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CONTENTS

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Inflation, Unemployment, and Money: Comparing the Evidence from Two Simple Models

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TWO years ago, Professors Barro and Fischer introduced their survey of monetary theory with the following statement:

> Perhaps the most striking contrast between current views of money and those of thirty years ago is the rediscovery of the endogeneity of the price level and inflation and their relation to the behavior of money.[1]

This assessment contrasts sharply with that of the Council of Economic Advisers in their 1978 *Annual Report*.[2] In a forty-one page chapter on inflation and unemployment, there are only two oblique references to monetary policy as a contributing factor to the inflationary process.

The theory of inflation that underlies the Council's discussion is conventional — inflation is usually initiated by excess demand, but once the momentum builds up, "the rate of wage and price increase reacts very slowly to idle resources and excess supply."[3] The Council believes there is a trade-off between inflation and unemployment, but rejects the terms of the trade-off as too costly. They argue that

> . . . it would take at least 6 years of the current degree of economic slack (an unemployment rate near 6½ percent) to cut the inflation rate from 6 to 3 percent.[4]

Consequently, the Council's recommended strategy for inflation control is one of "voluntarism", jawboning, and structural improvements. Implicit in this strategy is a stabilization policy stimulative enough to propel the economy to high employment and full utilization of capacity.[5]

The Council's strategy for economic policy rests on a belief in the inflation-unemployment trade-off and a neglect of money. In particular, the apparent current policy strategy is reminiscent of that applied in August 1971 when the price-wage freeze was introduced. At that time the same thinking prevailed — hold prices down directly and reduce unemployment via expansionary monetary and fiscal policy.[6]

[1]Robert J. Barro and Stanley Fischer, "Recent Developments in Monetary Theory," *Journal of Monetary Economics* (April 1976), p. 133.

[2]*Economic Report of the President*, 1978, pp. 138-78.

[3]Ibid., p. 150.

[4]Ibid.

[5]Ibid., pp. 73-75, 152-56.

[6]*Economic Report of the President*, 1972, pp. 22-27.

The purpose of this article is to demonstrate that the apparent trade-off between inflation and unemployment is in fact the result of variable monetary growth. The approach draws heavily on recent work by Professor Stein of Brown University.[7] The appearance of a trade-off results from differences in the timing of the response of inflation and unemployment to changes in monetary growth. However, the trade-off is an illusion. Unemployment responds to monetary growth in the short run, but tends towards a steady-state value in the long run. Effects of monetary growth on inflation are just the opposite; there is little effect in the short run, with the full and permanent effect coming in the long run. These processes have implications that are strongly at variance with those advocated by the Council of Economic Advisers.

The Relation Between Inflation and Unemployment: The Conventional View and Modifications

The relation between inflation and unemployment is usually depicted by the Phillips curve.[8] According to this relationship, high rates of inflation are associated with low rates of unemployment; likewise, low inflation rates are associated with high unemployment rates. Within recent years, however, experience in the United States and other countries has run counter to the prediction of the original relation. In particular, there have been times that inflation and unemployment have moved in the same direction, a phenomenon that has been labeled "stagflation." Economists have reacted to this experience by augmenting Phillips curve theory with consideration of the effects of inflationary expectations.[9]

Lately, the Phillips curve discussion has taken yet another twist. Some economists have suggested that accelerations and decelerations of inflation are related

[7]Jerome L. Stein, "Inflation and Stagflation," forthcoming in *Journal of Banking and Finance*, and "Inflation, Employment and Stagflation," *Journal of Monetary Economics* (April 1978), pp. 193-228.

[8]The original analysis is found in A. W. Phillips, "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957," *Economica* (November 1958), pp. 283-99.

[9]For a survey of the Phillips curve literature, see Robert J. Gordon, "Recent Developments in the Theory of Inflation and Unemployment," *Journal of Monetary Economics* (April 1976), pp. 185-220.

to the level of unemployment. For example, according to Modigliani and Papademos,

> . . . historical experience clearly supports the proposition that there exists some *critical* rate of unemployment such that, as long as unemployment does not fall below it, inflation can be expected to decline. . . .[10]

They go on to refer to this critical unemployment rate as the noninflationary rate of unemployment (NIRU). In this case, "noninflationary" is defined to mean that the rate of inflation, at whatever level, is not increasing.

The value of NIRU can be derived from an estimate of the following simple relation:[11]

$$p_t - p_{t-1} = \alpha_0 + \alpha_1 U_{t-1}$$

The symbol p is the year-to-year percent change in the GNP deflator and U is the unemployment rate. Using annual data from 1952 to 1976, this equation is estimated as

$$(1)\quad p_t - p_{t-1} = \underset{(1.970)}{2.463} - \underset{(-1.894)}{.453\, U_{t-1}} \qquad \begin{array}{l} R^2 = .15 \\ SE = 1.41 \\ DW = 1.79 \end{array}$$

Since the dependent variable is a second difference, there is considerable variation in it. The unemployment rate explains only a small portion of this variation, although both the coefficients in the equation are significant at the ten percent level (t statistics are shown in parentheses).

Since NIRU is defined as that rate of unemployment which is consistent with nonaccelerating inflation, its value can be found by setting $p_t - p_{t-1} = 0$ in equation (1) and solving for U. The value of NIRU for this estimated equation is 5.44 percent.

This estimate of equation (1) is consistent with the Council of Economic Advisers' assessment of the terms of the inflation-unemployment trade-off in their 1978 *Annual Report*. A 6.5 percent unemployment rate was used as an example of sufficient slack in the economy such that a deceleration of inflation of 0.5 percent per year would be generated. Substituting 6.5 into equation (1) yields a decline in p of 0.48 percentage points per year.

By way of comment, it should be noted that this model does not indicate how a particular rate of inflation or rate of unemployment is attained. Rather, the equation simply shows how inflation will change, given the degree of slack in the economy as measured by the unemployment rate. To complete the model, an equation specifying the determination of the unemployment rate would have to be added. In this way the effect of monetary and fiscal policy could be captured via the effect on the unemployment rate.

The Relation Between Inflation and Unemployment: A Monetary View

An alternate view of the relation between inflation and unemployment is that both variables are responding to the movements of a third variable. To the extent that there appears to be a relationship between movements in prices and unemployment, it is in fact a reflection of differential time responses to changes in the third variable. This is the monetary view, which stresses the long-run relation between money and prices, but also takes into account transitory effects of money on real product growth and unemployment.

According to the monetary view, shifts in the short-run Phillips curve are associated with changes in the growth rate of money. The hypothesis is that the *fundamental* determinant of the inflation rate is the rate of monetary expansion. Regardless of the initial conditions, the inflation rate will tend to converge to the rate of monetary growth, and the unemployment rate will tend toward its steady state value. This steady state value is not, however, related to the NIRU concept mentioned above. In fact, the monetary interpretation denies the validity of the NIRU argument.

In an attempt to keep the analysis simple, another single equation is specified as representative of the monetary view. Like Equation (1), the focus is on accelerations and decelerations of inflation. According to the monetary view, inflation will accelerate if money growth exceeds the ongoing inflation rate for an extended period of time (approximately one year). This simple representation of the monetary view appears as follows:

$$p_t - p_{t-1} = \beta_0 + \beta_1(m_{t-1} - p_{t-1})$$

Symbols are as defined above, with the addition of m, the year-to-year percent change in the narrowly defined money stock (M1).

Estimating this equation for the period 1954 to 1976, using annual data, yields the following:[12]

$$(2)\quad p_t - p_{t-1} = \underset{(4.106)}{.449\,(m_{t-1} - p_{t-1})} \qquad \begin{array}{l} R^2 = .43 \\ SE = 1.13 \\ DW = 1.93 \end{array}$$

[10] Franco Modigliani and Lucas Papademos, "Monetary Policy for the Coming Quarters: The Conflicting Views," *New England Economic Review* (March/April 1976), p. 4.

[11] The Modigliani-Papademos approach to estimating NIRU is much more convoluted. For a critique of the Modigliani-Papademos results, see Stein, "Inflation, Employment and Stagflation."

[12] β_0 was not significant, so the equation was reestimated without the constant.

These results indicate that inflation will accelerate by 0.45 of a percentage point in each year following that in which money growth exceeds the inflation rate by one percentage point. Based on the specification of this equation, inflation will not accelerate or decelerate if the money growth rate equals the inflation rate. Comparing the monetary equation with the conventional equation indicates that the monetary equation explains a larger proportion of the variation in $p_t - p_{t-1}$, and the standard error of the equation is reduced by 20 percent.

Suppose now that both views have merit. Can the rate of monetary expansion and the unemployment rate be used to explain accelerations and decelerations of inflation? To investigate this possibility, the following version was estimated:

$$p_t - p_{t-1} = \gamma_0 + \gamma_1 (U_{t-1} - U_E) + \gamma_2 (m_{t-1} - p_{t-1})$$

The value of the critical unemployment rate, as calculated from Equation (1), was inserted into the equation as U_E. Again, using annual data from 1952 through 1976, the following results were obtained:

$$(3)\quad p_t - p_{t-1} = \underset{(.004)}{.001} - \underset{(-.826)}{.177}\,(U_{t-1} - 5.44) + \underset{(3.301)}{.406}\,(m_{t-1} - p_{t-1})$$

$R^2 = .45$, SE = 1.16, DW = 1.99

For this specification of the equation, supposedly allowing for both conventional and monetary effects, neither the unemployment rate nor the constant are significant. However, the monetary variable remains significant, although the value of the coefficient is slightly less than in (2). The R^2 and standard error are only slightly changed from (2).

The implication of these results is that accelerations and decelerations of inflation are not systematically related to the degree of resource utilization as measured by the unemployment rate. Restricting the analysis to very simple models, changes in the rate of inflation are much more closely associated with monetary growth, with no independent effect coming from the unemployment rate.

What does the monetary view say about the determination of the unemployment rate? The monetary view recognizes short-run impacts of money on output and employment. This relationship can be specified as:

$$U_t - U_{t-1} = \delta_0 + \delta_1 U_{t-1} + \delta_2 (m_{t-1} - p_{t-1})$$

This equation is simply a distributed lag response of the unemployment rate, U, to monetary growth. There is a transitory effect of money on unemployment when monetary growth is greater or less than the inflation rate. Over the long run, however, steady monetary growth has no effect on unemployment because, according to equation (2), monetary growth and inflation are the same in equilibrium. As a result, the $m_{t-1} - p_{t-1}$ term goes to zero and the equilibrium unemployment rate is determined by δ_0 and δ_1.

The estimated unemployment equation for the period 1954-76 is as follows:

$$(4)\quad U_t - U_{t-1} = \underset{(5.079)}{3.958} - \underset{(-4.862)}{.721}\,U_{t-1} - \underset{(-4.466)}{.380}\,(m_{t-1} - p_{t-1})$$

$R^2 = .61$, SE = .80, DW = 1.57

The implied steady state value for the unemployment rate, found by setting $U_t = U_{t-1}$, is 5.49 (that is, $3.958 \div .721$), essentially the same result as in equation (1). The interpretation of this equation is that money growth in excess of the inflation rate has a temporary effect on unemployment, but this effect disappears as the inflation rate converges to the growth rate of money in the long run. The steady state unemployment rate for the monetary view differs from NIRU in that inflation can accelerate even if the unemployment rate is in excess of its critical value.

Policy Implications

The policy implications of these two views of the relation between inflation and unemployment differ substantially. The concept of NIRU suggests that policymakers need not consider inflation a problem until unemployment approaches this critical value. On the other hand, the monetary view stresses the effect of excessive monetary growth on inflation, independent of the prevailing unemployment rate. The lesson of the monetary view is that, in the long run, a steady growth of money will eventually result in a rate of inflation equal to that of monetary growth, and a rate of unemployment that will go to its steady state value. Only by constantly accelerating monetary growth is it possible to use monetary actions to reduce unemployment.

Consider the two views in terms of conditions as they exist in 1978. The inflation rate for 1977 over 1976 was 5.9 percent, and the unemployment rate in 1977 averaged 7 percent. The conventional view argues that inflation will not accelerate as long as unemployment stays above 5.44 percent. Consequently, it appears that output can be stimulated until the critical unemployment rate is reached. Then the stimulus can be reduced to a rate commensurate with long-term growth. The monetary view, on the other hand, indicates that money growth in excess of the ongoing inflation rate can lead to an acceleration in inflation

Table I

HYPOTHETICAL CASE A: CONVENTIONAL VIEW
Attempted Gradual Return to Full Employment

(1) $p_t - p_{t-1} = 2.463 - .453\ U_{t-1}$
(2) $U_t - U_{t-1} = -.412(x_t - 3.5)$

	x	U	p	y	m
1977 (Act.)	4.9%	7.0%	5.9%	11.0%	7.2%
1978	4.7	6.5	5.2	10.1	6.6
1979	4.7	6.0	4.7	9.6	6.1
1980	4.7	5.5	4.5	9.4	5.9
1981	3.7	5.4	4.4	8.2	4.7
1982	3.5	5.4	4.4	8.0	4.5
1983	3.5	5.4	4.4	8.0	4.5
1984	3.5	5.4	4.4	8.0	4.5
1985	3.5	5.4	4.4	8.0	4.5

Note: A path for U was selected and then the path of p was calculated using equation (1). The U path was used to derive the implied x (the growth rate of output), assuming potential output grows at 3.5 percent per year. The x and p paths were then used to derive y (the growth rate of nominal GNP), and then assuming velocity growth of 3.5 percent per year, the path of m was derived.

even if the unemployment rate is above its critical value.

