Money, Inflation, and the Monetarist Explanation: Evidence from the Postwar U.S. Experience

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I. Introduction

This paper examines the monetarist prediction of the relationship between money and inflation. It uses postwar U.S. data to examine the empirical validity of the underlying assumptions, as well as the accuracy of the monetarist prediction. The postwar period is sufficiently long and well-suitied from both statistical and economic standpoints because there were large variations in the time series in which we are interested which took place in a variety of political and economic settings, both domestic and international.

A monetarist analytical framework is used to test some of the relevant propositions, and the empirical methods used in this paper are similar to those that have been employed to support the monetarist argument. In that framework, alternative explanations of inflation are ultimately reduced to just two: namely, the monetarist position that inflationary pressure reflects a change in the quantity of money relative to output, or the Keynesian position which also looks at changes in velocity produced, for example, by changes in fiscal policy or investment demand.1 To quote Friedman (1966, p. 2), "excess nominal demand reflects a change in the quantity of money, as I believe it generally does, or a change in velocity produced, for example, by changes in fiscal policy or investment demand, as others may believe." These two positions are summarized in the quantity theory identity written in differential form

\[ DM + Dy = DP + Dy \]

where \( M \) is nominal money, \( v \) is income velocity, \( P \) is prices, \( y \) is real output, and \( D \) before a variable represents its percentage rate of change. This identity may be written in a more useful form:

\[ DP = (DM - Dy) + Dv \]

Monetarists pay almost exclusive attention to the first term \((DM - Dy)\) as a direct or ultimate cause of inflation \( DP \), whereas Keynesians additionally attach varying degrees of importance to changes in \( Dv \), in both the short and long run. Monetarists assume that the \( Dv \) may vary in the short run but is zero or a (technologically determined) constant in a long run steady state equilibrium (Friedman 1970, 1971).

The essence of the monetarist position is clearly stated by its best known exponent:

The control fact is that inflation is always and everywhere a monetary phenomenon. Historically, substantial changes in prices have always occurred together with substantial changes in the quantity of money relative to output. I know of no exception to this generalization, no occasion in the United States or elsewhere when prices have risen substantially without a substantial rise in the quantity of

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1 A third explanation of inflation viewing expansionary monetary and fiscal policies as merely reaccelerating "one-push" inflation is beyond the scope of this paper.
money relative to output or what the quantity of money has risen substantially relative to output without a substantial rise in prices. And there are numerous confirming examples. Indeed, I doubt there is any other empirical generalization in economics for which there is as much organized evidence covering so wide a range of space and time. People seem to be extraordinarily stubborn about the real amount of money that they want to hold and are unwilling to hold a different amount, unless there is a strong incentive to do so. This is true over both time and space. The U.S. Civil War inflation and the German, Bolshievik, and Brazilian inflations are cited as evidence in support of some of the above propositions. Some economists wonder, however, what are the extreme instances of this. The evidence is relevant to the problem that [U.S.] economic policy faces right now or has faced. Unlike the large monetary changes and effects typical of hyperinflation, postwar U.S. policy has generally been concerned with relatively small causes and small effects. The next section of the paper presents a general theoretical framework for examining the phenomenon of inflation and the section which follows presents evidence based on published data sources. Section IV presents the summary and conclusions.

II. Theoretical Framework

The central issue at hand is what formal sense can inflation be described as being "always and everywhere a monetary phenomenon?" For an answer one must begin with the quantity theory since the "quantity theory is the basic component of monetarism" [Mayer 1973, p. 5]. In the quantity theory, the rates of growth of velocity and real output are independent of the rate of growth of money (at least in the long run), and inflation is determined entirely by the supply and demand for money. That is:

\[ DP = (D^M - D^v) \]  

(2)

which implies that there is no systematic relation between velocity on the one hand and income and interest on the other [e.g., equation (7) below]. Modern quantity theory recognizes the possibility of a non-zero interest elasticity of the demand for money. The resulting velocity-interest relationship can, however, only be a short-run phenomenon because, in the steady state the assumption of a horizontal IS curve produces a zero change in interest, and hence in velocity. [Friedman 1968, Gibson 1970, and Moosa 1979.] It is this assumption of the long-run invariance of the interest rate, and consequently of velocity, that is responsible for the monetarist claim that fiscal policy is impotent, or equivalently, that for fiscal stimulus to be inflationary it must be money-accommodated. Hence, inflation is "always and everywhere a monetary phenomenon."

