression of female 25-54 labor force participation on the trends and the misery index. As shown in the table, the regression results showed a significant positive relation between the misery index and participation rates in the female 25-54 age group.

As mentioned earlier, if a significant negative correlation between the rate of growth of real GNP and the female participation rate had been found, that result would also have been consistent with the additional worker hypothesis. Intuitively, however, it seems most appropriate to identify the misery index more closely with the additional worker effect than the change in real GNP, for inflation and

[8] The sign was also negative for the regression using the current change in real GNP as an argument. The coefficient on the change in real GNP lagged 3 quarters was not significantly different from zero.

unemployment have immediate and direct effects on family real incomes. Therefore, it seems likely that the female 25-54 participation rates were affected more strongly by the additional worker effect than were the participation rates of males 25-54.

The labor force participation of age 25-54 males seems more likely to stem from behavior consistent with the classic backward-bending supply curve. The rationale for the backward-bending supply curve is that as individuals achieve certain levels of income, leisure becomes progressively more desirable and pecuniary income progressively less desirable. As a result, wage increases may sometimes induce workers to substitute leisure hours for work hours.

Speculations about Possible Effects of the Revolution in Female Labor Force Participation

As noted earlier, the composition of the labor force in 1988 is radically different from that of 1950. If the 1950 participation rates had continued to prevail, the 1988 labor force would contain 22 million fewer female workers and 8 million more male workers. Moreover, the growth in the female labor force has drawn from the prime 20-54 age population, while the source of decline in the male labor force participation has been in the older, 55 and over, ages.

One of the early rallying cries of the feminist revolution in the 1950s was that females were not encouraged to enter the labor force, but rather were expected to remain home and nurture their children. If that were true in the fifties, it has changed in the eighties. As Chart 1 shows, over 55 percent of all women over 16 participated in the labor force in 1988, far higher than the 35 percent female participation rate registered in 1950.

Whether the work situation for females has turned out to be consistent with the expectations of the feminist revolution, however, is open to question. First, a number of traditionally female jobs continue to pay lower wages than traditional male jobs. Second, the correlation of participation rates of 25-54 year-old females with the misery index provides evidence that a proportion of female workers have jobs not because they desire to work, per se, but because they and their families need the income.

How have males fared since 1950? Apparently quite well. Almost 45 percent of the male population over 65 was in the labor force in 1950, but only 15 percent in 1988. Such a change, of course, could indicate that prospective employers now tend to discriminate against older men, but that explanation seems unlikely. Rather, the reduction in labor force participation of 65 and over males most likely is beneficial to older men, as more of those who want to retire are now able to do so. The data also show declining participation rates for 55-64 men, especially since 1970. Again, the trend could be interpreted as hurtful to the welfare of the 55-64 men, but the accuracy of such an interpretation would be questionable. It seems much more likely that the declining rates for 55-64 men indicate increases in welfare as more men are able to choose early retirement.

This decreasing male labor force participation has come in the face of stable (65 and over) or rising (55-64) female labor force participation rates in the older age groups. Does this development mean that the older men are now living a life of leisure secured by their retirement benefits and the earnings of their breadwinning spouses? It could. Does it mean that older men and older women are now living lives of leisure, traveling around the country in their RVs, using up the inheritance that might otherwise have gone to children and grandchildren? It could, for although female labor force participation rates have risen, they still do not exceed male labor force participation rates. Does it mean that laid off older males get discouraged about their job prospects and drop out of the labor force? It might, but participation rates of older men do not seem to vary in any consistent way with the rate of growth of real GNP, so if they get discouraged it relates more to secular than to cyclical developments.

So who has benefitted from the feminization of the work force? If benefit is based upon freedom to follow one's preferences without worry about breadwinning, the beneficiaries are not all female, nor have all females benefitted. Rather, older men are now apparently able to choose to retire at earlier dates, while some prime age females apparently work outside the home only because they and their families are facing hard times and they cannot afford not to work outside the home.

References

1. Killingsworth, Mark, and James Heckman. "Female Labor Supply: A Survey." In *Handbook of Labor Economics*, edited by Orley Ashenfelter and Richard Layard, 103-204. Amsterdam: North-Holland, 1986.

2. Lazear, Edward. "Retirement from the Labor Force." In *Handbook of Labor Economics*, edited by Orley Ashenfelter and Richard Layard, 305-55. Amsterdam: North-Holland, 1986.

3. Pencavel, John. "Labor Supply of Men: A Survey." In *Handbook of Labor Economics*, edited by Orley Ashenfelter and Richard Layard, 3-102. Amsterdam: North-Holland, 1986.