Two different policy paths for the conventional model are shown in Tables I and II. Table I summarizes a policy directed toward a gradual return to full employment (NIRU) by 1980, and Table II shows an attempt to reach full employment quickly — in 1978. These cases were constructed by selecting a target path for unemployment and then calculating the effect of unemployment on inflation using Equation (1). An Okun's Law[13] equation (See equation (2), Table I) was added to the model to find the growth of output consistent with the unemployment path. By adding together the rates of increase in output and the price level the implied growth of nominal GNP was calculated as a step towards deriving the growth rate of money consistent with the path of the other variables.[14]

According to Table I, based on a gradual return to full employment, inflation and unemployment decline simultaneously until 1980, and then stabilize. By adding an assumption of constant velocity growth of 3.5 percent to the conventional model, steady state rates

[13]Arthur M. Okun, "Potential GNP: Its Measurement and Significance," *The Political Economy of Prosperity* (Washington, D.C.: The Brookings Institution, 1970), pp. 132-45.

[14]This is based on the following:

$$m + v = p + x$$

where m: rate of increase in money
v: rate of increase in velocity
p: rate of increase in the price level
x: rate of increase in output.

Table II

HYPOTHETICAL CASE B: CONVENTIONAL VIEW
Attempted Rapid Return to Full Employment

(1) $p_t - p_{t-1} = 2.463 - .453\ U_{t-1}$
(2) $U_t - U_{t-1} = -.412(x_t - 3.5)$

	x	U	p	y	m
1977 (Act.)	4.9%	7.0%	5.9%	11.0%	7.2%
1978	7.4	5.4	5.2	13.0	9.5
1979	3.5	5.4	5.2	8.9	5.4
1980	3.5	5.4	5.2	8.9	5.4
1981	3.5	5.4	5.2	8.9	5.4
1982	3.5	5.4	5.2	8.9	5.4
1983	3.5	5.4	5.2	8.9	5.4
1984	3.5	5.4	5.2	8.9	5.4
1985	3.5	5.4	5.2	8.9	5.4

Note: See Table I.

of monetary growth and inflation are also derived. These steady state rates appear little different than those for the monetary model. However, the path to this equilibrium differs substantially.

According to Table II, also based on the concept of NIRU, there appears to be no obstacle to returning to full employment quickly. The difference between the results in Tables I and II is that a quick return to full employment "locks" the model in at a higher growth rate of money and inflation than does the gradual approach. The reason for this disparity of results for the conventional model is that the attempted quick return to full employment allows the effect of unemployment on inflation to operate for only one year.

Table III

HYPOTHETICAL CASE A: MONETARY VIEW
Attempted Gradual Return to Full Employment

(1) $p_t - p_{t-1} = .449\ (m_{t-1} - p_{t-1})$
(2) $U_t - U_{t-1} = 3.958 - .721\ U_{t-1} - .380\ (m_{t-1} - p_{t-1})$

	x	U	p	y	m
1977 (Act.)	4.9%	7.0%	5.9%	11.0%	7.2%
1978	3.4	5.4	6.5	10.1	6.6
1979	2.9	5.4	6.5	9.6	6.1
1980	2.9	5.6	6.3	9.4	5.9
1981	2.0	5.7	6.1	8.2	4.7
1982	2.4	6.1	5.5	8.0	4.5
1983	2.8	6.0	5.0	8.0	4.5
1984	3.1	5.8	4.8	8.0	4.5
1985	3.2	5.7	4.7	8.0	4.5

Note: The path of m was taken from Table I and the path of p was calculated from equation (1). Given m and p, the U path was then calculated from equation (2). The y path from Table I and the p path were used to calculate an implied x.

Compare these results with those implied by the monetary model of inflation and unemployment. Using the growth rates of money derived for the conventional model in Tables I and II, the paths for inflation and unemployment for the monetary model are traced out in Tables III and IV. According to Table III, attempting a gradual return to full employment can be accomplished, but in the early stages there is an acceleration of inflation rather than the deceleration predicted by the conventional model. In 1980, inflation decelerates in response to the slowing in the growth rate of money. However, unemployment also rises again before the steady state is finally approached in 1984 and 1985.

Table V

ALTERNATIVE CASES: MONETARY VIEW
Rapid Return to Steady Money Growth

(1) $p_t - p_{t-1} = .449\ (m_{t-1} - p_{t-1})$

(2) $U_t - U_{t-1} = 3.958 - .721\ U_{t-1} - .380\ (m_{t-1} - p_{t-1})$

	2% Money Growth		4% Money Growth		6% Money Growth		8% Money Growth	
	p	U	p	U	p	U	p	U
1977 (Act.)	5.9%	7.0%	5.9%	7.0%	5.9%	7.0%	5.9%	7.0%
1978	6.5	5.4	6.5	5.4	6.5	5.4	6.5	5.4
1979	4.5	7.2	5.4	6.4	5.9	5.7	7.2	4.9
1980	3.4	6.9	4.8	6.3	5.9	5.5	7.5	5.0
1981	2.8	6.4	4.4	6.0	5.9	5.5	7.7	5.2
1982	2.4	6.1	4.2	5.8	6.0	5.4	7.9	5.3
1983	2.2	5.8	4.1	5.6	6.0	5.5	7.9	5.4
1984	2.1	5.7	4.1	5.6	6.0	5.5	7.9	5.4
1985	2.1	5.6	4.0	5.6	6.0	5.5	7.9	5.4

Examination of the other case (Table IV) — an attempted quick return to full employment — indicates severe oscillations in inflation and unemployment before the steady state is approached. The unemployment target is overshot, and the rapid growth in money in 1978 has its effect on the inflation rate for several years.

To explore in greater depth the implications of the monetary view, alternative simulations of steady growth rates of money are shown in Table V. In each case, the steady-state rate of monetary growth is begun in 1978. According to these simulations, there appears to be little prospect for reducing the inflation rate from its 1977 value without incurring a period of rising unemployment during the interim. However, the policies of inflation control (2 and 4 percent money growth) show that once the period of rising unemployment is weathered, both inflation and unemployment decline from their 1977 values toward their steady-state values.

Table IV

HYPOTHETICAL CASE B: MONETARY VIEW
Attempted Rapid Return to Full Employment

(1) $p_t - p_{t-1} = .449\ (m_{t-1} - p_{t-1})$

(2) $U_t - U_{t-1} = 3.958 - .721\ U_{t-1} - .380\ (m_{t-1} - p_{t-1})$

	x	U	p	y	m
1977 (Act.)	4.9%	7.0%	5.9%	11.0%	7.2%
1978	6.1	5.4	6.5	13.0	9.5
1979	1.0	4.3	7.8	8.9	5.4
1980	2.1	6.1	6.7	8.9	5.4
1981	2.6	6.1	6.1	8.9	5.4
1982	2.9	6.0	5.8	8.9	5.4
1983	3.1	5.8	5.6	8.9	5.4
1984	3.2	5.6	5.5	8.9	5.4
1985	3.2	5.6	5.5	8.9	5.4

Note: See Table III except that the paths for m and y are taken from Table II.

Conclusions

The Administration has taken an approach to controlling inflation that is predicated on the assumption that economic slack is a factor in determining the inflation rate. In particular, the direct approach to inflation control has been chosen by the Administration because the terms of the trade-off between inflation and unemployment are deemed unacceptable.

Policy based on this type of reasoning is potentially disruptive. According to the simple monetary model used here, attempts to stimulate output with expansionary monetary policy will have accompanying effects on inflation, despite apparent slack in the economy. Even though there is a similarity in long-run targets, substantially different paths to this equilibrium are derived, depending on which model is used and how fast the policymakers hope to achieve their targets.

Does the Stage of the Business Cycle Affect the Inflation Rate?

JOHN A. TATOM

WITH the U.S. economy well into its fourth year of expansion and approaching high rates of resource employment, renewed fears of accelerating inflation have surfaced. One source of such concern is the widely held view that the rate of inflation is a cyclical phenomenon, falling during recessions and rising as the economy approaches a cyclical peak. According to this explanation, inflation is influenced by the degree of slack in markets for goods, services, and resources. When there are ample supplies of unused resources available, price pressures are presumed to diminish. Similarly, the inflation rate is believed to accelerate as high employment conditions arise. During such periods, resource availability becomes more limited and firms, competing for scarce resources to meet growing demand for their products, bid up resource prices and consequently product prices.[1]

Such an explanation has considerable appeal since it appears to be based upon standard supply-demand considerations, but the analysis is incomplete and its use for explaining inflation is limited. The explanation obscures the nature of the inflationary process, fostering confusion about the cause of inflation and, more important, confusion over appropriate Government policies.

An alternative view contends that inflation results from a sustained rate of growth in the money stock which exceeds the growth rate of the quantity of money demanded by the nation's wealth owners. While the focus of this view is on the economy's rate of monetary expansion, it leaves open the possibility that in the short run, slack, or its absence, can exert an additional independent influence on the rate of inflation. The analysis below indicates that such an independent causal link between slack and the inflation rate is not supported by recent experience, once the rate of monetary expansion is taken into account. An apparent relationship between the rate of inflation and the extent of slack in resource and goods markets can easily arise, however. When monetary growth is procyclical, the timing of the impact of changes in monetary growth on the extent of capacity utilization *and* on the inflation rate can give rise to such observations.

For example, a recession can be caused by a slowing of the growth rate of the money stock. Such a slowdown in money growth, if sufficiently sharp and maintained, will reduce the growth rate of total spending for final goods and services, expectations of inflation, and the rate of inflation. As a consequence, increased slack (temporarily) and reduced inflation will both be observed, but each is solely the result of the pattern of money growth. There need be no independent causal relationship between economic slack and the inflation rate.

Similarly, an acceleration in monetary growth can cause a temporary reduction in slack in the economy while fueling the longer-term trend rate of growth of the money stock and, consequently, the inflation rate. Such a sequence of events would ensure that an acceleration in the rate of inflation, as well as tighter markets for resources, goods, and services, would be observed at about the same time, but again solely as a consequence of the pattern of money growth.

THE EVIDENCE FROM POSTWAR RECESSIONS

Slack is not a well defined economic concept, but it refers to conditions in which existing resources are not utilized to the extent associated with "full employment." Such underutilization is typically represented by a higher unemployment rate or a lower

[1]Such an explanation is part of the rationale for an impending acceleration in inflation predicted by Irwin L. Kellner, *Business Report*, Manufacturers Hanover Trust, Spring 1978. The view that slack, or the lack of it, influences the outlook for the inflation rate has also been expressed recently by Lindley H. Clark, Jr. "How Much Slack?", *The Wall Street Journal*, May 2, 1978 and in "The Labor Market May Be Breeding Inflation," *Business Week*, July 31, 1978, pp. 93-94. Such analysis also plays a crucial role in the Council of Economic Advisers' recent discussion of the inflation problem. See *Economic Report of the President*, 1978, pp. 149-50, 168-72.

Table I

Inflation Rate and Postwar Recessions
(Compound Annual Rates of Change of the GNP Deflator)

	IV/48-IV/49	III/53-II/54	III/57-II/58	II/60-I/61	IV/69-IV/70	IV/73-I/75
Inflation Rate During:						
Year Prior to Peak	4.1%	1.9%	3.4%	1.6%	5.3%	7.5%
Recession (Peak to Trough)	−2.0	1.5	.9	.6	5.1	11.0
Year Following Recession	5.2	1.7	2.5	1.9	4.7	5.8

utilization rate of manufacturing plant and equipment than the rates achieved during economic booms. Even without a precise definition, however, most observers would agree that during a recession the economy has sufficient resources available at existing resource prices to produce goods and services at a faster rate than is observed. During the early periods of economic recovery following a recession, more slack would be present than during the peak period before the recession. Thus, some evidence on the relationship between the degree of economic slack and inflation can be obtained by looking at the inflation rate which existed before, during, and after the six postwar U.S. recessions. If inflation is a cyclical phenomenon, rising and falling with the pace of economic activity, then the inflation rate should be greatest during the period immediately *prior* to a cyclical peak, and lower during the recession and subsequent recovery period.

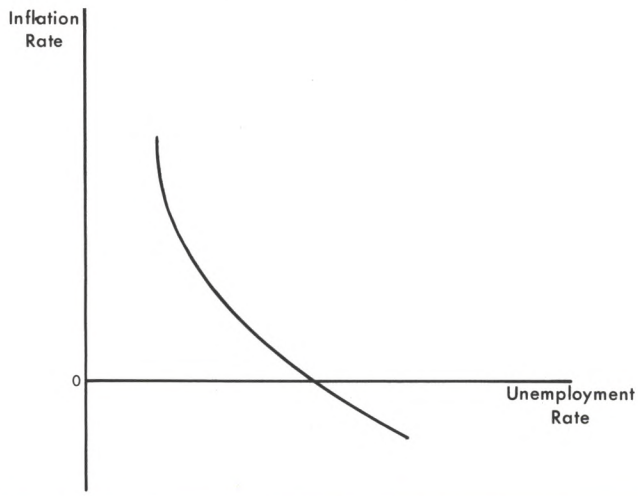
In fact, the evidence from the four postwar recessions prior to the 1970s appears to be fairly consistent with the cyclical view (Table I). In each case, inflation was not a significant problem during the recession, averaging no more than a 1.5 percent annual rate. In the first recession (1948-49), prices actually fell, on average. Also in each case, the rate of inflation was lower than in the year prior to the recession. A comparison of the inflation rate in the year following a recession with that prevailing prior to the recession yields mixed results. In two of the first four recessions, prices rose slower after the recession than they did before the recession, and in two cases they rose faster following the recession.

In contrast, the rate of inflation was relatively high during the two most recent recessions. Nonetheless, even these experiences appear to offer some evidence supporting the cyclical view. In the 1969-70 recession, the inflation rate slowed slightly during the recession and in each of the two cases, the inflation rate was lower in the year following the recession than it had been in the year preceding the recession. While the postwar evidence is not compelling, it does, in the majority of cases, appear to be consistent with the cyclical view of inflation.