Monetarists, however, prefer an asset demand specification of the demand for money with permanent (expected) income (or wealth) as the relevant scale variable [Friedman 1971]. Equation (3) thus become

\[ DP = (D^M - D^v) \]  

(3)

where \( D^v \) is anticipated real economic growth. Denoting by \( D^v \) the anticipated nominal income growth and by \( D^v \) the

anticipated inflation rate, equation (4) may equivalently be written as

\[ DP = (D^M - (D^v + D^v)) - D^P + (D^M - D^v) \]  

(5)

This equation reflects the basic idea underlying the dynamic model presented in Friedman [1971]. Regardless of the nature of the lag in the effect of money on output, positive values of \( D^v \) (or \( D^v + D^v \)) would lead to changes in the inflation rate \( DP \), as well as in nominal and real economic growth. However, through a process of adaptive expectations, a steady state will be reached in which \( DP = D^P, D^P = D^v + D^v \) and \( D^v = D^v \) [Friedman 1970, 1971]. It follows that if velocity growth is zero in the steady state and \( D^v = D^v \), Friedman [1971] emphasizes that changes in the money supply growth rate produce long and variable lagged responses of affected variables but that the demand for money adjusts without changes in other real factors. This is reminiscent of the policy function of the demand for money entering the demand for money function. However, the variability of these response leads, as well as the length of the underlying adaptive expectation process, is implicitly assumed to be finite (bounded) with the lag ranging from four to eight quarters. Consequently, \( DP \) is equal to the monetary stimulus \( (D^M - D^v) \) lagged four to eight quarters. Weaker assertion that it only the movements of \( DP \) and the lagged monetary stimulus \( (D^M - D^v) \) (judged, say, by their turning points) coincide [Friedman 1971].

A less extreme monetarist assumption is that velocity growth is not zero in the steady state but, rather, equals some technologically determined constant. Combining these assumptions with the additional assumption that active stabilization policy is likely to impair rather than improve economic stability (the acceleration theorem) leads to the constant money growth rate. That is, if steady state velocity growth is a technologically determined constant \( D^v \), then it follows that (non-inflationary) monetary growth \( D^v \) should be equal to the difference between long-run economic growth \( D^v \) and \( D^v \) \( D^v \). If \( D^v \) is equal to zero, then \( D^v \) should equal \( D^v \). Thus, the success of this rule is made to depend on the empirical behavior of velocity growth, which is implicitly assumed to converge (within four to eight quarters) onto a zero or a technologically determined constant value [Friedman 1976].

Alternative outcomes may not be ruled out. A positively sloping LM curve and a non-horizontal IS curve will produce a velocity-interest relationship and restrict the potency of fiscal policy on prices and/or output by prohibiting the velocity-accommodation of real stimuli. Furthermore, if the income elasticity of the demand for money is not equal to unity, then a positive velocity-income relationship emerges. Formally, if the real demand for money, \( m \), is specified as

\[ m = a + b r + c DP + \]  

(6)

where \( r \) is the nominal interest rate and \( a, b, \) and \( c \) are parameters, then the definition of velocity equal to \( jm \) implies that

\[ v = a + b r + c DP + \]  

(7)

where \( x \neq 1 \) indicates the existence of a velocity-income relationship. Evidence on income elasticities (\( x < 1 \)) is now more compelling as evidence concerning the interest sensitivity of the demand for money [e.g., Goldfield 1973, Moosa 1977a, and Laidler 1978].

It follows that a more general form of equation (1) may be written as

\[ DP = (D^M - D^v) + (D^v - D^v) \]  

(8)

where \( D^v \) is the desired rate of growth of money when income elasticity of the demand
for money is different from unity. That is, \( DM^* = aDy \) with \( a = 1 \) and hence the appearance of income-induced changes in velocity \( Dy \) in the second term. The difference \( (Dy - Dy) \) would then represent the rate of growth of velocity due to factors other than the rate of growth of real income, such as a change in the rates of interest and anticipated inflation, or in shift variables.