4. U.S. President. *Economic Report of the President*. Washington, D.C.: U.S. Government Printing Office, February 1982.

5. U.S. President. *Economic Report of the President*. Washington, D.C.: U.S. Government Printing Office, January 1989.

CHANGES IN MANUFACTURING EMPLOYMENT IN NORTH CAROLINA COUNTIES, 1980-85

*Christine Chmura and Jane Ihrig**

A turbulent economic environment challenged manufacturers from 1980 through 1985. During this period, the foreign exchange value of the dollar rapidly appreciated, oil prices surged and then plunged, inflation declined from double digit rates, and the U.S. economy went through two recessions. Moreover, manufacturing employment declined by more than a million workers.

Steven A. Waldhorn, Director of the Center for Economic Competitiveness at SRI International, has argued that rural areas lost a larger proportion of manufacturing employment than urban areas between 1980 and 1985 for the following reasons:

> . . . Rural areas tend to be at a competitive disadvantage because of their industry mix and structure. They also tend to be dependent on just a few industries; these industries also happen to be the ones most affected by increasing foreign competition. Lower-cost foreign locations are attracting some basic U.S. manufacturing operations . . . at the expense of rural economies.[1]

This study focuses on manufacturing employment in the Fifth District state of North Carolina because: 1) at 31 percent of total employment in the state, manufacturing in North Carolina accounts for a proportion of jobs that is higher than that of any other state in the nation, and 2) rural areas in North Carolina lost a larger percentage of manufacturing jobs than urban areas between 1980 and 1985. As will be shown for North Carolina, however, and contrary to Waldhorn's statement, rural areas were generally not at a competitive disadvantage to urban areas because of their mix of industries.

To evaluate if Waldhorn's thesis applied to North Carolina, this paper investigates whether this state's rural areas were relatively more dependent on manufacturing industries whose employment declined nationwide between 1980 and 1985. The paper also analyzes changes in rural and urban jobs in three North Carolina industries—textiles, apparel, and chemicals—that lost the most jobs from 1980 to 1985, to determine if rural locations were disproportionately affected in these three industries. Finally, the article examines whether industry-specific changes in the foreign exchange value of the dollar affected manufacturing employment in North Carolina counties from 1980 to 1985.[2]

RURAL VERSUS URBAN COUNTIES

There are many different ways to define urban and rural areas. Most often, researchers use counties as the basic geographical unit. They define urban counties as those that are in metropolitan areas—all others are rural. Because there is much diversity within the urban and rural categories, some researchers use more than two categories to define the rural-urban character of counties.

This article uses a 10-class system to measure the degree of urbanization in counties. Under this system, counties are classified by population density and proximity to metropolitan areas into categories called "Beale codes."[3] As shown in Table I, the higher the integer value of the Beale code, the more rural the county. Following a precedent set by a U.S. General Accounting Office study, this article defines rural areas as counties classified as Beale codes 6, 7, 8, and 9.[4]

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* The authors wish to thank Dan M. Bechter and William E. Cullison for helpful comments.

[1] "New Perspectives on Rural Development," *Hearing To Identify Prospects for Economic Development in Rural America*, before the Subcommittee on Rural Economy and Family Farming of the Committee on Small Business, United States Senate (Washington, D.C.: U.S. Government Printing Office, 1988), pp. 58, 62-63.

[2] This article uses ES-202 data from the U.S. Department of Labor in which employment is disclosed for all counties at the 2-digit standard industrial classification level. The authors thank the North Carolina State Employment Commission for permitting access to this unpublished data set in which employment is listed for all data categories.

[3] Economic Research Service of the U.S. Department of Agriculture.

[4] U.S. General Accounting Office, *Rural Development: Federal Programs That Focus on Rural America and Its Economic Development* (Washington, D.C.: General Accounting Office), January 1989.

Table I

RURAL-URBAN CONTINUUM (BEALE CODE) COUNTY CLASSIFICATION SYSTEM AND THE DISTRIBUTION OF COUNTIES AND EMPLOYMENT IN THE NATION AND NORTH CAROLINA IN 1985

Beale Code, Population and County Metropolitan Area (MA)		Percent of Counties		Percent of Mfg Employment	
		U.S.	NC	U.S.	NC
0	Central to MAs of over 1,000,000	2.0	0.0	30.0	0.0
1	Fringe of MAs of over 1,000,000	6.3	0.0	15.7	0.0
2	In MAs of 250,000 to 1,000,000	10.4	17.0	24.1	42.5
3	In MAs of less than 250,000	7.1	8.0	8.7	15.2
4	Urban 20,000 or more, adjacent to MA	5.1	5.0	5.1	8.7
5	Urban 20,000 or more, not adjacent to MA	5.1	7.0	2.9	5.9
*6	Urban less than 20,000, adjacent to MA	18.7	19.0	5.9	14.5
*7	Urban less than 20,000, not adjacent to MA	25.4	17.0	6.0	10.0
*8	Completely rural, adjacent to a MA	6.5	5.0	0.6	5.1
*9	Completely rural, not adjacent to a MA	13.5	22.0	1.0	2.8
	TOTAL URBAN (0+1+2+3+4+5)	36.0	37.0	86.5	72.3
	TOTAL RURAL (6+7+8+9)	64.1	63.0	13.5	27.8