THE CYCLICAL VIEW OF INFLATION

The cyclical view is embodied in what is referred to as the "Phillips Curve," which indicates a trade-off relationship between the rate of inflation and the unemployment rate such as that shown in Figure I.[2] The existence of such a trade-off means that policymakers can only choose among the available combinations of unemployment and inflation in setting policies. In the cyclical context, it is clear from Figure I that the lower unemployment rate associated with a cyclical peak requires a higher inflation rate,

Figure I
The Phillips Curve



[2]See A. W. Phillips, "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957," *Economica* (November 1958), pp. 283-99, and Richard G. Lipsey, "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1862-1957: A Further Analysis," *Economica* (February 1960), pp. 1-31. The original analysis was stated in terms of a wage inflation-unemployment rate trade-off. This was quickly translated into a price inflation-unemployment rate trade-off by assuming that prices of goods and services are a constant mark-up over wage costs.

while a lower inflation rate occurs only when the unemployment rate is higher, such as during a recession.

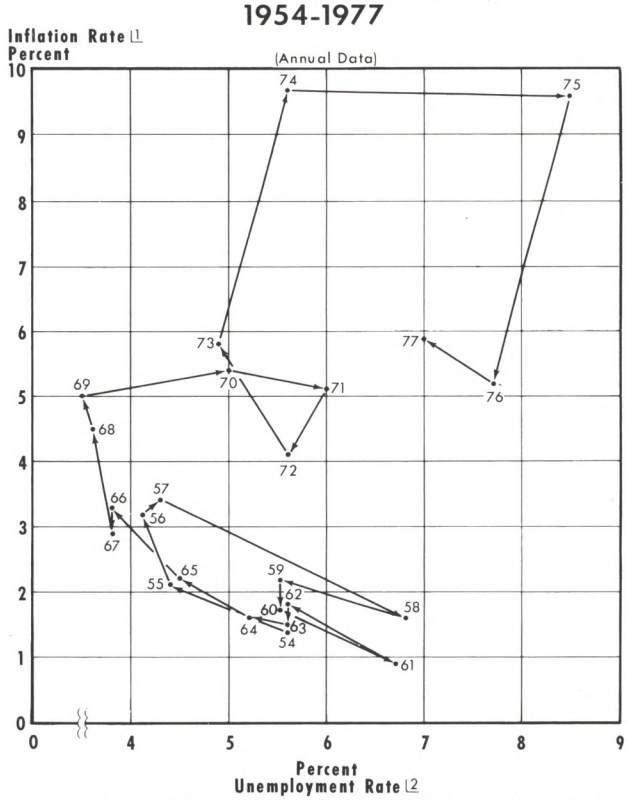
During the decade of the 1960s, such a trade-off was believed by many observers to be stable and to arise from the application of supply and demand analysis to the market for labor services. In the past decade, however, it has become increasingly uncertain that such a stable empirical relationship exists. Chart I shows the combinations of the annual inflation rate and unemployment rate for the United States from 1954 to 1977. From 1954 to 1969 the hypothesized relationship appears to exist and to be fairly stable. The gyrations of inflation and unemployment in the seventies, however, eliminate confidence in the existence and stability of the Phillips Curve.

Moreover, a considerable literature has developed since the late 1960s on the factors which influence the Phillips Curve, and views concerning it have changed markedly.[3] The most notable developments concern the "natural rate hypothesis" and the "expectations-adjusted Phillips Curve." The natural rate hypothesis indicates that in the long run the Phillips Curve is vertical at a "natural" unemployment rate where unemployment is associated with only frictional and structural characteristics of labor markets. The expectations adjustment allows the short-run Phillips Curve to shift in response to changing expectations concerning the inflation rate.[4]

These two developments are represented in Figure II where the long-run Phillips Curve is indicated at the natural unemployment rate U_n, and the short-run Phillips Curve is drawn as before, but its position can shift in response to changes in the expected rate of inflation, π^*. Unlike the earlier trade-off view, the dynamics of inflation and unemployment adjustment

Chart I

Inflation and Unemployment 1954-1977



Sources: U.S. Department of Commerce and U.S. Department of Labor

[1] Percentage Change in the GNP Implicit Price Deflator.

[2] Percent of Civilian Labor Force.

Latest data plotted: 1977

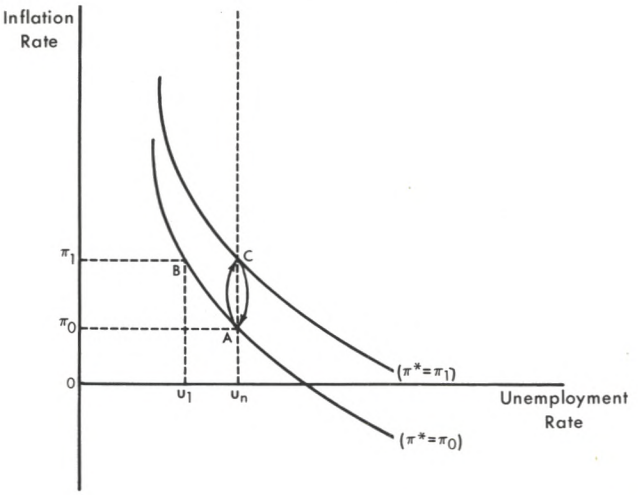
introduced by these hypotheses does not require that a unique relationship between slack and the inflation rate exists. While an inverse relationship exists for movement *along* a short-run Phillips Curve, shifts in the curve can lead to the observation of both rising inflation and rising unemployment (such as from 1973 to 1974), or both could fall (such as from 1975 to 1976).

For example, suppose the economy is at point A in Figure II and the monetary authorities increase the rate of money stock growth in an attempt to reduce unemployment. According to the old Phillips Curve view, output demand and employment demand would expand, reducing unemployment. Moreover, as employers bid up wages in their attempt to expand employment, the inflation rate would rise to π_1. The economy would move to point B. The change introduced by the newer view is that such a policy would lead to revised expectations of inflation, shifting the short-run curve upward. The natural rate

[3] See Thomas M. Humphrey, "Some Recent Developments in Phillips Curve Analysis," Federal Reserve Bank of Richmond *Economic Review* (January/February 1978), pp. 15-23, for a discussion of the evolution and, according to some theorists, the demise of the Phillips Curve analysis. Also, see Anthony M. Santomero and John J. Seater, "The Inflation-Unemployment Trade-off; A Critique of the Literature," *Journal of Economic Literature* (June 1978), pp. 499-544. One of the original empirical studies of these developments is Leonall C. Andersen and Keith M. Carlson, "An Econometric Analysis of the Relation of Monetary Variables to the Behavior of Prices and Unemployment," *The Econometrics of Price Determination*, Proceedings of a Conference Sponsored by Board of Governors of the Federal Reserve System and Social Science Research Council, Washington, D.C., October 30-31, 1970, pp. 166-83.

[4] These developments, as well as the importance of two different views of the Phillips Curve for policy analysis, are discussed in the accompanying *Review* article by Keith M. Carlson, "Inflation, Unemployment, and Money: Comparing the Evidence from Two Simple Models."

Figure II
The "New" View of the Phillips Curve



would tend to be restored so that actual inflation would equal the anticipated rate at point C. The movement from point A to C could follow the path shown by the upward arrow, where initially inflation and slack would move in opposite directions, and later in the same direction. Similarly, a policy action to lower inflation to π_0 could lead to the reverse path indicated by the downward arrow from C to A.

Thus, even if there is a short-run Phillips Curve which exhibits an inverse relationship between the inflation rate and the unemployment rate, there is little reason to expect that observed changes in the two measures will represent movements along the curve. Instead, expectational factors, according to the new Phillips Curve view, can give rise to both direct and inverse relationships between slack and the inflation rate. While the observations in Chart I may or may not be compatible with the new view of the Phillips Curve, such a view offers little support for the existence of a unique trade-off and even less support for its relevance, in the short run. In the long run, it denies the existence of the inverse relationship.

AN ALTERNATIVE VIEW OF INFLATION

One of the oldest and most tested postulates of economic theory is that inflation is a monetary phenomenon. A sustained change in the rate of growth of the stock of money inevitably causes a similar change in the inflation rate. When inflation is viewed in this context, the question addressed here must be restated. While the extent of slack in the economy *alone* does not appear (Chart I) to account for the inflation rate, it may be that slack exerts *some* independent influence. Does the state of economic activity, as indicated by measures of "slack," influence the rate of inflation independently of the course of monetary growth? To examine this question, a standard formulation of the money-price link is developed. Then the question of the independent influence of slack on the inflation rate, *given monetary growth,* is addressed.

Money Growth and Inflation

The linkage between the growth rate of money and inflation is usually thought to arise from a stable relationship between the stock of money (and its growth rate) and the dollar value of the nation's income or total spending on final goods and services (and its growth rate). An increase in the rate of growth of the money stock, according to this view, results in a proportionate rise in the growth rate of total spending. This growth in total spending can be divided into the rate of increase of the dollar prices of the nation's output (inflation) and the rate of growth of the volume of output. In the long run, the output-growth component of spending demand tends to be constant.[5] Thus, a change in the growth rate of the money stock ultimately tends to be reflected fully in the rate of change in prices or the inflation rate.

As an empirical matter, the response of spending to a change in the growth rate of the money stock does not occur instantaneously but, instead, appears to be completed over a four-quarter period. More importantly, the initial spending response to a change in the growth rate of the money stock is primarily reflected in the real output growth component instead of in the inflation rate. The proportional impact of money stock growth on the inflation rate occurs only after a fairly long period of adjustment.[6]

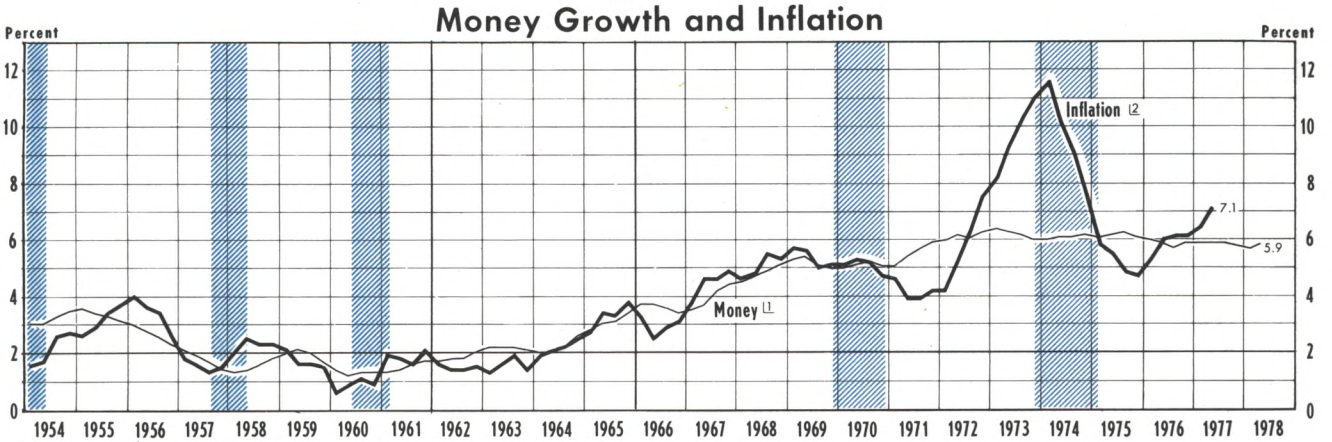
The hypothesis that the rate of inflation depends upon the long-term rate of money growth has been formalized in an equation which relates the rate of inflation in a quarter directly to the rate of monetary

[5]The rationale for this steady growth in output is that the growth of the nation's ability to produce output is determined by growth in the supplies of resources such as labor and capital and the growth rate of resource productivity and these growth rates tend to be fairly constant.

[6]One study which provides a more detailed statement of the theory and evidence supporting these conclusions is Leonall C. Andersen and Keith M. Carlson, "A Monetarist Model for Economic Stabilization," this *Review* (April 1970), pp. 7-25.

Chart II

Money Growth and Inflation



Shaded areas represent periods of business recessions.
[1] Twenty-quarter annual growth rate of M1.
[2] Four-quarter annual growth rate of the GNP Deflator, ending four quarters in the future.
Latest data plotted: Inflation-2nd quarter 1977; Money-2nd quarter 1978

growth which prevailed in the past. One such equation, which can serve as the point of departure here, is:

$$(1) \qquad \Delta \ln P = \alpha_0 + \alpha_1 \sum_{0}^{n} w_i \, \Delta \ln M_{-i}$$

where prices, P, are measured by the GNP deflator, and the money supply, M, is measured by M1. The rate of increase of prices and money are measured by changes in their logarithms ($\Delta \ln$).[7] An estimate of the equation for the period I/1954-I/1978 which considers money growth in the current and prior twenty quarters is:

$$(1') \qquad 400 \cdot \Delta \ln P = \underset{(-1.223)}{-.460} + \underset{(12.409)}{1.140} \sum_{0}^{20} w_i \, 400 \cdot \Delta \ln M_{-i}$$

$$\bar{R}^2 = .64 \qquad d = 1.07$$

$$SE = 1.54$$

The equation has the characteristics typically hypothesized — the constant term is not significantly different from zero (t-statistics are indicated in parentheses) and the sum of the past money growth coefficients is not significantly different from unity.