It is evident from the foregoing analysis that the monetarist and Keynesian positions attach different parameter values to the same (modified Hickian) theoretical model—[Barro-Fisher (1976), Modigliani (1977), and Arrow (1978)]. By making different assumptions about the values of these parameters, different predictions of velocity growth behavior emerge from the same transmission mechanism. Accordingly, we will examine in the next section not only the empirical validity of some of the above monetarist predictions but also some of the underlying assumptions concerning velocity growth behavior, the pivotal variable in the monetarist explanation of inflation. This paper does not question the relation between inflation \( Dp \) and lagged monetary growth \( DM \). That is a well-established proximate empirical regularity (Figure A2 in the Appendix). It is, however, the purpose of this paper to examine the monetarist "theoretical" explanation of this "empirical regularity." This "only money matters" explanation focuses solely on the relation between inflation \( Dp \) and lagged monetary stimulus \( (DM - Dy) \). The next section examines the empirical validity of this claim.

This paper examines only some of the monetarist explanations that command wide agreement. For instance, there are different monetarist monistions on the relative inflationary or deflationary potential of bond or money-financed government deficits, and on other issues not directly linked to inflation analysis [see Moyer (1978)]. Neither do we attempt to synthesize or compare the usefulness of the monetarist model with the alternative Phillips curve and structural models for the analysis of inflation. It follows that we will not be concerned with, say, the expectation-augmented Phillips curve or with the acceleration theorem, which has been embraced also.

III. Empirical Evidence

A. Data

This study used quarterly data covering the period 1948.2-1975.4. The nominal money supply \( M \) is represented by \( M1 \) data obtained from the Federal Reserve Bulletin. All other data were obtained from the Survey of Current Business. It is assumed that \( M1 \) rather than \( M2 \) is the relevant empirical definition of money for testing the monetarist inflation prediction, though we also produce some evidence with money broadly defined. The implicit deflator for gross national product, \( P \), is used to calculate the inflation rate \( DP \), real income \( y \) is measured by the real gross national product; real government expenditures \( y \) (include federal, state, and local government expenditures; real investment expenditures \( y \) are represented by the expenditures on gross private domestic investment; velocity \( v \) is calculated by \( y/v \); and the interest rate \( \epsilon \) is represented by the 90-day treasury bill rate. A "\( Dp " \) before a variable represents its percentage rate of growth. Hence, the alternative measure of the desired rate of growth of nominal money \( DM^* \) [equation (3)] is measured by \( 0.60Dy \). \( Dy \) is equal to 0.40Dy, represents the income-related growth in velocity because \( \epsilon \) in (6) and (7) is assumed to be equal to 0.60.

B. Smoothing Technique for Graphical Display

In general, our empirical method involves eliminating the "white-noise" from the data series and then graphically examining the relation between the white-noise-free drift or systematic components of the different time series. We make improved use of the highly flexible Almon (1965) procedure to capture the systematic components of the different time series. In particular, we use a nine-period (approximately equal to half the average trade-cycle-period) second-degree polynomial with the beginning and end lag points constrained to zero value; the Almon variable generated is then used as our measure of the systematic component. The use of a polynomial lag distribution to capture the systematic component of a time series would seem to introduce some bias into our measure; however, because of identical lag weights on all the variables, any such bias is identical in all the time series, making them directly comparable. We, nonetheless, eliminate the lag bias by working with lag adjusted measures; this makes them "rationally" in the sense that the mean values of their unsystematic components become approximately zero. Applied in an identical fashion to all the variables, this lag adjustment takes the form of finding the highest correlation between the actual value of a variable and its forward-lagged filtered value.

The efficiency of this approach for capturing the systematic component can be seen, for example, by comparing the actual and systematic components of the rate of growth of real output. Adopting the convention that a prime next to a variable represents its systematic component, we find that the mean values of \( Dy \) and \( Dy^* \) for the sample period 1948.2-1975.4 are 3.49 and 3.50, respectively. The respective values for the inflation rate are 3.24 and 3.23. These values are in accord with the required expected (mean) value of zero for the unsystematic components of the different time series. Its usefulness for comparative purposes can be seen by examining the variables in the quantity theory identity \( DM^* + Dy = DP + Dy^* \). Observe in Figure 1 that, as required by the identity, when \( (DM^* - Dy) \) equals zero, \( DP \) is equal to \( Dy \). Figure A1 in the Appendix, which contains plots of \( DP \) and \( DP^* \), provides a further illustration of the efficiency of our filtering procedure. The unsystematic components of the different time series were found to be characterized by "white-noise" and the filtering efficiency of this procedure was not
found to be sensitive to the use of alternative lag lengths.\(^7\)

**C. Graphical Testing**

By making intensive use of a graphical analysis of the different time series, this paper uses an approach that has served so well to popularize monetarism in both lay and academic circles. It is thus interesting to observe that for the most part, this method yields (in consistency with regression estimates presented below) results which are not supportive of the monetarist position.