Notes: Metropolitan status was determined by the U.S. Office of Management and Budget, June 1983, based on the results of the 1980 census. Metropolitan areas must have either 1) a city of at least 50,000 population, or 2) an urbanized area of at least 50,000 with a total metropolitan population of at least 100,000. This criterion further defines Beale codes 3, 4, and 5. A completely rural (Beale codes 8 and 9) county has no town in it with over 5,000 population. A county adjacent to a metropolitan area must have an adjacent physical boundary *and* at least 2 percent of its employed labor force must commute to metropolitan central counties.

* Counties in these four classes are considered rural by the U.S. General Accounting Office in their study *Rural Development: Federal Programs That Focus on Rural America and Its Economic Development*, January 1989.

Sources: Beale codes were obtained from the Economic Research Service, U.S. Department of Agriculture; employment data were obtained from the Bureau of Labor Statistics, U.S. Department of Labor, ES-202 data.

The distribution of counties within rural and urban areas in North Carolina differs considerably from that of the national average, so changes in manufacturing employment in North Carolina are not necessarily representative of national trends (see "percent of counties," Table I). For example, North Carolina has no counties in the largest metropolitan areas (Beale codes 0 or 1), but 17 percent of its counties are in metropolitan areas with populations of 250,000 to 1,000,000 (Beale code 2). The figure shows the location of these counties in North Carolina.

The distribution of manufacturing jobs by Beale code in North Carolina is also different from that of the nation (see "percent of mfg employment," Table I). Only 72 percent of the manufacturing workers in North Carolina work in urban counties, compared with 87 percent in the nation. The greatest difference is in Beale code 2 counties, which contain over 40 percent of North Carolina's manufacturing jobs but only 24 percent of the nation's.

INFLUENCE OF INDUSTRY MIX ON EMPLOYMENT DECLINES

It has been argued that rural counties were more susceptible to downturns in the economy because a higher proportion of their jobs were in industries that reduced employment nationwide between 1980 and 1985.[5] This section examines whether the nationally contracting industries actually were more predominant in rural than in urban areas of North Carolina and whether these industries experienced relatively larger employment losses in the state's rural areas. This section also examines the concentration of employment in contracting industries in North Carolina's rural counties.

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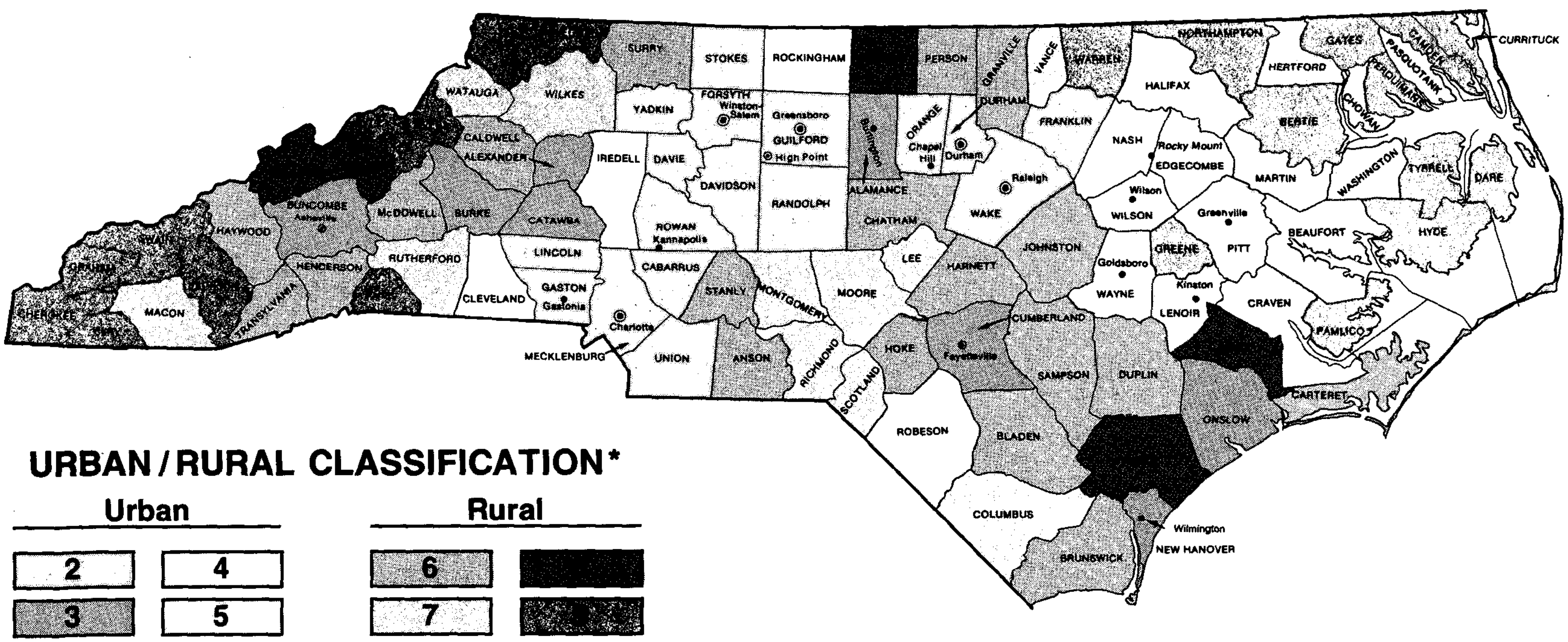
[5] Industries may have reduced employment for a number of reasons, not all of which indicate worsening sales, profits, or growth potential. In this article, however, any industry characterized by employment reduction will be termed a "contracting" industry and, conversely, any industry characterized by employment gains will be called an "expanding" industry.