A simplification of this result is that the rate of inflation equals the trend rate of money stock growth. Temporary developments, such as unusually adverse weather or strikes, may temporarily influence the inflation rate from quarter to quarter, but the fundamental, permanent component of the inflation rate is determined by the trend growth of the money stock. Before examining the independent influence of slack, given this view of inflation, it is useful to look at the explanatory power of the trend rate of money stock growth for the period since 1954 (Chart II).

The errors produced with this simple relationship are most notable over the 1971-75 period. In 1971-73 the pattern of errors reflects the existence of wage and price controls and their removal. Initially the inflation rate was held below the rate indicated for money growth but later, as controls ended, the inflation rate exceeded the rate of money growth. The pattern of errors cancels out over a period long enough to allow prices to "catch up" to their normal relation to the stock of money. From late 1973 through early 1975, the relationship understates the rate of increase in prices by a sizeable amount. During this period, there was a substantial increase in the relative price of energy resources which reduced the economic capacity of the nation's productive facilities. This change caused a sharp, but brief, once-and-for-all rise in the level of prices in 1974, and

[7] This equation is taken from Denis S. Karnosky, "The Link Between Money and Prices — 1971-76," this *Review* (June 1976), pp. 17-23. He argues that the sources of an autoregression problem indicated by the Durban-Watson statistic for the estimate in (1') are the presence of wage and price controls and their removal in the early 1970s as well as the price level surge associated with the large increase in the relative price of energy resources in 1973-75. Such an autoregression problem was not present up to mid-1971 and the properties of the equation were the same. It must be noted that the equation is intended as a short-hand description of the fundamental inflation process, and excludes other potentially important exogenous variables. The equation is estimated using a third degree polynominal with a zero tail constraint.

the inflation rate quickly fell back in line with the rate indicated by past money growth.[8]

Does the State of Economic Activity Affect the Money - Price Link?

If the presence or absence of underutilized resources has an *independent* influence on the rate of inflation, then the discrepancy between the inflation rate and the trend growth of the money stock should be systematically related to measures of the extent of "slack" in the economy. For example, using the cyclical view, one would expect that when there is evidence of slack in the economy, the rate of inflation would tend to be smaller than monetary growth *alone* would indicate. Moreover, the extent of the reduction in the inflation rate would presumably be related to the extent of resource unemployment. Conversely, when the nation's resources are fully employed, one would expect, again using the cyclical approach, that the rate of inflation would exceed the rate indicated by monetary factors alone.[9]

To examine this hypothesis, three measures of slack are used. The first is the "GNP gap" which measures the percent by which the economy's ability to produce goods and services, given its resources and their productivity, exceeds its actual output of goods and services as measured by real GNP.[10] A given percentage gap indicates the percentage by which the nation's output of goods and services could be expanded by fully utilizing the capital, labor, and energy resources available.

A second measure looks only at the extent of utilization of labor services. This measure is the difference between the actual unemployment rate of the civilian labor force and the rate which would prevail if labor were fully employed.[11] The third measure reflects slack in the utilization of capital resources. It is calculated by subtracting the Federal Reserve Board capacity utilization rate from 87.5 percent. The latter figure is used here as full utilization of capacity, since it is the rate generally achieved at postwar cyclical peaks. Chart III shows the three measures of slack.

According to the cyclical view, the relationship between the discrepancies of the inflation rate from trend money growth in Chart II and the slack measures in Chart III would be expected to be significantly negative. In fact, the simple correlation coefficients of the inflation rate residuals are –.07, –.24, and –.27 for the GNP gap, excess unemployment rate, and excess capacity measures, respectively. While the correlation coefficients all show the correct sign to support the cyclical view, they are much closer to zero (indicating no relationship) than they are to minus one (indicating perfect correlation). Moreover, regression analysis of the inflation rate discrepancy-slack relationship indicates no significant relationship between inflation and slack, once trend money growth is taken into account. The average error between the inflation rate and trend money growth is not significantly different from zero in such regressions.[12]

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[8]For a discussion of the experience in 1971-76 and the support it provides for the monetary explanation of inflation see Karnosky, "The Link Between Money and Prices." The price level impact of the capacity loss, the mechanism linking prices to the loss of economic capacity, in 1973-74 is explained in more detail in Robert H. Rasche and John A. Tatom, "The Effects of the New Energy Regime on Economic Capacity, Production, and Prices," this *Review* (May 1977), pp. 2-12.

[9]This statement of the hypothesis may be considered to be a version of the new Phillips Curve view of inflation outlined above when an additional assumption is added to that view. The required assumption is that the expected rate of inflation, which shifts the Phillips Curve, is the rate indicated by the rate of monetary expansion, i.e. equation (1′). Then departures of the actual inflation rate from the expected inflation rate should be systematically related to the extent of slack, if the short-run Phillips Curve is negatively sloped. Viewed in this light, the evidence presented below is a test of the existence of a negatively sloped short-run Phillips Curve, given the expectations assumption.

[10]The potential output series used here is a modified series based upon the methods discussed in Robert H. Rasche and John A. Tatom, "Energy Resources and Potential GNP," this *Review* (June 1977), pp. 10-24. The series is prepared by this Bank and is available, together with a description of the method, from the author.

[11]The full-employment unemployment rate used here is that prepared and described by Peter K. Clark, "Potential GNP in the United States, 1948-1980," *U.S. Productive Capacity: Estimating the Utilization Gap* (Center for the Study of American Business, Washington University, St. Louis, 1977), pp. 21-66.

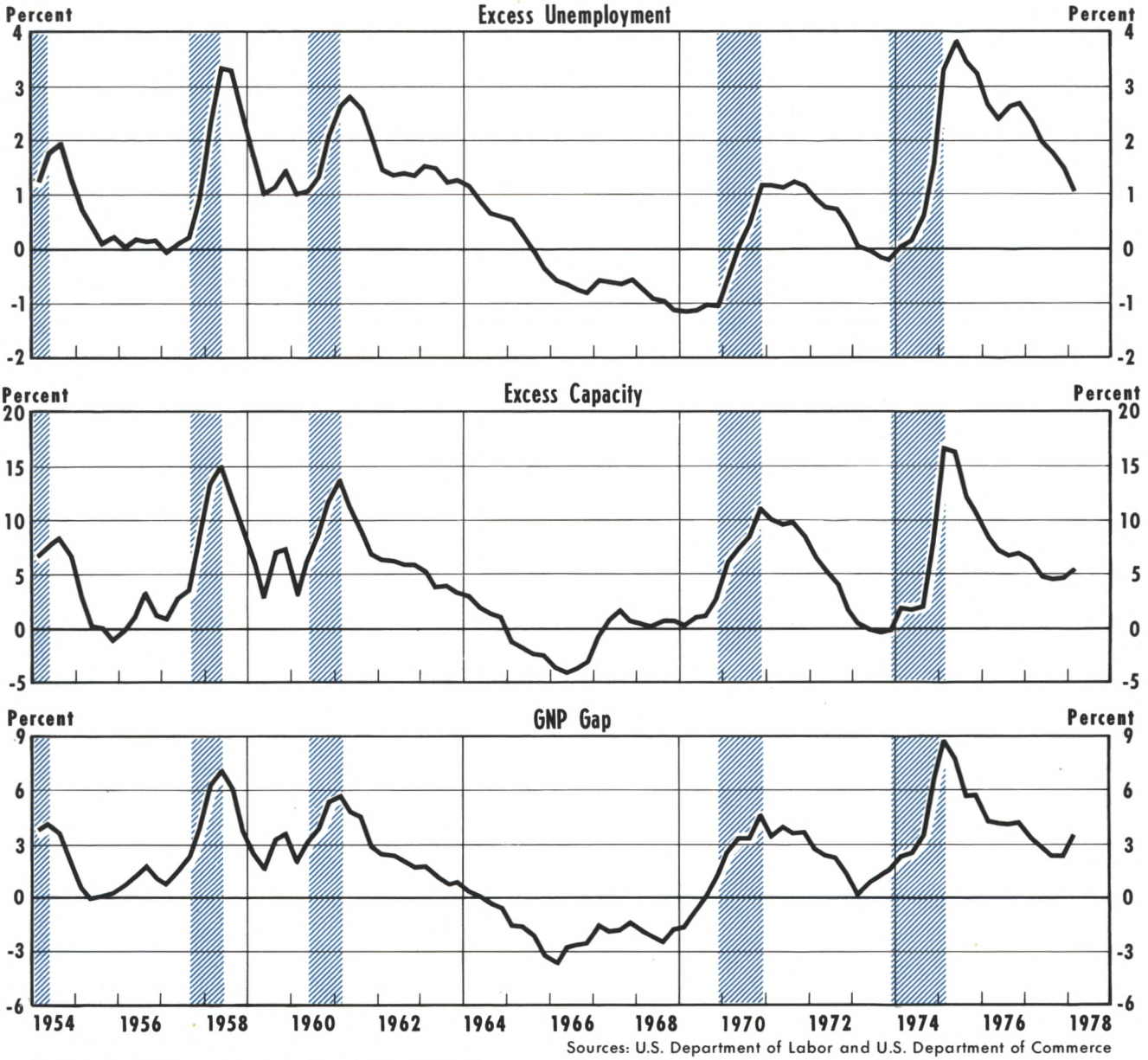
[12]For example, a regression equation for the hypothesis that actual inflation during the year less trend money growth through the current quarter depends upon the current gap yields the estimated equation:

$$100\ (\ln P_{t+4} - \ln P_t) - 20\ (\ln M_t - \ln M_{t-20}) = \underset{(.19)}{} \underset{(-.03\,G_t)}{}$$

where P_t is the price index in quarter t, M_t is the stock of money in quarter t and G_t is the existing gap in period t. The standard error of the equation is 1.20, and the t-statistics for the constant and G coefficient are 1.23 and —.66, respectively. Thus, a significant negative relationship can be rejected at the 99 percent confidence level. In addition the statistically insignificant constant indicates a zero mean difference between trend money growth and the subsequent inflation rate. The adjusted R^2 is zero to two decimal places. The equations referred to in the text are estimated with a Cochrane-Orcutt adjustment and in no case does the constant have a t-statistic larger than .96, or a slack coefficient have a t-statistic larger than 1.31, in absolute value.

Chart III

Measures of Slack



Sources: U.S. Department of Labor and U.S. Department of Commerce

Shaded areas represent periods of business recessions.
Latest data plotted: 1st quarter

A more detailed test of the hypothesis that slack influences the rate of inflation is to use equation (1′) directly. Then the cyclical view may be regarded as an argument that "initial conditions" matter or that the predetermined stage of the business cycle is a significant omitted variable in equation (1) and (1′). This hypothesis can be tested by adding the lagged value of a measure of slack to equation (1′). Table II shows the results obtained for three alternative measures of slack: the GNP gap, the excess of the unemployment rate over the full-employment unemployment rate, and the Federal Reserve Board's capacity utilization rate.[13] It should be noted that the capacity

[13]When a Cochrane-Orcutt procedure is used to adjust for the significant autoregression in the equations, none of the results are altered except that the d-statistics become satisfactory. The results reported in Table II were also obtained for the shorter sample period I/1954-II/1971. An alternative hypothesis is that slack slows inflation, but only when it is large and, otherwise, inflation is determined only by money growth. Using a dummy variable of one for quarters in which

Table II

Estimates of the Effect of Initial Conditions (I/1954 — I/1978)

Lagged Variable Added to Equation (1')*	Coefficient	t-statistic	Sum of Money Growth Coefficients	t-statistic
Gap	.07	.90	1.13	12.26
Excess Unemployment	.03	.16	1.14	12.29
Capacity Utilization Rate	.03	.70	1.14	12.38

$\bar{R}^2$	Durban-Watson d - statistic
.64	1.10
.64	1.08
.64	1.08

*All equations are estimated using a third degree Almon polynominal with a zero tail constraint. The money growth coefficients include a current and 20 lagged growth rate effects.

utilization rate measures the inverse of slack here since the rate is not subtracted from the arbitrary high-employment benchmark of 87.5 percent as in Chart III. The effect of initial slack on the rate of inflation has the wrong sign (positive when it is hypothesized to be negative) in the first two cases and is not significantly different from zero for any slack measure. The inclusion of a slack variable has no noticeable effect on the monetary growth coefficient or on the quality of the fit of the equation.[14]

The monetarist view also suggests that the extent of slack is influenced, in the short run, by changes in the rate of monetary growth, but that in the long run such changes have no effect on real economic activity. Table III presents estimates of the three slack variables as determined by the current and past money growth rates contained in the equations of Table II.[15] In each case, the sum of the money growth coefficients is not significantly different from zero, verifying the hypothesized absence of long-run real effects of monetary growth.[16]

It is useful to examine the pattern of response of a slack variable, such as the GNP gap, to a change in the rate of money growth, since it sheds more light on the cyclical variability introduced by a change in the rate of money growth. Chart IV shows the pattern of response of the GNP gap to a one percent increase in the rate of growth of the money stock obtained from the first equation in Table III.[17] For the first eight quarters of such an increase in money growth, the GNP gap is reduced until it is about .77 percentage points smaller. In the subsequent three years, however, such money growth leads to an increase in the GNP gap so that, in the long run, there has been no significant change in the size of the gap. Thus, an increase in the rate of money growth has real effects in the short run as the GNP gap is reduced. There are no long-run real effects of a permanent change in the rate of money growth; only the inflation rate is affected.[18]

While the analysis above shows that the stage of the business cycle does not exert an independent influence on the rate of inflation, the sometimes contrasting evidence from recession experiences may be disconcerting. The apparent conflict is easily resolved by the modern view of the Phillips Curve, which suggests such dynamic changes may sometimes occur, and by the monetary explanation of inflation and short-run fluctuations in economic activity. Recessions

slack is greater than one standard deviation above its sample mean, and zero otherwise again does not alter the equation (1') and the dummy variable is statistically insignificant in each case.