Figure 1 enables us to determine the empirical validity of some monetarist assertions and related assumptions. The strong form of the monetarist claim is that in a growing economy, the inflation rate is equal to the excess of the rate of growth of nominal money over real output over some prior and variable period; for the U.S. it is thought to be between four to eight quarters earlier (Friedman 1976). This claim must be dismissed since \(DP\) is almost never equal to \((DM' - Dy')\), either lagged or unlagged, and differs from it by substantial margins. In contrast to this claim, \(DP\) is inversely related to \((DM' - Dy')\) lagged six quarters (average of four and eight) (Figure 2). The difference between \(DP\) and \((DM' - Dy')\) is identically equal to \(Dx'\), the value of which is neither zero nor constant (zero value being a necessary condition for the steady state \(DP = DM - Dy\)). There is no tenancy for velocity growth to even approach zero (or any constant value), and it takes on substantial values for many years at a time, and maintains a statistically significant inverse relationship with \((DM' - Dy')\).

Neither is there evidence in support of the weaker monetarist claim which states that there is a coincidence in the short run movements of \(DP\) and \((DM' - Dy')\) lagged between four and eight quarters (Friedman 1976). Figure 2 shows that the short run correlation has the wrong sign when monetary stimulus is lagged, as the model requires. Indeed, Figure 2 indicates an apparently perverse relation in that turning points in \(DP\) lead rather than lag turning points in \((DM' - Dy')\). Even though temporal ordering of turning points of \(DP\) and \((DM' - Dy')\) may be an unreliable test for causality and the size of the lag in the effect of monetary stimulus on inflation (Tobin 1970), the temporal ordering of turning points strongly suggests a simultaneous or bidirectional relationship, possibly due to the "accommodative" posture of monetary policy operating in a regime of wage-price stickiness [Gordon (1976), Hall (1975)].

**D. Regression Tests**

A similar qualitative picture of the temporal association between the variables emerges in equation (9), which is a Cochrane-Orcutt (1949) generalized least squares regression of the actual rate of inflation \(DP\) on current, past and future actual values of monetary stimulus \((DM - Dy)\), estimated from quarterly data for the post-Adams period 1953:1-1975:4. For notational convention let \((DM - Dy) = Dx\). The results were qualitatively similar when the right-hand side variables appeared separately in the regression.

\[
\begin{align*}
DP &= 0.02DX_{t-4} - 0.03DX_{t-3} - 0.03DX_{t-2} - 0.03DX_{t-1} + 0.03DX_{t-5} \\
&+ 0.02DX_{t-6} + 0.04DX_{t-7} - 0.03DX_{t-8} + 0.18DX_{t-9} - 0.04DX_{t-10} \\
&+ 0.07DX_{t-11} + 0.05DX_{t-12} + 0.09DX_{t-13} + 0.09DX_{t-14} + 2.64 \\
&- 2.45(1.78) (2.34) (3.04) (14.36)
\end{align*}
\]

\(R^2 = 0.69\) \(DW = 1.99\) \(SE = 1.15\) \(\rho = 0.31\) \(\phi = 2.95\)

\(\rho\) is the value of the autoregressive parameter.
E. The Role of Velocity

Exclusive concern with the coincidence in the movements of DP and (DM – Dy) thus produces results that are contrary to the monetarist prediction. Furthermore, it is evident from Figures 1 and 2 that even the average value of DP for the period 1948.2-1964.6 was closer to that of Dy than to that of (DM – Dy), which was generally negative (contractionary). Moreover, Figure 3 reveals a close correspondence between the rates of growth of velocity on the one hand and private investment and government expenditures, Dg + i′, on the other, a relationship not affected by separating Dg + i′ into Dg and D(i′). In the monetarist model, this association is given a causal interpretation [see Friedman (1966, n. 2) quoted in the second paragraph of this paper]. A dynamized Hrickian framework suggests that, despite the contractionary monetary policy over that period (DM – Dy) < 0, both income growth and inflation were due to the large increases in the rate of growth of government and private investment expenditures accommodated by income and interest-induced increases in velocity growth. This is clearly borne out by Figure 3 and the average values in Table 1. High values of real stimulus (Dg + i′) are associated with high values of Dv′, and vice versa. After 1966.4, when Dg + i′ declines, so does Dv′, while (DM – Dy) is consistently positive and large and its level is more closely associated with that of DP. It may thus be inferred that the behavior of velocity cannot be usefully ignored in the analysis of inflation, in either the short run (which monetarists accept) or the long run (which they do not). The behavior of Dv′, due mainly to changes in Dg + i′, was the dominant (direct or ultimate) cause for changes in DP in the earlier period (1948.2-1964.6), whereas the behavior of (DM – Dy) was the (direct or ultimate) cause for those changes for most of the later period (1967.1-1975.4).