Urban / Rural Classification of North Carolina Counties



* *See Table I for definitions.*

◉ Place of 100,000 or more inhabitants ⊙ Place of 500,000 tp 100,000 inhabitants • Place of 25,000 to 50,000 inhabitants

Dependence on Industries with Declining Employment (Contracting Industries)

In the United States, employment in six manufacturing industries declined more than 10 percent between 1980 and 1985, when the average decline in manufacturing employment was 5.2 percent. (See Table II.) The largest employment reduction, 29.6 percent, was in primary metals followed by textiles, which declined 17.6 percent.

Manufacturing employment in North Carolina increased slightly during the same period. Only in the textile industry did employment fall by more than 10 percent.

Table II provides little support for the argument that manufacturing jobs in contracting industries were located predominately in rural areas of North Carolina. Of the twelve industries that contracted nationally, only five comprised a greater percentage of manufacturing employment in the rural than in the urban counties. Also, only two of the six industries that experienced employment declines in North Carolina had relatively more manufacturing in rural counties. Therefore, the data in Table II suggest that rural counties in North Carolina were not more susceptible than urban counties to downturns between 1980 and 1985 because of a dependence on industries that contracted nationally.

Table II

CHANGES IN MANUFACTURING EMPLOYMENT FROM 1980 TO 1985 IN THE UNITED STATES AND NORTH CAROLINA AND THE PERCENTAGE DISTRIBUTION OF NORTH CAROLINA MANUFACTURING EMPLOYMENT WITHIN RURAL AND URBAN AREAS

Change in Jobs 1980-85			Proportion of Manufacturing Employment in North Carolina, 1985	
U.S.	NC		Urban	Rural
Declined More Than 10 Percent Nationally				
-29.6	28.7	Primary Metals	1.4	1.2
-17.6	-15.8	Textiles	24.3	28.7
-13.4	-4.7	Miscellaneous	0.8	0.6
-12.2	18.1	Nonelectrical Machinery	8.5	3.3
-11.8	7.2	Stone, Clay & Glass	2.3	2.8
-11.3	-3.2	Apparel	8.7	14.6
Declined Less Than 10 Percent Nationally				
-9.8	-4.7	Tobacco	3.9	0.6
-8.6	28.5	Rubber	4.0	2.9
-8.9	-1.4	Fabricated Metals	3.8	1.8
-6.4	2.6	Food	4.9	7.0
-6.0	-5.3	Chemicals	4.7	4.0
-1.8	5.6	Paper	2.0	4.0
Increased Nationally				
0.4	3.4	Lumber	3.2	7.5
1.2	6.6	Instruments	1.3	1.3
4.1	53.1	Transportation Equipment	3.1	1.7
4.5	18.2	Electronic Machinery	8.5	5.7
6.2	2.9	Furniture	10.3	10.2
13.3	29.3	Printing	3.9	1.4
-5.2	0.2	TOTAL MANUFACTURING	99.6*	99.6*

* Totals do not add to 100 because leather and petroleum are excluded. These two industries have relatively few employees in North Carolina.