[14]Note that the d-statistic is not affected either which indicates that slack is apparently not one of the important missing variables. An alternative hypothesis might be that it is the rate at which slack is reduced, rather than the level of slack which affects the inflation rate. While it is difficult to argue that such a rate is an exogenous variable, including quarterly changes in the slack variables in the reduced form above yields the same results as for the level of slack, that is, they exert no independent influence on the inflation rate.

[15]The high adjusted R^2 results from the use of a Cochrane-Orcutt adjustment. Without such an adjustment, the adjusted R^2 is smaller than .4 for each equation, indicating that multicollinearity is *not* likely to be the source of the lack of significance of the slack variables in Table II.

[16]The results tend to support another major proposition concerning the functioning of the economy — the economy is inherently stable. Neither the gap equation nor the excess unemployment equation, yield a constant term which is significantly different from zero, indicating that while changes in the rate of money growth affect the output gap and excessive unemployment in the short run, both tend to zero in the long run — independently of a constant rate of money growth. Similarly, the significant constant term in the capacity utilization rate equation of 82 percent may be considered the steady-state capacity utilization rate which is also independent of any given sustained rate of money growth. A similar conclusion using annual data and a model of the capacity utilization rate may be found in John A. Tatom, "The Measurement and Meaning of Potential Output — A Comment on the Perloff and Wachter Results," Carnegie-Rochester Conference Series on Public Policy, *Journal of Monetary Economics*, forthcoming January 1979. Not only is the natural rate the same as that derived here, the timing of the adjustment of capacity utilization to changes in the money growth rate is also the same as that used here.

[17]The t-statistics of the individual coefficients of money growth exceed 2.9 in every quarter except at the turning point where the change in the gap is quite small in quarters 6 to 8.

[18]Similar qualitative results have recently been found by Robert J. Barro, "Unanticipated Money, Output, and the Price Level in the United States," *Journal of Political Economy* (August 1978), pp. 549-80. Using a rational expectations model and annual data, he finds the timing of the impact of money

Table III

Monetary Growth and The Cycle
(I/1954 — I/1978)

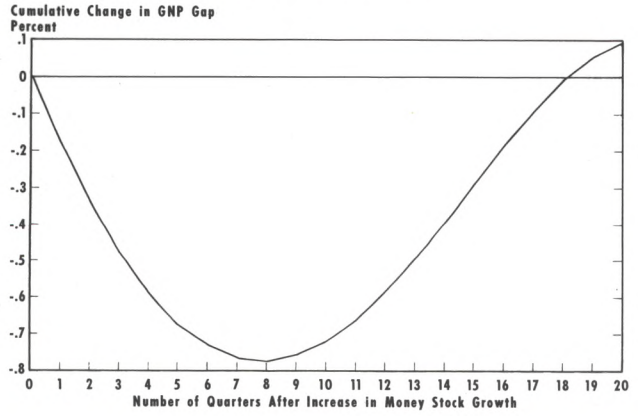
Dependent Variable*	Constant	t-statistic	Sum of Money Growth Coefficients	t-statistic	$\bar{R}^2$	d	ρ
Gap	2.21	.93	.09	.18	.90	1.47	.93
Excess Unemployment	2.24	1.80	−.27	−1.06	.92	1.02	.95
Capacity Utilization Rate	82.01	22.95**	.06	.07	.85	1.31	.89

*All equations are estimated using a Cochrane-Orcutt adjustment and a third degree Almon polynominal with a zero tail constraint. The money growth coefficients include a current and 19 lagged growth rate effects.

**Significant at one percent level.

usually develop as a result of a sharp drop in the rate of growth of the stock of money.[19] Since such a drop in money growth lowers the trend rate of growth of money, it is not surprising that the basic inflation rate often slows. Such a reduction in money growth slows the rate of growth of total spending for the economy's goods and services, temporarily leading to a recession. Thus, the cyclical variations in the inflation rate arise because of the influence of monetary policy on both the presence of the cycle *and* on the rate of inflation.

Chart IV
Cumulative Change in the GNP Gap
Due to a Permanent One Percent Increase
in Money Stock Growth



CONCLUSION

Recent concern that the inflation rate will accelerate in the 1978-79 period *due to increasing limitations on resource availability* is unwarranted. The stage of the business cycle does not affect the inflation rate.[20] The future course of the inflation rate will depend instead on how monetary policy affects the growth of the stock of money. Other factors, such as the impact of unusual winter weather in 1977 and 1978 or the recent coal strike, may have temporary impacts on the rate of inflation, but the inflation rate is fundamentally a monetary phenomenon. While some evidence exists which appears to provide casual support for the view that the inflation rate is influenced by the stage of the business cycle, this evidence is misleading. The confusion arises from a failure to account for both the short-run influence of monetary growth on economic activity and the long-run influence of monetary growth on the inflation rate. To the extent that the nation's cyclical experience has been caused by procyclical variations in the money stock, one would expect procyclical movements in the inflation rate. The evidence presented here provides support for this view as well as indicating the unimportance of the stage of the cycle as an independent determinant of the inflation rate.

growth on inflation to occur over a longer period than indicated here while the temporary effects on real output growth occur over a similar period.

[19]This conclusion has a considerable history. See for example, William Poole, "The Relationship of Monetary Decelerations to Business Cycle Peaks: Another Look at the Evidence," *Journal of Finance* (June 1975), pp. 697-712.

[20]Phillip Cagan argues in "The Reduction of Inflation by Slack Demand," in William Fellner, Project Director, *Contemporary Economic Problems 1978*, (Washington, D. C.: American Enterprise Institute for Public Policy Research, 1978), pp. 13-45, that slack *does* slow the inflation rate. He uses two different models to study the relationship between six measures of inflation and three slack measures like those used here, for the periods 1953-69 and 1953-77. The alternative inflation series are the GNP deflator; consumer price index; wholesale price index, crude materials; wholesale price index, intermediate materials; wholesale price index, finished goods; and average hourly earnings. Actually, the statistical evidence (t-statistics) are only supportive of the hypothesis in the cases of the consumer price index and wholesale finished goods in his first model, and to some extent, only average hourly earnings in the second model. When the experiment reported in Table II is performed using measures of inflation based upon other price indexes (consumer price index, all items; consumer price index for all urban consumers; producer price index, all commodities; producer price index, industrial commodities; and hourly compensation, private business sector) none of the three measures of slack is significant. The data series used and sample period are not identical. Nonetheless, it appears that once the impact of money growth on inflation is accounted for, slack does not affect the inflation rate even in the limited number of cases supported by Cagan's results.

Effectiveness of State Reserve Requirements

R. ALTON GILBERT

AN important decision made by each commercial bank is whether to be a member of the Federal Reserve System (FRS). National banks are required by law to be members but can withdraw from membership with little difficulty by obtaining state charters. State banks may choose whether to be members without affecting the status of their state charters.

In recent years many banks have withdrawn from the FRS, and the primary reason given is that they must hold a larger share of their assets in non-earning form as members than if they were nonmembers.[1] The FRS has proposed to reduce member bank reserve requirements as a means of making membership more attractive. State bank regulators, however, might wish to counter this action in order to keep the number of banks under their supervision from declining, and might seek to do so by lowering reserve requirements for nonmember banks. For states to offset the effects of a reduction in FRS reserve requirements on the attractiveness of membership, state reserve requirements would have to be effective, in the sense of influencing the cash holdings of nonmember banks or other aspects of nonmember bank behavior. Thus, effectiveness of state reserve requirements is one of the issues to consider in estimating the attractiveness of proposals for reducing member bank reserve requirements.

Effectiveness of state reserve requirements is analyzed from three approaches. The first approach examines how close nonmember banks keep their cash reserves to required cash reserves. A second approach examines the influence of state reserve requirements on the way nonmember banks report their uncollected funds. Most states do not count cash items in the process of collection (CIPC) as cash reserves; however, nonmember banks in such states can use uncollected funds to meet reserve requirements by reporting them as demand balances due from correspondents, instead of as CIPC. This second approach tests whether nonmember banks in states which do not count CIPC as cash reserves report more of their uncollected funds as demand balances due from correspondents than nonmember banks in other states. A third approach tests the effects of state reserve requirements on the percentages of banks which are FRS members in various states. Details of state reserve requirements are reported in a previous issue of this *Review*.[2]

[1]Peter Rose, "Exodus: Why Banks are Leaving the Fed," *The Bankers Magazine* (Winter 1976), pp. 43-49.

FIRST APPROACH

Nature of Data Available and Appropriate Comparisons

Most state banking authorities compare average cash assets to required cash reserves over one-week or two-week periods to determine whether banks are meeting their reserve requirements. However, data are available in a common format across states only as

[2]R. Alton Gilbert and Jean M. Lovati, "Bank Reserve Requirements and Their Enforcement: A Comparison Across States," this *Review* (March 1978), pp. 22-32. Another approach that has been used to test the effectiveness of state reserve requirements is to estimate the relation between cash assets held by nonmember banks and required cash reserves. See Lawrence G. Goldberg and John T. Rose, "Do State Reserve Requirements Matter?" *Journal of Bank Research* (Spring 1977), pp. 31-39. That approach is not used in this paper for the following reasons. If state reserve requirements influence cash holdings of nonmember banks, demand for correspondent balances by nonmember banks would also be a function of additional variables, which should be held constant in testing the influence of state reserve requirements on cash holdings of nonmember banks. Data on some other determinants of demand for correspondent balances, such as daily variability of deposit liabilities, are not available for nonmember banks. For evidence on the significance of deposit variability for demand for correspondent deposits, see William G. Dewald and G. Richard Dreese, "Bank Behavior with Respect to Deposit Variability," *Journal of Finance* (September 1970), pp. 869-79. Another reason concerns the interpretation if a positive relation is found between cash holdings and required cash reserves of nonmember banks. Such a relation might indicate that banks which hold relatively large percentages of their assets in cash do so because of relatively high reserve requirements. On the other hand, such a relation might indicate that state banking authorities keep reserve requirements relatively high in states in which nonmember banks hold relatively high percentages of their assets in cash voluntarily. In such states there would be little pressure on banking authorities from banks to lower reserve requirements. In other states in which banks wish to hold lower cash ratios, banking authorities would be under pressure to keep reserve requirements no higher than voluntary cash holdings.

of individual days. One source is the quarterly *Report of Condition* for all Federally insured banks; the other is balance sheets as of each Wednesday for nonmember weekly reporting banks. Since these observations are for individual days, at quarterly or weekly intervals, observed cash holdings may be less than the required amounts without necessarily indicating that banks are violating state reserve requirements. Alternately, reserves could be above required levels as of individual days without necessarily indicating that nonmember banks voluntarily hold more reserves than required.

Another complication in drawing conclusions from ratios of reserves to required reserves for effectiveness of state reserve requirements is that banks often choose to hold excess reserves. Relatively small *member* banks hold substantial amounts of excess reserves, although most of them would tend to hold less cash if their reserve requirements were reduced.[3]

These problems of interpretation are dealt with by comparing the ratio of cash reserves to required cash reserves for nonmember banks with the ratio of reserves to required reserves for member banks of comparable size, calculated for the same individual days. The nonmember ratios are calculated using state requirements, and member bank ratios using FRS requirements. Member bank reserve requirements are used here as a standard for effective reserve requirements. To indicate how this standard is applied, suppose nonmember banks have ratios of cash reserves to required cash reserves which are significantly higher than such ratios for member banks of comparable size. State reserve requirements would be considered not effective, in the sense that cash holdings of nonmember banks apparently would not be determined by state reserve requirements to the same extent that reserves of member banks are determined by their required reserves.

Empirical Results

One recent quarterly *Report of Condition* is used to calculate ratios of cash reserves to required cash reserves for member and nonmember banks of comparable size. These calculations indicate that *nonmember banks in most states hold cash reserves which are substantially larger than their required cash reserves.* Cash reserves several times as large as required cash reserves were most common among the smallest nonmember banks, with larger banks having smaller ratios. In all but two of the 38 states for which such comparisons are made, the average ratios of cash reserves to required cash reserves *were significantly higher than those ratios for member banks of comparable size.* Thus, based upon this information, *state reserve requirements appear to be less effective than FRS reserve requirements.*[4] Details of calculations and statistical tests are presented in section I of the Appendix.

In 1976 there were 23 weekly reporting banks which were nonmembers. Two of those banks were located in states with no cash reserve requirements. Of the remaining 21 banks, 12 had average ratios of cash reserves to required cash reserves which were not significantly different from such ratios for member banks of comparable size.[5] These 12 banks are located in seven states. Thus, results for nonmember weekly reporting banks provide *evidence of effective state reserve requirements for some of the relatively large nonmember banks in several states.*

There are only a few nonmember banks that are as large as weekly reporting banks. Evidence from this approach indicates that state reserve requirements are not effective for most nonmember banks in all but a few states, since their cash holdings are so much larger than their required cash reserves.

SECOND APPROACH

All but seven states have reserve requirements which must be satisfied completely, or in part, with cash reserves, which include vault cash and demand deposits with other domestic commercial banks. Among the 43 states with reserve requirements which must be met with cash assets, 17 allow banks to count at least some types of cash items in the process of collection (CIPC) as cash reserves. CIPC represent primarily the dollar value of checks deposited with correspondent banks for which the correspondents have not received payment.

[3]There tend to be economies of scale in managing a bank's reserve position. For instance, Treasury bills have minimum dollar denominations, and correspondent banks generally have minimum dollar units in which they invest excess reserves of respondent banks in the Federal funds market. Also, there are efficiencies due to specialization, since the persons who manage the reserve positions of relatively small banks generally have additional responsibilities. Excess reserve ratios of relatively small member banks indicate that the transactions and cash management costs which are necessary to reduce excess reserves are larger than the potential increases in income from investing them.