The use of Dy′ as a measure of the desired rate of growth of money in the measure of monetary tightness or ease (DM – Dy) assumes that the income elasticity of the velocity in step with Dy′. As DP approached some unacceptable threshold rate, the increase in DP would slow down and the increase in Dy′, which is less than that of DP, would cause (DM – Dy) to rise with DP. As inflation exceeds some unacceptable threshold rate, DM may even decline and possibly become negative; if there is an additional interest and income expansion-induced decline in investment, Dy′ may become negative making (DM – Dy′) more negatively related. The monetarist may observe some improvement in the rate of DP and monetary policy may become easier; Dy′ would begin to expand and the cycle would repeat itself. However, depending on the extent of capacity utilization and the excess of fiscal policy, the accommodation may, at varying degrees, also come through income and interest-induced increases in velocity growth, the former effect being due to the presence of economies of scale in the holding of money balances.

Money, Inflation, and the Monetaryist Explanation

Table 1: Average Rates of Change*  

<table>
<thead>
<tr>
<th>Period</th>
<th>DM</th>
<th>Do</th>
<th>Ds</th>
<th>DM-Ds</th>
<th>DM-Dv′</th>
<th>DM-Do</th>
<th>DM-Dy′</th>
<th>Dy′</th>
<th>Ds</th>
<th>Do</th>
<th>Dv′</th>
<th>Dg + i′</th>
<th>Dy′</th>
<th>Dv′</th>
<th>Dy′</th>
<th>Dg + i′</th>
</tr>
</thead>
<tbody>
<tr>
<td>1948.2-1964.6</td>
<td>1.63</td>
<td>0.69</td>
<td>2.62</td>
<td>5.92</td>
<td>-4.29</td>
<td>-1.92</td>
<td>4.54</td>
<td>-4.35</td>
<td>7.18</td>
<td>11.99</td>
<td>14.48</td>
<td>14.48</td>
<td>23.08</td>
<td>19.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1951.3</td>
<td>2.16</td>
<td>2.24</td>
<td>2.26</td>
<td>2.14</td>
<td>0.02</td>
<td>0.88</td>
<td>1.38</td>
<td>0.58</td>
<td>0.72</td>
<td>11.04</td>
<td>-235.52</td>
<td>11.04</td>
<td>-235.52</td>
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<td></td>
</tr>
<tr>
<td>1958.3</td>
<td>1.98</td>
<td>3.08</td>
<td>2.38</td>
<td>3.24</td>
<td>-1.42</td>
<td>-0.06</td>
<td>2.44</td>
<td>-0.59</td>
<td>2.78</td>
<td>4.48</td>
<td>12.72</td>
<td>-254.60</td>
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<td>-254.60</td>
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<tr>
<td>1965.4</td>
<td>2.47</td>
<td>4.07</td>
<td>1.72</td>
<td>4.82</td>
<td>-2.35</td>
<td>-0.42</td>
<td>2.14</td>
<td>0.67</td>
<td>1.09</td>
<td>5.54</td>
<td>16.64</td>
<td>17.32</td>
<td>16.64</td>
<td>17.32</td>
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<td></td>
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<tr>
<td>1967.1</td>
<td>6.70</td>
<td>8.00</td>
<td>4.13</td>
<td>3.77</td>
<td>3.33</td>
<td>4.68</td>
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<td>5.61</td>
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<tr>
<td>1973.4</td>
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<td>4.04</td>
<td>8.70</td>
<td>0.45</td>
<td>4.66</td>
<td>4.85</td>
<td>3.85</td>
<td>7.52</td>
<td>1.34</td>
<td>-1.51</td>
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<td>40.72</td>
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<td>40.72</td>
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<tr>
<td>1975.4</td>
<td>7.03</td>
<td>3.92</td>
<td>2.80</td>
<td>4.62</td>
<td>-1.83</td>
<td>-0.22</td>
<td>2.31</td>
<td>0.20</td>
<td>2.03</td>
<td>4.94</td>
<td>13.66</td>
<td>-138.12</td>
<td>13.66</td>
<td>-138.12</td>
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<tr>
<td>1969.4</td>
<td>6.17</td>
<td>8.65</td>
<td>2.29</td>
<td>3.77</td>
<td>4.73</td>
<td>0.92</td>
<td>5.81</td>
<td>-0.05</td>
<td>4.78</td>
<td>50.97</td>
<td>50.97</td>
<td>50.97</td>
<td>50.97</td>
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<tr>
<td>1975.4</td>
<td>3.48</td>
<td>3.25</td>
<td>2.34</td>
<td>3.50</td>
<td>-0.01</td>
<td>1.39</td>
<td>1.86</td>
<td>1.93</td>
<td>3.59</td>
<td>11.32</td>
<td>-75.43</td>
<td>11.32</td>
<td>-75.43</td>
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</tr>
</tbody>
</table>