Employment Losses by Industry Groups in Rural versus Urban Counties

To further examine the proposition that rural counties in North Carolina lost a relatively larger percent of manufacturing employment because of an unfavorable industrial mix, total changes in manufacturing employment by Beale code were examined for the three groups of industries identified in Table II. For example, shown in Table III under the column heading "declined more than 10 percent" are percent changes in employment for the following six industries: primary metals; textiles; miscellaneous; nonelectrical machinery; stone, clay, and glass; and apparel. With these groupings, one can determine if nationally contracting industries lost more employment in rural than in urban county classes in North Carolina.

The last two rows in Table III show that manufacturing employment in urban areas of North Carolina rose 1.3 percent from 1980 to 1985, while manufacturing employment in rural areas fell 2.3 percent. Manufacturing employment growth in rural counties, however, was actually stronger than in urban counties for industries that lost employment nationally. It was in the industries that gained employment nationally that employment growth in rural areas was slower.[6]

[6] The same conclusion was drawn when the mean changes in county manufacturing employment were considered by the industry groups shown in Table III and by Beale code. Larger standard deviations, however, were generally associated with the mean employment changes in the rural county classes.

Table III

PERCENTAGE CHANGES IN MANUFACTURING EMPLOYMENT FOR DESIGNATED INDUSTRY GROUPS BETWEEN 1980 AND 1985

		Industries Where National Manufacturing Employment		
Beale Code	Total Manufacturing	Declined More Than 10 Percent	Declined Less Than 10 Percent	Increased
	(Percentage Change in Manufacturing Employment)			
2	2.6	-8.0	15.3	18.7
3	2.8	-4.7	9.5	-4.8
4	-3.1	-11.2	13.2	21.7
5	-4.8	-13.5	16.3	-0.3
6	-3.2	-7.3	2.3	-0.7
7	-1.7	-0.6	7.8	-8.0
8	5.3	27.7	-29.4	11.0
9	-1.6	-10.0	93.3	-11.8
URBAN	1.3	-8.4	1.1	20.8
RURAL	-2.3	-4.2	9.2	-4.4

Employment Concentrations by Selected Industry

When the concentration of each industry's employment is considered, it appears that some of the nationally declining industries were more concentrated in rural counties. As Table IV shows, in 1980 over half of all manufacturing employment in six urban and ten rural North Carolina counties was in textiles, the industry that recorded the second largest employment decline nationwide. Also, more than 30 percent of the manufacturing employment in thirty-five North Carolina counties was in textiles, and twenty-one of these thirty-five counties were rural. As is also shown in Table IV, the apparel and lumber industries in North Carolina were relatively concentrated in rural counties.

The data thus indicate that while some individual rural counties might well have lost relatively more manufacturing employment as a result of the turbulent economic environment of the early eighties, such

Table IV

EMPLOYMENT CONCENTRATIONS AS A PERCENT OF THE COUNTY'S TOTAL MANUFACTURING EMPLOYMENT FOR SELECTED INDUSTRIES, 1980

	Number of Counties					
	30% or More of Total Employment		50% or More of Total Employment		80% or More of Total Employment	
	Urban	Rural	Urban	Rural	Urban	Rural
Food	0	5	0	0	0	0
Textiles	14	21	6	10	1	0
Apparel	1	15	0	9	0	1
Lumber	0	9	0	3	0	1
Furniture	4	3	1	1	0	0
Paper	0	3	0	0	0	0
Chemicals	1	2	0	1	0	1
Nonelectrical Machinery	1	4	0	0	0	0

losses were not generally characteristic of the rural counties of North Carolina.[7]

INFLUENCES FROM RAPID DOLLAR APPRECIATION

Analysts often associate the decline in rural manufacturing employment from 1980 to 1985 with the decline in the world demand for U.S. manufactured goods caused by the concurrent rapid dollar appreciation. For example, William H. Branson and James P. Love found that in the entire nation, ". . . the more *rural* the state, the more sensitive manufacturing employment in the state is to foreign trade."[8]

This section reports on a new attempt to see if the change in the foreign exchange value of the dollar did in fact affect manufacturing employment growth in North Carolina between 1980 and 1985. A single equation regression was used.

Regression Model

In an effort to capture the effect of increases in the exchange rate on manufacturing employment by county, a real exchange rate was created for each county, weighted to take account of the county's industry mix. Each county-specific exchange rate was calculated as a weighted average of real industry-specific exchange rates.[9] The weights were percentages of manufacturing employment in each county in 1980 at the 2-digit SIC level. (See the Appendix for the changes in the exchange rate between 1980 and 1985 for all counties in North Carolina.)