[4]Note that this result does not imply a comparison of the burden of reserve requirements of FRS members to the burden of state reserve requirements for nonmembers. The issue being considered is how close member and nonmember banks keep their cash reserves to their respective required cash reserves.

[5]Each of the nonmember weekly reporting banks in 1976 had total deposits greater than $180 million.

Differences among states in treatment of CIPC as reserves could have significant implications for the effective levels of state reserve requirements if nonmember banks reported all of their uncollected funds as CIPC, because uncollected funds constitute substantial proportions of required reserves for most banks.[6] However, many banks report part or all of their uncollected funds as demand balances due from correspondents. Some banks may follow such an accounting practice to use uncollected funds for meeting reserve requirements. To illustrate why a bank might do this, consider a nonmember bank which desires to hold an amount of vault cash plus *collected* demand balances with correspondents which is less than its required cash reserves. If this bank is in a state which does not count CIPC as reserves, it could increase its reserves for purposes of meeting state requirements by classifying its uncollected deposits at correspondents as demand balances due from banks, rather than as CIPC.

Regression analysis is used to test the influence of state reserve requirements on the methods nonmember banks use for classifying uncollected funds. Two hypotheses are tested: in states that have cash reserve requirements and do not count CIPC as reserves, (1) nonmember banks report less of their uncollected funds as CIPC than do other banks, and (2) the percentage of banks reporting uncollected funds as CIPC is smaller in states with higher reserve requirements and in states which enforce reserve requirements more rigorously.

The regression results support both of these hypotheses (see Appendix, section III). The percentage of nonmember banks reporting CIPC as zero is significantly higher in states that have cash reserve requirements and do *not* count CIPC as cash reserves. Another measure of how nonmember banks report uncollected funds is the percentage of banks reporting CIPC less than 25 percent of their demand balances due from correspondents. With this second measure as the dependent variable, significant independent variables are those which reflect treatment of CIPC as cash reserves, the level of state reserve requirements, and methods of monitoring reserve positions of nonmember banks.

These results have implications for the level of state reserve requirements relative to cash assets nonmember banks would desire to hold voluntarily. *Cash reserve requirements of several states tend to be large enough relative to voluntary holdings of vault cash plus collected demand balances due from correspondents to induce behavior by nonmember banks which minimizes the burden of state reserve requirements.* Whether nonmember banks are able to fully offset the burden of state reserve requirements by reporting uncollected funds as demand balances due from correspondents cannot be determined from this analysis.

THIRD APPROACH

The major cost of Federal Reserve membership is reserves required of members, relative to reserves held by nonmembers. If state reserve requirements are effective, differences in requirements among states would tend to induce differences among states in the percentages of banks that choose Federal Reserve membership: the percentage of banks within a state that are members of the Federal Reserve System would tend to be higher in states with relatively high state reserve requirements and rigorous enforcement by state banking authorities.

This hypothesis is also tested using regression analysis.[7] Results of those tests indicate that the percentage of banks in the Federal Reserve is not significantly higher in states with relatively high reserve requirements. Thus, by just examining the *levels* of state reserve requirements, such requirements do not appear to influence the membership choice of banks.

Two aspects of the *enforcement* of state reserve requirements, however, do significantly influence the choices of banks concerning FRS membership. The most important variable reflects differences among states in methods of monitoring the reserve positions of nonmember banks. The most rigorous method state bank supervisors use to monitor the reserve positions of nonmember banks is frequent reports from banks on their reserve positions. *The percentage of banks in*

[6]Uncollected funds as a proportion of cash assets can be measured most accurately for member banks which send most of their checks to a Federal Reserve Bank for collection. Member banks receive credit for deposits with Reserve Banks according to a time schedule which approximates the time required for the FRS to make collection. Uncollected funds which represent deposits at Federal Reserve Banks for which member banks have not yet received credit must be reported as CIPC. For a group of 49 member banks which regularly deposit checks with their Federal Reserve Bank, CIPC was about 83 percent of their reserve balances with their Federal Reserve Bank. See R. Alton Gilbert, "Utilization of Federal Reserve Bank Services By Member Banks: Implications for the Costs and Benefits of Membership," this *Review* (August 1977), p. 3.

[7]See the Appendix, section IV, for a description of the data and statistical tests.

the Fed is significantly higher in states which require nonmember banks to file frequent reports on their reserve positions than in states which use less rigorous methods to monitor compliance with reserve requirements. This result is consistent with the hypothesis that banks are more likely to choose Fed membership in states with more rigorous enforcement of reserve requirements.

The other significant aspect of state reserve requirements is enforcement of penalties on reserve deficiencies. Several states have dollar penalties which are relatively low or, according to the state banking supervisors, are seldom enforced. The percentage of banks in the Fed is significantly lower in such states than in other states which have higher dollar penalties, enforce dollar penalties on reserve deficiencies more rigorously or have various types of nondollar penalties.

These results indicate that *enforcement* of state reserve requirements, not the *level* of requirements, influences the choice of banks concerning Federal Reserve membership. One possible explanation for this finding is that the measures of enforcement — requirements for reporting on reserve positions, the level of dollar penalties, and degrees to which penalties are imposed — reflect differences among states in the nature of bank supervision in general, not just enforcement of reserve requirements. Additional research would be necessary to determine whether states with relatively more rigorous enforcement of reserve requirements also have more rigorous enforcement of other banking regulations.

CONCLUSIONS

Empirical tests presented in this paper provide conflicting evidence on the effectiveness of state reserve requirements. Most nonmember banks in all but a few states hold ratios of cash reserves to required cash reserves which are significantly larger than ratios of reserves to required reserves for member banks of comparable size. These results are consistent with the view that the cash holdings by most nonmember banks are not determined by state reserve requirements, but by cash requirements for banking transactions. Under this interpretation, most nonmember banks would *not* tend to hold less cash if their cash reserve requirements were reduced. Thus, states could not offset Federal Reserve System (FRS) actions intended to increase the attractiveness of membership — such as lowering member bank reserve requirements — by lowering reserve requirements for nonmember banks in response.

However, other evidence presented above calls for qualifications to this general conclusion. Several relatively large nonmember banks (total deposits of $180 million and above) keep their cash reserves as closely tied to their required cash reserves as do member banks of comparable size. This evidence indicates that state reserve requirements are effective for some of the relatively large nonmember banks in several states.

Other evidence which is not necessarily consistent with the general conclusion on effectiveness of state reserve requirements is that on reporting of uncollected funds by nonmember banks. In states which do not count cash items in the process of collection (CIPC) as cash reserves, nonmember banks report CIPC which is a smaller percentage of their demand balances due from correspondents than do nonmember banks in other states. This evidence indicates that nonmember banks tend to use their means of reporting uncollected funds to minimize the burden of state reserve requirements.

Additional evidence which supports the conclusion that state reserve requirements are not effective concerns the influence of state reserve requirements on the percentage of banks in various states which are FRS members. The *level* of state reserve requirements does not significantly influence the percentage of banks which are FRS members. However, some differences among states in methods of monitoring the reserve positions of nonmember banks and enforcing reserve requirements are significantly related to differences in the percentage of banks that are FRS members.

An overall assessment of results in this analysis supports the view that in general state reserve requirements are not effective. Evidence cited above which is inconsistent with this general conclusion calls for only limited qualifications, and may raise more questions than it answers.

Only a small number of nonmember banks have total deposits over $180 million. Thus, evidence on effectiveness of state reserve requirements for several nonmember banks in that size range applies to only a small percentage of banks which would posssibly be influenced by a reduction in FRS reserve requirements.

Evidence that nonmember banks in some states attempt to minimize the burden of state reserve requirements by the way they report uncollected funds does not indicate whether any burden remains after banks take such actions. Nonmember banks in states

which do not count CIPC as cash reserves may be able to avoid all burden of state reserve requirements by reporting their uncollected funds as demand balances due from correspondents.

Differences among states in methods of monitoring reserves of nonmember banks and enforcing reserve requirements may be related to differences among states in overall stringency of banking regulation. Therefore, the evidence cited above concerning variables which influence the percentages of banks which are FRS members may indicate as much about the influence of differences among states in overall bank regulation as it does about the influence of state reserve requirements on membership choice.

Thus, evidence developed in this paper indicates that the FRS could increase the attractiveness of membership by lowering member bank reserve requirements. With only a few exceptions, states could not offset the effects of such an action by lowering reserve requirements for nonmember banks.

APPENDIX

Specification of Data and Empirical Results

RATIOS OF CASH RESERVES TO REQUIRED CASH RESERVES FOR MEMBER AND NONMEMBER BANKS

Ratios from the Report of Condition

Ratios of cash reserves to required reserves are calculated for all nonmember banks in states that have cash reserve requirements, using data as of June 30, 1976.[1] The ratios are averaged for nonmember banks in each state within the following size groups in terms of total deposits:

(a) up to $10 million,

(b) $10 million to $50 million,

(c) $50 million to $100 million, and

(d) $100 million to $500 million.[2]

Average ratios of reserves to required reserves are presented in Table A-I. Each t-statistic (calculated for the difference between the mean ratio for nonmember banks and the mean ratio for members of comparable size) is used to test the hpothesis that reserve requirements of a state are effective.[3] In each case in which the difference in mean ratios is not significantly different from zero, reserve requirements of that state are considered as significant in determining the cash holdings of nonmember banks as FRS reserve requirements are in determining the reserves of member banks.

Results in Table A-I indicate that nonmember banks in most states hold cash reserves which are substantially above their required cash reserves. Nonmember banks in all but two states, South Dakota and Wisconsin, had average ratios of reserves to required reserves which were significantly higher than the average reserve ratios for member banks of comparable size. Reserve requirements are relatively high in both of these states. Thus, based upon the criterion used in this section, state reserve requirements are as effective as FRS reserve requirements in only two of the 38 states examined.

[1]See Appendix, section II, for discussion of a possible bias in the *Report of Condition* data.

[2]In most states there are few, if any, nonmember banks with total deposits over $500 million. The influence of bank size on the ratios of reserves to required reserves is held constant by dividing nonmember banks in each state into these size groups. A few banks which had extreme ratios were eliminated from the analysis. The banks which were eliminated from calculations in this section were also eliminated from analysis in the following sections. Another study has drawn inferences about the effectiveness of state reserve requirements based upon reserve ratios from the *Report of Condition*. One limitation of the study is that no criterion was developed from determining how large reserves can be in relation to required reserves as of an individual day and yet be consistent with effective state reserve requirements. See Perry D. Quick, Appendix A, "Nonmember Bank Reserve Requirements," in "The Burden of Federal Reserve Membership, NOW Accounts, and the Payment of Interest on Reserves," prepared by the Staff of the Board of Governors of the Federal Reserve System, June 1977, pp. 71-96.

[3]Mean ratios of reserves to required reserves, based upon the *Report of Condition* for June 30, 1976, are calculated for the combined group of member banks in those states which have cash reserve requirements. This group of states includes most member banks in the nation.

Table A-I

RATIOS OF CASH RESERVES TO REQUIRED CASH RESERVES OF NONMEMBER BANKS[1]

State	Size Group (millions of dollars)	Percent Reserves are of Required Reserves	t-statistic[2]
Alabama	up to $10	160.31%	6.568
	$10 to $50	137.11	8.007
Arkansas	up to $10	209.07	13.958
	$10 to $50	170.41	18.672
California	up to $10	254.89	22.246
	$10 to $50	193.09	24.315
	$50 to $100	156.44	15.447
	$100 to $500	138.52	16.745
Connecticut	$10 to $50	249.14	46.290
Georgia	up to $10	373.19	23.858
	$10 to $50	311.54	48.760
Indiana	up to $10	135.97	2.158
	$10 to $50	126.74	4.515
	$50 to $100	121.86	2.009
Iowa	up to $10	168.42	6.662
	$10 to $50	144.05	9.513
Kansas	up to $10	198.01	9.821
	$10 to $50	168.33	17.578
Kentucky	up to $10	393.93	37.602
	$10 to $50	366.17	66.537
Louisiana	$10 to $50	305.88	54.920
	$50 to $100	217.35	38.815
Maryland	up to $10	257.78	24.392
	$10 to $50	248.20	44.192
Massachusetts	up to $10	750.57	82.297
	$10 to $50	694.43	158.275
Michigan	up to $10	223.75	17.321
	$10 to $50	204.33	29.772
	$50 to $100	177.70	23.772
	$100 to $500	160.48	32.349
Minnesota	up to $10	222.97	12.884
	$10 to $50	161.08	12.532
Mississippi	up to $10	307.82	29.688
	$10 to $50	217.57	32.779
Missouri	up to $10	175.34	7.829
	$10 to $50	142.86	9.474
	$50 to $100	132.51	6.174
Montana	up to $10	153.83	5.586
	$10 to $50	119.45	2.126
Nebraska	up to $10	174.96	7.122
	$10 to $50	153.16	13.257
New Hampshire	up to $10	227.72	18.810
	$10 to 50	148.16	12.039
New Jersey	$10 to $50	148.78	12.083
	$100 to $500	121.99	6.053
New Mexico	$10 to $50	266.21	51.053
New York	$10 to $50	134.28	7.198
North Carolina	up to $10	205.90	14.929
	$10 to $50	171.30	19.862
North Dakota	up to $10	136.63	2.384
	$10 to $50	133.11	6.714
Ohio	up to $10	265.28	23.989
	$10 to $50	218.67	33.300
	$50 to $100	175.85	23.248
Oklahoma	up to $10	205.09	12.276
	$10 to $50	172.73	19.001
Oregon	$10 to $50	208.00	32.538
Pennsylvania	up to $10	278.15	27.375
	$10 to $50	196.38	27.186
	$50 to $100	159.11	16.678
	$100 to $500	181.31	44.859
South Carolina	up to $10	218.11	16.866
	$10 to $50	185.09	24.542
South Dakota	up to $10	133.50	1.850
	$10 to $50	131.18	6.167
Tennessee	up to $10	171.08	7.971
	$10 to $50	151.91	12.648
	$50 to $100	166.33	19.659
Texas	up to $10	180.81	8.870
	$10 to $50	166.74	15.762
	$50 to $100	155.93	14.250
	$100 to $500	174.68	38.898
Utah	up to $10	250.86	20.367
	$10 to $50	157.20	15.127
Virginia	up to $10	190.05	11.944
	$10 to $50	145.62	11.093
Washington	up to $10	193.29	12.598
	$10 to $50	155.98	14.665
West Virginia	up to $10	206.05	13.773
	$10 to $50	179.97	22.361
Wisconsin	up to $10	134.81	1.898
	$10 to $50	109.74	−1.161
	$50 to $100	113.53	−1.233
Wyoming	$10 to $50	169.97	19.538