*These are averages of actual rates of growth rather than of the systemic components of those rates, even though the difference between them is practically nil. For example, the mean values of DP and Dy′ are 3.24 and 3.25 respectively.
income (because of the presence of economies of scale in the holding of money balances), the interest rate (because it is the opportunity cost of holding money), and the anticipated inflation rate (because the real rate may not be constant and because substitution may take place not only between money and other financial assets but also between money and physical goods), as arguments in the velocity equation.

Recognition of the presence of such economies of scale in the holding of money balances results in a significant improvement in our ability to explain the average rate of inflation. We assume, in accord with available evidence (Goldfield (1973); Moosa (1977a)), that the income elasticity of the demand for money is 0.60. It follows from equations (6) that the income elasticity of velocity is 0.40. We may then develop two additional adjusted measures of monetary stimulus, \( DM^* \) and \( D_t - Dy_t \).

Following the development of equation (8), \( DM^* \) in our measure \( DM - DM^* \) is equal to 0.60Dy, and \( D_t - Dy_t \) in our measure \( DY - D_t \) is equal to 0.40Dy. Consequently, \( D_t - Dy_t \) represents the growth in velocity due to non-income factors (interest, anticipated inflation, and shift variables). Table 1 shows the average values of several relevant variables for several sub-periods and Figure 4 plots the values of \( D_t \), \( DM - DM^* \), and \( D_t - Dy_t \). Figures A3 and A4 in the Appendix show the relationship between the actual and adjusted measures of monetary stimulus and velocity growth. Following our earlier argument that velocity growth due to non-monetary influences, was more closely associated with the inflation rate in the earlier period whereas monetary stimulus was more closely associated with the inflation rate in the later period, we compare the average values of \( D_t \) for the two sub-periods (1948-2-1966.4 and 1967.1-1975.4) with \( DM - Dy_t \) and \( D_t - Dy_t \) on the one hand and with the adjusted measures \( DM - DM^* \) and \( D_t - Dy_t \) on the other. It is readily seen that ability to explain \( D_t \) with adjusted measures of monetary stimulus and velocity growth is markedly improved assuming economies of scale in holding money balances. For the earlier period, the average rate of inflation of 2.08 compares with average values of adjusted measures of velocity growth and monetary stimulus of 2.31 and -0.22 on the one hand, and of 3.92 and -1.83 for their respective unadjusted measures on the other. For the later period, the average rate of inflation of 5.65 compares with average values of adjusted measures of monetary stimulus and velocity growth of 4.73 and 0.92 on the one hand, and of 3.77 and 1.87 for their respective unadjusted measures on the other. Based on a dynamic interpretation of the Hicksian framework, relationships reflected in Figures 3 and 4 and in Table 1, indicate that changes in velocity growth due to high rates of growth of government and investment expenditures were the (direct or ultimate) cause of inflation in the earlier period, while excessive monetary stimulus was the (direct or ultimate) cause of inflation in the later period. This generalization (elaborated upon and qualified below) is permitted by the particular combination of real and monetary stimuli that prevailed in these two relatively homogeneous sub-periods, and is corroborated by statistical difference-of-means tests. In principle, of course, these stimuli may work in a variety of combinations reinforcing or offsetting (to varying degrees) the positive, neutral, or negative impulse of one another.