The change in the foreign exchange value of the dollar, which were county-specific and industry-weighted, was assumed to be inversely related to industry output and thus to manufacturing employment. As the dollar appreciates, for example, domestic goods become more expensive to foreigners and foreign goods become cheaper to U.S. consumers, all other things equal. The counties with industry mixes that showed the largest dollar appreciation thus were expected to show the largest reductions in manufacturing employment.

The Beale code of each county was also included in the regressions to test the hypothesis that rural areas suffered greater percentage losses in manufacturing employment than urban areas. The Beale code coefficient was expected to be inversely related to changes in manufacturing employment.

Regression Results

Separate regressions were run for counties that gained manufacturing employment and counties that lost employment. As shown in the box, the exchange rate variable was not found to be significant in either regression. In the regression of counties that lost manufacturing employment, only the Beale code variable was significant.[10]

The regression results thus provide no support for the notion that the changes in North Carolina's manufacturing employment from 1980 through 1985 resulted from increases in the exchange rate.

The Beale code coefficient was not significant in the regression of counties that gained manufacturing employment from 1980 to 1985, but it was significant and negative for the counties that experienced a loss in manufacturing employment. This result suggests that the rural-urban character of the county played a role in the manufacturing employment change only when counties lost jobs: when counties lost manufacturing employment, rural counties lost the larger percentage.

CHANGES IN EMPLOYMENT FOR THREE MAJOR INDUSTRIES

The regressions indicated that rural areas showed greater employment losses only among counties where employment declined. Therefore, the three manufacturing industries—textiles, apparel, and chemicals—in North Carolina that lost the most jobs between 1980 and 1985 are examined to see if the

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[7] For a study of rural-urban changes from 1980 to 1985 in manufacturing employment for all counties in the nation, see Dan M. Bechter and Christine Chmura, "The Competitiveness of Rural County Manufacturing During a Period of Dollar Appreciation," *Regional Science Perspectives*, forthcoming.

[8] William H. Branson and James P. Love, "The Real Exchange Rate and Employment in U.S. Manufacturing: State and Regional Results," National Bureau of Economic Research, Inc., Working Paper No. 2435 (1987), p. 16.

[9] The real industry-specific exchange rates were obtained from Kent Hill at the Federal Reserve Bank of Dallas.

[10] The regression models shown also included variables for manufacturing wage levels in 1980, education levels in 1980, and the change in manufacturing wages from 1980 to 1985. In the regression of counties that gained employment, only the change in wage variable was significant. When the regression was run with all counties—those whose employment increased and those whose employment decreased—problems were encountered with heteroscedasticity. After the data were weighted by the variance of the employment variable, the transformed model produced no statistically significant coefficients. In the original regression that was run with all counties, the exchange rate and the change in wage variables were significant at the 1 percent level.

Gains in Employment: 43 observations (t statistic in parentheses)

EMPL8085 =	Intercept +	Change in Exchange Rate +	Beale Code	$\bar{R}^2$
	−0.478	1.556	0.027	.35
	(−0.86)	(1.31)	(1.38)	

Losses in Employment: 57 observations (t statistic in parentheses)

EMPL8085 =	Intercept +	Change in Exchange Rate +	Beale Code	$\bar{R}^2$
	0.052	0.085	−0.021	.14
	(0.22)	(0.18)	(−2.65)	

declines in these particular industries affected the county's overall manufacturing employment. First, a brief overview of the most important forces that affected these industries from 1980-85 is presented. Then this section examines which Beale code classes lost the greatest proportion of jobs in the textile, apparel, and chemical industries (see Table V) and how these losses affected total manufacturing in the county.

Textiles

The textile industry was especially affected by the changing economic environment of the early to mid-1980s. The dollar volume of textile imports rose over 60 percent in real terms between 1980 and 1985. Perhaps because of pressures from foreign competitors, the textile industry underwent a consolidation. Many firms merged, downsized, or closed completely. Consequently, the number of textile firms in North Carolina dropped by 730 to about 12,000 in 1985.

As the textile firms became fewer, however, the remaining firms were becoming more productive. The textile industry made record amounts of capital expenditures in 1981, 1984, and 1985, and reduced employment substantially in the early 1980s. The technological improvements ultimately made the industry more competitive. As a result, the textile industry recorded record profits in 1986 and 1987.

Although 26 percent of all manufacturing jobs in North Carolina were in the textile industry in 1985, the loss of almost 40,000 textile jobs in the state between 1980 and 1985 caused surprisingly little change in the total manufacturing employment of its counties. Although thirteen of North Carolina's one hundred counties lost over 30 percent of their textile jobs, in none of those counties did those lost jobs exceed 2 percent of the county's total manufacturing employment. Moreover, four of the thirteen counties that lost textile jobs gained total manufacturing jobs from 1980 to 1985.