[1]Observations of cash assets and deposit liabilities for member and nonmember banks are derived from the *Report of Condition*, June 30, 1976. Average ratios of reserves to required reserves are calculated for nonmember banks in each of the four size groups in each state with cash reserve requirements. Ratios are reported for size groups with ten or more nonmember banks. Ratios of reserves held to required reserves are calculated for member banks in 43 states that have cash reserve requirements for nonmember banks. Information on the ratios of reserves to required reserves for member banks is provided below:

Size Group (Total Deposits in Millions of Dollars)	Number of Banks	Mean Percent that Reserves are of Required Reserves	Standard Deviation of Ratio
up to $10	1082	123.18	48.710
$10 to $50	2608	113.29	28.942
$50 to $100	512	116.79	33.183
$100 to $500	408	113.25	33.658

[2]t-statistics are calculated for differences between mean ratios of reserves to required reserves of nonmember banks and mean ratios of reserves to required reserves of member banks of similar size. With the exception of all three size categories for Wisconsin and the "up to $10 million" category for South Dakota, all t-statistics are significant at the 5 percent level.

Ratios for Nonmember Weekly Reporting Banks

Weekly reporting banks comprise a national sample of relatively large commercial banks which report balance sheet information as of each Wednesday. In 1976, 23 weekly reporting banks were nonmembers, each with total deposits over $180 million. Two of those banks are located in states with no cash reserve requirements. Ratios of cash reserves to required cash reserves were calculated for the remaining 21 banks as of each Wednesday in 1976 and averaged for each bank over the year (see Table A-II).

As a basis for comparison, average ratios of reserves to required reserves, under reserve requirements of the Federal Reserve, were calculated for 18 member banks in the Eighth District, with total deposits of at least $180 million. For comparability with data for nonmembers, the measure of cash reserves for each member bank is its reserve balance at the Federal Reserve at the close of each Wednesday plus average daily vault cash during the reserve settlement week ending two weeks earlier. Average daily required reserves are based upon deposit liabilities two weeks earlier. Ratios of reserves to required reserves are calculated for each member bank for each Wednesday in the period from September 15, 1976 through January 12, 1977.

Mean ratios of reserves to required reserves of the 18 member banks are used to establish an acceptance region for testing the hypothesis that the mean reserve ratio for each nonmember bank was drawn from the same distribution as that for member banks. This hypothesis is not rejected, at the 5 percent level of significance, if the mean ratio for a nonmember is in the range from 0.585 to 1.509.

Using this criterion, the hypothesis that reserve requirements are effective is *not* rejected for 12 of the 21 nonmember banks, located in California, Hawaii, Michigan, New York, North Carolina, Ohio, and Pennsylvania. Thus, results in Table A-II provide evidence of effective reserve requirements in several states for some of the relatively large nonmember banks.

Table A-II

RATIO OF RESERVES TO REQUIRED RESERVES: COMPARISON FOR LARGE MEMBER AND NONMEMBER BANKS

State	Bank Number	Average Ratio for Each Wednesday, 1976	Interpretation: Hypothesis of Effective State Reserve Requirements*
California	1	1.166	Accept
	2	1.484	Accept
	3	1.091	Accept
	4	1.020	Accept
Connecticut	1	1.810	Reject
	2	2.329	Reject
	3	2.241	Reject
Delaware	1	5.625	Reject
Hawaii	1	0.986	Accept
	2	0.839	Accept
Maryland	1	1.846	Reject
Michigan	1	1.353	Accept
Missouri	1	2.004	Reject
New York	1	2.029	Reject
	2	1.112	Accept
North Carolina	1	1.800	Reject
	2	1.445	Accept
Ohio	1	1.300	Accept
Pennsylvania	1	1.553	Reject
	2	1.062	Accept
	3	1.333	Accept

*The hypothesis of effective state reserve requirements is not rejected if the average ratio of reserves to required reserves for a nonmember bank is in the range from 0.585 to 1.509.

ANALYSIS OF POSSIBLE BIAS IN *REPORT OF CONDITION* DATA

One possible problem with relying upon the *Report of Condition* for information on cash holdings of nonmember banks is that banks might increase their cash holdings on the known dates for the *Report of Condition* and reduce them immediately afterwards. Banks might behave that way if they generally hold cash reserves which are less than required reserves, since that report is disclosed to the public and made available to state banking authorities.

Determining whether cash holdings of nonmember banks from the *Report of Condition* are unusually high requires information from other sources for comparison. One source is the data for nonmember weekly reporting banks discussed above.

Although weekly reporting banks are larger than most nonmembers used in the calculations from the *Report of Condition*, they are probably part of the nonmember group which would have the greatest incentives to hold unusually high cash reserves on the *Report of Condition* dates. Nonmember banks in the smaller size groups in most states report cash reserves which are substantially above required cash reserves. These banks would not have incentives to hold cash reserves that much larger than their required cash reserves for just the day of the report. In contrast, the larger nonmember banks in most states tend to have lower ratios of cash reserves to required cash reserves than the small banks. Therefore, if any nonmember banks increase their cash reserves on *Report of Condition* dates to appear to be meeting reserve requirements, the relatively large nonmember banks would be most likely to do so.

One Wednesday in 1976 occurred on June 30, which is a *Report of Condition* date. For each of the 21 nonmember weekly reporting banks in states with cash reserve requirements, cash reserves reported as of June 30 are compared to the average of their cash reserves as of the four previous Wednesdays and the following four Wednesdays.

Eight of the 21 banks had higher cash reserves on June 30 than the average of both the previous and fol-

Table A-III

IDENTIFICATION OF INDEPENDENT VARIABLES AND SPECIFICATION OF HYPOTHESES

Symbol	Description of Variable	Direction of Influence on Dependent Variables: Percentage of Banks Reporting CIPC (a) equal to zero, (b) less than 10 percent of due from balances, or (c) less than 25 percent of due from balances	Direction of Influence on Dependent Variables: Percentage of Banks in the Federal Reserve System
MPC 0	Percentage of member banks reporting CIPC equal to zero.	+	
MPC 10	Percentage of member banks reporting CIPC less than 10 percent of their demand balances due from correspondent banks.	+	
MPC 25	Percentage of member banks reporting CIPC less than 25 percent of their demand balances due from correspondent banks.	+	
EFF	Dummy variable with value of unity if a state has cash reserve requirements and CIPC are not counted as reserves.	+	
RR	Measure of state cash reserve requirements. For each nonmember bank in a group, cash reserves required by the state are subtracted from reserves that would be required as a Federal Reserve member, and the difference is divided by total deposits. These ratios are averaged for nonmember banks in each group.	−	−
WEEKLY	Value of unity if the reserve settlement period is weekly, zero otherwise.	+	+
BIWEEKLY	Value of unity if the reserve settlement period is biweekly or semimonthly, zero otherwise.	?	?
REPORT	Value of unity if nonmember banks must file frequent reports with the state banking authorities on deposit liabilities and reserve positions, zero otherwise.	+	+
REC EXAM	Value of unity if nonmember banks do not have to report on reserve positions regularly, but must keep records on reserve positions to be inspected by state examiners during regular examinations, zero otherwise.	?	?
REP DEF	Value of unity if nonmember banks must report reserve deficiencies to state banking authorities within a short period of time after deficiencies occur, zero otherwise.	+	+
LO PEN	Value of unity if there are small dollar penalties on reserve deficiencies or if dollar penalties are infrequently enforced, zero otherwise.[1]	?	?
HI PEN	Value of unity if there are relatively large dollar penalties for reserve deficiencies which are enforced with relative frequency, zero otherwise.[2]	+	+
NE	Dummy variable with value of unity if a state has no cash reserve requirements, zero otherwise.		−
Ratio 150	Dummy variable with value of unity if the average ratio of cash reserves to required cash reserves for a group of nonmember banks is less than 1.5, zero otherwise.		+

1States in this category are Georgia, Iowa, Louisiana, Mississippi, New Mexico, North Dakota, South Dakota, and Wisconsin.

2States in this category are Alabama, Arkansas, California, Minnesota, Nebraska, New York, Oklahoma, Oregon, Texas, Washington, and West Virginia.

lowing four weeks. However, such results may reflect largely the degree to which cash holdings of banks fluctuate on a daily basis. To illustrate such an effect, seven banks had cash reserves on June 30 *smaller* than their average in the previous and the following four weeks.

Also, some of the eight banks that had higher cash holdings on June 30 would have little incentive for holding unusually high cash reserves on the *Report of Condition* date. Three of them are located in states that require nonmember banks to file reports on daily reserve positions shortly after each reserve settlement period. Of the remaining five banks with especially high cash reserves on June 30, two had exceptionally high average ratios of reserves to required reserves over the year 1976 (average ratios of 1.85 and 2.33), indicating that they generally

hold excess cash reserves. Thus, data for nonmember weekly reporting banks provide little evidence that they hold unusually high reserves on *Report of Condition* dates.

EFFECTS OF STATE RESERVE REQUIREMENTS ON REPORTING OF UNCOLLECTED FUNDS BY NONMEMBER BANKS

Specification of Variables

Banks in each state are divided into the size groups used in Table A-I. The following measures are used separately as *dependent variables.*

(a) percentage of nonmember banks which report CIPC that is equal to zero on their June 30, 1976 *Report of Condition,*

(b) percentage of nonmembers which report CIPC that is less than ten percent of their demand balances due from correspondents, and

(c) percentage of nonmember banks which report CIPC that is less than 25 percent of their demand balances due from correspondents.

Independent variables are described below. Their hypothesized influences are summarized in Table A-III.

Influence of Bank Size — Means of classifying uncollected funds appear to be related to bank size, the percentages specified above tending to be higher for smaller banks. Influences of bank size are estimated by using dummy variables (see Table A-III for specification of those variables).

Classification of Uncollected Funds by Member Banks — Ratios of CIPC to demand balances due from correspondents for *member* banks may be systematically related to the same ratio for nonmember banks of similar size in the same state. Independent variables reflecting the practices by member banks of reporting uncollected funds are constructed in the same way as the dependent variables specified above.

Geographic and transportation factors may influence the speed with which checks are collected by both member and nonmember banks in different states. Including independent variables based upon the ratios for member banks of CIPC to balances due from correspondents would account for these common influences on uncollected funds.

Another reason for including these measures for member banks is the variation among correspondent banks in methods of accounting for uncollected funds. Most of the observations in this paper are for banks with total deposits of less than $50 million. Many member banks in that size range clear checks through correspondents instead of through the FRS.[4] For these member banks, the practice of classifying uncollected funds as CIPC or balances due from correspondents will be influenced by the accounting practices of the correspondent banks through which they and nonmember banks clear checks. Member banks have no incentive to classify uncollected funds as due from balances, since both CIPC and demand balances due from correspondents are subtracted from gross demand deposits to determine demand deposits subject to member bank reserve requirements.

Use of these measures for member banks as independent variables could bias the results. Correspondents might adjust their methods of accounting for uncollected funds to accommodate the desire of nonmembers to use uncollected funds to meet state reserve requirements. Methods of accounting for uncollected funds by member banks would reflect, to some extent, the accommodation of correspondents to nonmember bank wishes. In this case, inclusion of variables for classification of uncollected funds by member banks in the regression analysis would bias downward the estimated influence of state reserve requirements on the classification of uncollected funds by nonmembers. To allow for such bias, variables for member banks are removed in some regression equations.

Classification of CIPC in State Reserve Requirements — A dummy variable is specified to reflect the incentives of nonmember banks to classify uncollected funds as demand balances due from correspondents: EFF has a value of unity for states that have cash reserve requirements and do not count CIPC as reserves, and has a value of zero otherwise.[5]

Measurement of State Reserve Requirements — Levels of state reserve requirements are difficult to compare. Some apply to demand deposits only; others apply to all deposits grouped together. Most states have different reserve requirements for demand and time deposits. Reserve requirements are flat percentages in some states and graduated in others. Thus, comparison of reserve requirements among states depends upon the size of banks for which comparisons are made and the composition of their deposit liabilities.

If a state allows nonmember banks to meet all of their reserve requirements with interest-earning assets, that state is considered to have no cash reserve requirements. Levels of reserve requirements are not calculated for those states. For each nonmember bank in other states, the relative level of state cash reserve requirements is measured by calculating cash reserves that would be required as a Federal Reserve member, subtracting cash reserves required as a nonmember, and dividing the difference by total deposits. This ratio, denoted as RR, is averaged for banks in each size group in the various states.