As is well known, no amount of evidence pointing to the association between variables can by itself establish causal relationships. Thus, the evidence presented above does not "prove" that inflation in the pre-1966 period was induced or accommodated by changes in velocity growth or that, in the post-1966 period, it was induced or accommodated mainly by changes in monetary growth. Subjective judgement is inevitably involved in evidence evaluation and the confidence attached to alternative theoretical models.

F. Additional Evidence

Further insight into the postwar inflation experience of the U.S. is obtained by a more careful examination of the relationship between the time series of \( D_t \) and \( DM^* \) as shown in Figure 5. Current values of both variables are used, not because we assume a zero lag in the effect of money on prices but because, as indicated by equation (9), an unlagged relationship corresponds most closely to the monetarist prediction, apparently due to a simultaneous or bi-directional relationship. The relation between \( D_t \) and \( DM^* \) is graphed in Figure 6. Figures 5 and 6, and their summary in Table 1, show that there were three or four distinct phases in the postwar inflation experience of the U.S. First, we have the immediate postwar years extending beyond the Korean War when \( D_t \) was highly variable and unrelated to \( DM^* \). Apparently, this variable reflects the high volatility of \( D_t \) and \( D_t \), the readjustment of the economy to the devaluation caused by World War II, and the uncertainty and dislocation preceding and following the Korean War. The negative value of \( DM^* \) and the large positive values of \( D_t \) and \( D_t \) suggest the importance of non-monetary (i.e., non-money supply) influences on \( D_t \). Non-monetary influences also stand out more clearly in Figure 6 where the adjusted measure of monetary stimulus is used as the explanatory variable. There is a second period extending to around 1966, when velocity growth associated with high rates of growth of government expenditures and private investment expenditures provides the dominant explanation for \( D_t \). Monetary policy has, on balance, a small restraining influence on \( D_t \) during this period, judging by the small aver-
age negative value of 0.42 assumed by \( \frac{\text{DM} - \text{DM}^*}{} \) (see Table 1).

A third phase began around 1966 when monetary stimulus became consistently positive and its level was closer to that of \( D^* \). The relation is much tighter for high values of monetary stimulus than for low or negative values when velocity growth was relatively higher. A fourth phase began in 1973. We observe in Figures 5 and 6 that the relation between \( D^* \) and monetary stimulus \( shifts upward \) in 1973, reflecting the force of supply shocks that hit the U.S. and other economies. These shocks seem to have added an average of three to four percentage points to the inflation rate between 1973 and 1975. These were not sustained shocks, however; we thus observe a gradual tapering off of their impact on prices, though by late 1975, their effects on the inflation rate were still evident. This importance of supply factors is also evident from the observed departure during this period in the typical positive relationship between changes in \( \Delta (p + i) \) and the rate of interest rate growth, \( Dr \) (Table 1).

**G. Potential Sources of Bias**

Our analysis thus far has been conducted under the assumption that \( M1 \) rather than \( M2 \) is the relevant empirical definition of money. This assumption is supported by recent evidence. For example, Goldfeld (1973) finds that \( M2 \) has a poorer forecasting performance, fails formal stability tests, and concludes that more rather than less disaggregation is desirable. Money (1977) finds that \( M1 \) and near money substitutes are so non-homogenous in demand that aggregation is devoid of economic meaning. Further, time deposits are not a medium of exchange and thus in the analysis of inflation, \( M1 \) ought to be the relevant empirical definition of money, since the recorded higher prices were the result of transactions consummated using a medium of exchange. Finally, the absolute and comparative slowness in the adjustment toward equilibrium of estimated time deposit demand functions violates a key element of monetarist models, namely, "full and instantaneous adjustment of the amount of money demanded to the amount supplied" (Friedman 1971). Nevertheless, for completeness, Table 1 also presents measures of \( M2 \) monetary stimulus and velocity growth for the sub-periods dealt with in the preceding two paragraphs. It is evident that the overall conclusions of the paper remain intact.  

To the extent that changes in the supply of money influence variables that determine the demand for money, a dynamic interdependence is forged between supply and demand and hence, between the supply of money and velocity. This must be taken into account in the analysis of inflation. The absence of such a dynamic model in this paper does not materially affect our conclusions because part of our purpose is to show how the recognition of velocity-income relation due to the presence of economies of scale in the holding of money balances, helps in better explain the inflation rate. Since we also demonstrate this (in Table 1) by looking at the average rate of inflation over extended, relatively "homogeneous" sub-periods rather than the period to period (quarter by quarter) inflation rate, the absence of a dynamic model is of much less moment.