From 1980-85, while overall textile employment was falling in North Carolina, textile employment increased by more than 30 percent in eight counties, most of which were rural. In fact, textile jobs in one rural county increased by 550 workers. More-

Table V

EMPLOYMENT LOSSES IN TEXTILES, APPAREL, AND CHEMICALS, 1980-85

		Number of Counties					
		Lost More than 30% of Industry Jobs		Lost More than 80% of Industry Jobs		Gained More than 30% of Industry Jobs	
Industry	Total Jobs Lost	Rural	Urban	Rural	Urban	Rural	Urban
Textiles	39,807	4	9	2	2	6	2
Apparel	2,812	8	6	3	0	12	5
Chemicals	2,099	9	3	3	1	6	13

over, in Beale codes 8 and 9 textile employment increased 71 percent and 8 percent, respectively.

Textile industry employment fared somewhat better in North Carolina than it did nationally. United States employment declined 18 percent between 1980 to 1985, compared with a 16 percent decline in North Carolina. The relative advantage of the textile industry in North Carolina and its most rural counties may be due, in part, to its lower wages. According to a study of location decisions of manufacturers, relocations are ". . . often in response to a decline in sales or profits. Relocations will benefit relatively low-cost locations, especially areas which are seen as having low labor costs."[11] In 1985, the average annual income for textile workers in the nation was $15,956, compared with $14,396 in North Carolina and $12,222 in Beale codes 8 and 9. Textile wages in North Carolina, however, are higher than in 17 other states in the nation. Thus, the state's competitive advantage in textiles cannot be totally explained by low wages.

Apparel

The apparel industry employs about one-third as many persons in North Carolina as does textiles. Although national import penetration was stronger in the apparel industry than in textiles (the real dollar value of apparel imports doubled between 1980 and 1985), considerably fewer apparel jobs were lost in North Carolina: 2,310, compared with almost 40,000 jobs in textiles.

Fourteen counties in North Carolina lost more than 30 percent of their apparel jobs, and a little over half of these counties were rural. The decline in apparel jobs, however, was less than 2 percent of the counties' total manufacturing jobs in all but two counties where the apparel jobs lost were 5 percent of the counties' manufacturing employment. Six of these fourteen counties gained total manufacturing jobs during 1980 to 1985.

Twenty-two rural counties showed gains in apparel employment, as did fifteen urban counties. Moreover, gains in apparel employment exceeded 30 percent in seventeen North Carolina counties; most of which were rural, and apparel employment in two rural counties grew by more than 200 percent.

As in the textile industry, employment in the apparel industry in North Carolina fared better than that of the nation. National employment dropped 11 percent, but employment fell only 3 percent in North Carolina. In the case of North Carolina's two most rural classes (Beale codes 8 and 9), however, employment fell more than in the nation, 27 percent and 12 percent, but there was a gain of 759 apparel workers in the other two rural categories (Beale codes 6 and 7).

Wages could explain part of the relative gain in apparel jobs in North Carolina. Apparel workers in the nation received an annual average income of $12,569 in 1985, compared with $9,000 in North Carolina and $8,876 in its two most rural areas. Wage differentials, however, do not explain why Beale codes 6 and 7 recorded increases in employment while Beale codes 8 and 9, where wages were lower, showed declines. Perhaps the wage differential was so small that other factors such as access to better highway systems, proximity to textile plants, or availability of skilled labor caused apparel employment to grow faster in Beale codes 6 and 7.

Chemicals

Although the chemical industry accounted for only about 5 percent of North Carolina's manufacturing jobs, its employment in the state declined by 2,099 persons from 1980 to 1985. Most of the decline in jobs occurred from 1980 to 1983 because of two forces: 1) the output of three major sectors (transportation equipment, construction, and agriculture) that substantially affect the level of shipments of chemicals fell sharply throughout the nation, and 2) oil, which is used in producing many chemical products, fluctuated widely in price, rising more than 15 percent between 1980 and 1981.

Even though two-thirds of North Carolina's chemical output was synthetics and plastics instead of the more recession-resistant drugs and cleaning products, employment in the chemical industry in North Carolina contracted 5 percent from 1980 to 1985, compared with 6 percent in the nation. The largest employment losses occurred in rural areas. Nine of the twelve counties where employment declined more than 30 percent were rural. In three rural counties, chemical jobs declined more than 80 percent. In none of these counties, however, was the loss in chemical jobs more than 1 percent of all manufacturing jobs.