Monitoring and Enforcing State Reserve Requirements — There is substantial variation among states in procedures for monitoring the reserve positions of nonmember banks and for enforcing state reserve requirements. Dummy variables are used to reflect differences in reserve settlement periods, in methods of monitoring reserve posi-

[4] R. Alton Gilbert, "Utilization of Federal Reserve Bank Services By Member Banks: Implications for the Costs and Benefits of Membership," this *Review* (August 1977), pp. 2-15.

[5] Values for the levels of state cash reserve requirements and the indicators of monitoring and enforcement discussed below are set equal to zero for states that count CIPC as reserves and for those states with no cash reserve requirements.

Table A-IV

EFFECTS OF STATE RESERVE REQUIREMENTS ON THE REPORTING OF UNCOLLECTED FUNDS BY NONMEMBER BANKS

INDEPENDENT VARIABLES
(t-statistics in parentheses under regression coefficients)

Equation Number	Size 10	Size 50	Size 100	MPC 0	MPCI 25	EFF	EFF*RR	EFF*RR* REC EXAM	EFF*RR* REP DEF	EFF*RR* WEEKLY	Constant	$\bar{R}^2$	Standard Error	Degrees of Freedom[a]
(Dependent variable: percent of nonmember banks reporting CIPC as zero)														
1	38.65 (5.094)	8.64 (1.169)	−0.99 (−0.113)								19.45 (2.791)	0.495	15.582	77
2	8.47 (1.429)	−3.19 (−0.628)	−3.10 (−0.533)	0.87 (9.834)							15.92 (3.412)	0.775	10.404	76
3	8.80 (1.504)	−3.17 (−0.633)	−3.22 (−0.561)	0.85 (9.583)		4.01 (1.734)					14.41 (3.074)	0.781	10.270	75
4	7.91 (1.331)	−3.67 (−0.727)	−3.56 (−0.619)	0.85 (9.610)		4.75 (1.929)	−1.21 (−0.890)				14.86 (3.147)	0.780	10.284	74
5	37.77 (5.091)	8.09 (1.120)	−1.31 (−0.155)			7.39 (2.180)					16.49 (2.377)	0.519	15.216	76
6	37.65 (4.984)	8.01 (1.097)	−1.371 (−0.160)			7.52 (2.067)	−0.21 (−0.104)				16.57 (2.358)	0.513	15.315	75
7	34.35 (5.272)	8.276 (1.279)	−3.718 (−0.501)			7.02 (2.343)					16.66 (2.671)	0.507	14.829	93
(Dependent variable: percent of nonmember banks reporting CIPC as less than 25% of demand balances at correspondents)														
8	13.34 (3.207)	8.14 (2.010)	−2.74 (−0.575)								80.50 (21.073)	0.246	8.542	77
9	5.73 (1.145)	2.59 (0.579)	−4.58 (−0.983)		0.15 (2.545)						75.62 (18.176)	0.296	8.254	76
10	5.90 (1.184)	2.69 (0.603)	−4.50 (−0.971)		0.16 (2.597)	−2.44 (−1.334)					76.52 (18.246)	0.303	8.212	75
11	13.61 (3.277)	8.32 (2.057)	−2.64 (−0.555)			−2.30 (−1.211)					81.42 (20.966)	0.251	8.516	76
12	13.45 (3.181)	8.22 (2.011)	−2.72 (−0.567)			−2.12 (−1.041)	−0.29 (−0.254)				81.53 (20.738)	0.241	8.569	75
13	14.20 (3.671)	8.53 (2.276)	−0.09 (−0.020)					7.50 (3.720)	−8.02 (−3.559)	−2.12 (−1.409)	80.69 (22.659)	0.361	7.865	74
14	11.08 (2.833)	7.24 (1.864)	−4.34 (−0.974)								81.37 (22.388)	0.225	8.903	94
15	11.29 (3.033)	7.45 (2.016)	−2.38 (−0.559)					6.01 (2.994)	−7.97 (−3.495)	−1.91 (−1.184)	81.95 (23.604)	0.304	8.436	91

[a]Observations are for size groups in states with 10 or more nonmembers and 10 or more members, except equations 7, 14, and 15, which are for groups with 10 or more nonmembers with no minimum number of members.

tions of nonmember banks, and in penalties for reserve deficiencies.

Interaction Terms — Variation in the level of state reserve requirements may have a stronger effect on the classification of uncollected funds by nonmember banks in those states with more strict monitoring and enforcement of state reserve requirements. Interaction terms for the level of reserve requirements and dummy variables for enforcement are included as independent variables to test this hypothesis.

Empirical Results

In the first seven equations in Table A-IV, the dependent variable is the percentage of nonmember banks reporting CIPC equal to zero. The percentage of *member* banks reporting CIPC as zero is positively related to that percentage for nonmember banks [equations (2) – (4)]. Thus, the accounting practices of member and nonmember banks appear to reflect the common influences discussed above.

The one aspect of state reserve requirements which influences the percentage of nonmember banks that report CIPC as zero is the variable for states that have cash reserve requirements and do *not* count CIPC as reserves (EFF), having a positive influence as hypothesized [equations (5) – (7)]. Among states with cash reserve requirements which do not count CIPC as reserves, the level of reserve requirements (RR) does not add significantly to the explanation of the dependent variable [equation (6)].

However, when the percentage of member banks reporting CIPC as zero is included as an independent variable, the variable that reflects the status of CIPC in state reserve requirements (EFF) is not significant [equations (3) and (4)]. This result is consistent with the view that both member and nonmember banks base their methods of accounting for uncollected funds upon the accounting methods of correspondent banks, and that correspondent banks adjust their accounting methods to serve the interests of nonmember banks in meeting reserve requirements.

Equations (8) – (15) of Table A-IV present regression results with another dependent variable — the percentage of nonmemebr banks reporting CIPC which is less than 25 percent of their demand balances due from correspondents.[6] Several measures of state reserve requirements are significant, if the variable reflecting the reporting of uncollected funds by member banks is eliminated from regressions. The combination of measures of reserve requirements which yields the lowest standard error [reported in equation (13)] includes levels of state reserve requirements (RR), dummy variables reflecting differences among states in treatment of CIPC as reserves (EFF), and methods of monitoring reserve positions of nonmember banks (REC EXAM, REP DEF, and WEEKLY).[7]

[6]Effects of state reserve requirements were insignificant with the percentage of banks reporting CIPC which is less than ten percent of due from balances as the dependent variable.

[7]Value of the F-statistic for testing the combined influence of these three variables, compared to the explanation due to bank size variables alone, is 5.61. With 3 degrees of freedom in the numerator and 74 in the denominator, the F-statistic is significant at the 0.5 percent level. Equations (8) and (13) were reestimated with the expanded sample used in equation (7). The combination of variables reflecting state reserve requirements in equation (15) is significant at the 5 percent level (F-statistic of 4.564 with degrees of freedom of 3 and 91).

EFFECTS OF STATE RESERVE REQUIREMENTS ON CHOICE OF MEMBERSHIP STATUS BY BANKS

Specification of Variables

Percentage of banks that are members (as of June 1976) is the dependent variable. Membership status is strongly related to bank size; most very small banks are nonmembers and most large banks are members (see Table A-V). Effects of bank size are held constant by calculating the percentage of banks that are members in individual size groups in the various states, using the same size categories as in the previous sections.[8] Independent variables and hypotheses concerning the direction of influence of these variables on the percentage of banks that are Federal Reserve members are presented in Table A-III.

Empirical Results

Regression results are presented in Table A-VI. One test involves two measures of reserve requirement levels as

Table A-V

PERCENT OF INSURED COMMERCIAL BANKS IN EACH SIZE GROUP THAT WERE MEMBERS OF THE FEDERAL RESERVE SYSTEM AS OF DECEMBER 31, 1976

Asset Size (in millions)	Percent
$ 5 or less	18.7%
5 - 9.9	25.5
10 - 24.9	38.0
25 - 49.9	48.9
50 - 99.9	58.5
100 - 299.9	66.3
300 - 499.9	78.6
500 or more	86.7

Source: Federal Deposit Insurance Corporation

[8]The influence of state reserve requirements on choice of membership status by banks has been tested in other studies. See Chris Joseph Prestopino, "Do Higher Reserve Requirements Discourage Federal Reserve Membership?," *Journal of Finance* (December 1976), pp. 1471-80; John T. Rose, "Do Higher Reserve Requirements Discourage Federal Reserve Membership?: Comment," Board of Governors of the Federal Reserve System, mineo, June 1977. However, a major problem with those studies is that percentages of banks in the Federal Reserve System are calculated for entire states. They include measures to reflect the size distributions of banks in individual states. The approach in this study probably deals with that effect more directly. Another advantage of the approach in this paper is that it increases the number of degrees of freedom for statistical tests.

Table A-VI

EFFECTS OF STATE RESERVE REQUIREMENTS ON THE PERCENT OF BANKS THAT ARE FEDERAL RESERVE MEMBERS

Equation Number	INDEPENDENT VARIABLES (t-statistics in parentheses under regression coefficients)													
	Size 10	Size 50	Size 100	RR	NE	RR* Ratio 150	REPORT	REC EXAM	REP DEF	LO PEN	Constant	$\bar{R}^2$	Standard Error	Degrees of Freedom[a]
1	−38.04 (−6.573)	−23.69 (−4.165)	−9.82 (−1.582)								68.95 (13.709)	0.340	17.422	111
2	−37.46 (−6.368)	−23.36 (−4.080)	−9.62 (−1.544)	0.12 (0.091)	5.89 (1.138)						67.91 (13.152)	0.336	17.477	109
3	−36.99 (−6.238)	−22.64 (−3.889)	−8.76 (−1.379)	−0.41 (−0.269)	5.39 (1.030)	2.81 (0.738)					67.82 (13.105)	0.333	17.514	108
4	−36.16 (−5.513)	−22.41 (−3.457)	−8.74 (−1.238)								66.97 (11.615)	0.297	18.234	98
5	−34.85 (−5.577)	−20.79 (−3.364)	−8.74 (−1.302)				13.99 (3.383)				62.77 (11.170)	0.365	17.334	97
6	−35.91 (−5.926)	−21.95 (−3.666)	−9.46 (−1.450)					−14.46 (−4.225)			75.65 (13.251)	0.400	16.844	97
7	−34.20 (−5.468)	−20.13 (−3.254)	−8.20 (−1.223)				15.52 (3.602)		5.35 (1.228)		60.71 (10.375)	0.368	17.289	96
8	−34.11 (−5.536)	−20.06 (−3.291)	−7.85 (−1.185)				11.75 (2.784)			−8.92 (−2.014)	64.34 (11.514)	0.384	17.067	96

[a]Observations in equations (1) - (3) are for size groups in all states with five or more members and five or more nonmembers. **Observations in the remaining equations exclude size groups in states with no cash reserve requirements.**

independent variables: the measure of the level of cash reserve requirements (RR) and a dummy variable for states in which there are no cash reserve requirements (NE) [equation (2)]. The regression coefficients of those variables are not significant.

The regression coefficient for the level of state reserve requirements might be insignificant due to variation among states in the amounts of cash assets that banks hold in relation to their required reserves. In some states nonmember banks hold cash assets which, on average, are several times larger than required reserves, while in other states the ratios of reserves to required reserves are close to unity. Influence of the level of state reserve requirements on the percentage of banks that are Fed members might be greatest in those states in which cash holdings are relatively close to required cash reserves.

This hypothesis is tested by adding an independent variable calculated as the level of reserve requirements (RR) multiplied by a dummy variable with a value of unity if cash reserves are less than 150 percent of required cash reserves, and zero otherwise (Ratio 150). This variable is insignificant. Therefore, if state reserve requirements influence choice of membership status, the effects will have to reflect aspects of those requirements other than just the levels of cash requirements.

The most significant aspect of state reserve requirements in influencing membership choice is the procedure for reporting reserve positions to state banking authorities. The percentage of banks which are members is significantly higher in states that require nonmember banks to file periodic reports on their reserve positions (REPORT) [equation (5)].[9]

Some states monitor the reserve positions of banks by requiring them to report reserve deficiencies to the banking authorities shortly after incurring reserve deficiencies. The regression coefficient of a dummy variable which reflects this requirement (REP DEF) is not significantly different from zero [equation (7)]. With the

[9]The dummy variable for states in which nonmember banks do not send reports to their state banking authorities, but keep records of reserve positions for inspection by examiners (REC EXAM), has a negative regression coefficient which is approximately the same in absolute value as the regression coefficient for REPORT [equation (6)]. This result indicates that these two variables provide essentially the same information. In all but 18 of the 102 observations, either one or the other has a value of unity. Of these two variables, only REPORT is used in the other equations.

variable for periodic reporting of reserve positions to state banking authorities (REPORT) as an independent variable, the requirement of reporting reserve deficiencies (REP DEF) does not significantly influence the membership choice of banks.

Another variable which does significantly influence the percentage of banks in the Federal Reserve is a dummy variable for states which indicated that their dollar penalties for reserve deficiencies are relatively low or seldom imposed (LO PEN). The regression coefficient for this variable is negative [equation (8)], indicating that the percentage of members is relatively low in such states.[10]

[10]In regressions not reported in Table A-VI, the dummy variable for states with more strict enforcement of dollar penalties for reserve deficiencies (HI PEN) was substituted for LO PEN, other variables the same as in equation (8). The regression coefficient of HI PEN was not significantly different from zero. Additional tests were conducted to determine whether differences in levels of reserve requirements among states have significant influences on the percentage of banks that are members if significant features of state policies on monitoring and enforcement are held constant. Those tests involved adding independent variables derived by multiplying the measure for levels of reserve requirements (RR) by each of the significant dummy variables for enforcement (REPORT, LO PEN). In those equations (not reported in Table A-VI) the regression coefficient for those additional independent variables were insignificant.