The largest percentage gains in chemical industry employment were located in urban areas. Thirteen of the nineteen counties in which chemical industry employment increased more than 30 percent from 1980 to 1985 were urban. Some rural areas had large employment gains, however. In one rural county, for example, chemical employment increased from six to eight hundred forty-one workers from 1980-85 and in another it increased from one to seventy-three workers.

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[11] Eva Mueller and James N. Morgan, "Location Decisions of Manufacturers," *American Economic Review* 52 (May 1962): 215.

Similar to the textile and apparel industries, the competitive advantage of the North Carolina chemical industry may be a result of its relatively low wages. North Carolina's annual average wage in the chemical industry in 1985 was $20,563 compared with $30,699 for the United States (North Carolina ranks 14th).

Conclusions

Manufacturing employment in North Carolina rural areas declined 2 percent from 1980 to 1985, compared with a gain of 1 percent in urban areas. Not all rural counties were equally harmed by the turbulent economic environment that existed during this period, however, and manufacturing employment declined in only a small number of rural counties.

Most rural counties were not at a competitive disadvantage to urban counties because of an unfavorable industrial mix, but there were exceptions. Rural areas as a whole did not hold a greater proportion of the nationally declining industries but some rural counties were comprised of a greater proportion of declining industries, particularly textiles. Moreover, a regression analysis suggested that movements in the foreign exchange value of the dollar between 1980 and 1985 did not have a statistically significant effect on changes in manufacturing employment in North Carolina counties. Among counties experiencing declines in manufacturing employment, however, the regression results suggested that rural counties experienced greater losses than urban counties.

The case studies of the textile, apparel, and chemical industries in North Carolina indicated that wages within the state, and especially within its rural areas, were much lower than the national average. In some industries, this wage differential may have been a factor that gave North Carolina a competitive edge, allowing the state to grow in spite of the vicissitudes of the early 1980s. Other factors that may also have played a role in North Carolina's employment growth include: state and county policies such as low taxes and high education expenditures as well as a favorable business climate.[12]

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[12] North Carolina was rated in the top 10 states in the nation for its favorable manufacturing climate for each year from 1981 through 1985 according to Alexander Grant & Company, *General Manufacturing Climates of the Forty-Eight Contiguous States of America* (Chicago: Alexander Grant & Company), various issues.

APPENDIX

Percent Increase in North Carolina Real County-Specific Exchange Rates 1980-85

Alamance	39.84	Johnston	36.69
Alexander	32.74	Jones	38.33
Alleghany	42.69	Lee	36.37
Anson	40.44	Lenoir	40.39
Ashe	33.86	Lincoln	38.00
Avery	37.63	McDowell	39.45
Beaufort	36.85	Macon	35.18
Bertie	36.93	Madison	33.09
Bladen	35.39	Martin	30.81
Brunswick	41.69	Mecklenburg	36.40
Buncombe	36.14	Mitchell	35.69
Burke	36.33	Montgomery	39.27
Cabarrus	42.02	Moore	37.44
Caldwell	32.93	Nash	38.25
Camden	28.02	New Hanover	35.52
Carteret	31.71	Northampton	33.25
Caswell	41.23	Onslow	35.94
Catawba	34.85	Orange	33.22
Chatham	37.67	Pamlico	37.96
Cherokee	35.30	Pasquotank	30.68
Chowan	35.15	Pender	35.20
Clay	40.92	Perquimans	39.69
Cleveland	39.21	Person	38.43
Columbus	33.54	Pitt	38.27
Craven	31.80	Polk	40.11
Cumberland	34.95	Randolph	36.15
Currituck	34.16	Richmond	39.10
Dare	47.73	Robeson	37.70
Davidson	33.86	Rockingham	41.09
Davie	36.02	Rowan	38.76
Duplin	39.33	Rutherford	39.16
Durham	38.84	Sampson	39.39
Edgecombe	37.84	Scotland	38.24
Forsyth	39.76	Stanly	38.75
Franklin	34.84	Stokes	37.59
Gaston	39.61	Surry	39.72
Gates	26.10	Swain	37.32
Graham	32.94	Transylvania	31.47
Granville	39.17	Tyrrell	30.42
Greene	38.71	Union	36.56
Guilford	37.26	Vance	40.09
Halifax	35.56	Wake	34.50
Harnett	37.54	Warren	33.96
Haywood	28.34	Washington	35.43
Henderson	35.12	Watauga	33.18
Hertford	34.44	Wayne	35.76
Hoke	40.98	Wilkes	36.75
Hyde	36.82	Wilson	38.05
Iredell	36.60	Yadkin	38.77
Jackson	36.95	Yancey	39.37