The relation between monetary stimulus and inflation is a dynamic one, yet no plausible lag structure can be invoked to argue the monetarists' case and account for the almost consistently positive value of \( D^* \) and the almost consistently negative value of \( \frac{\text{DM}^* - \text{DM}}{} \) for the almost twenty-year-long period 1948.2-1966.4. Even with the most generous interpretation of the data, the situation in the earlier period of almost twenty years appears to be a far cry from the pure form of the

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1A detailed analysis of the data is available from the author upon request.
“fiscal-induced money-accommodated” type of inflation. The fiscal inducement was rather velocity-accommodated. Moreover, with high values of $\frac{DP}{M}$ and a small average value of $(DM - DM)_{0.22}$, velocity growth in turn did not appear to have been mainly money-induced either.

IV. Summary and Conclusions

Inflation is a more complicated phenomenon than admitted by monetarists. The post-war inflation experience of the U.S., ranging from a low rate steady inflation to a high rate variable one, indicates an association of uneven strength between inflation and monetary stimuli. We have attempted to show that any analysis of inflation that relies exclusively on observing monetary stimuli is likely to be misleading because the rate of growth of velocity, influenced as it is also by non-monetary forces, is neither zero nor constant in either the short or long run. If the Hicksonian paradigm is used to give the observed associations a causal interpretation, then it may be said that excess demand due to increases in private investment and government expenditure was the main direct or ultimate cause of moderate inflation in the earlier postwar years up to the mid to late 1960's, during which period monetary policy generally played a restraining role. The situation in this period was very different from the pure form of the "fiscal-induced money-accommodated" type of inflation. Rather, it was income and interest-induced velocity growth that did the accommodating. From about the mid to late 1960's, monetary stimulus $(DM - Dy)$ became positive and was more closely associated with the level and movement of a higher rate of inflation. Beginning in 1973, additional pressure on prices was exerted by the food and oil crises.

The experience of the U.S. in the immediate postwar years, when inflation was mostly positive, and at times large, and when velocity increased at a high rate in the midst of a contractionary monetary policy, is evidence against the monetarist position that there has been "no occasion in the United States or elsewhere when prices have risen substantially without a substantial rise in the quantity of money relative to output." The related proposition that when the quantity of money has risen substantially relative to output so have prices, receives empirical support when we examine the post-1966 inflation experience of the United States. However, even during this period, the rate of growth of velocity, due in part to supply-induced increases in (anticipated) inflation, was at times substantial and contributed commensurately to the price rise.

We conclude that the monetarist theoretical explanation yields accurate predictions for only the period 1967-1973, a period of relatively high inflation spanning the Vietnam conflict. For the remainder of the postwar period, non-monetary factors (such as investment and fiscal-induced velocity growth, and some supply factors, which apparently were not money-induced or accommodated) had an important and sometimes dominant influence on the inflation rate. This overall finding supports Solow's (1966) Keynesian position that the importation causality relationship during hyperinflation is not very pertinent to the U.S. postwar inflation experience and is contrary to Friedman's (1966) monetarist position that the "central fact in that inflation is always and everywhere a monetary phenomenon." If the monetarist model is deemed to apply only to periods of substantial and sustained inflation, then such episodes were not only unusual, but supply factors and velocity growth were not insignificant and at times dominant during many of these episodes.

This paper does not question the empirical relation between inflation $(DP$ and monetary growth $(DM$. That proximate "irreversible link" is amply evident. This paper does question the tentative theoretical explanation offered by monetarists for this observed empirical regularity. Little empirical support was found for the pivotal monetarist assumption concerning the behavior of velocity growth; its rate of growth was neither zero nor constant, even in the very long run. It was found, instead, to more sympathetically with the (non-zero) rates of growth of the nominal interest rate and real output. While the influence of technological change on velocity growth is undoubtedly present, empirical estimates of demand for money functions suggest that the capital-theoretic explanations of the Baumol-Tobin theories can provide a straightforward rationalization of the observed velocity-income relationship. In the absence of empirical evidence supporting the assumption of a horizontal IS curve, it is not surprising that we were able to show that income- and interest-induced velocity-accommodation of real stimuli was the dominant cause of inflation over the pre-1966 period. Monetary stimulus $(DM - DM)_{0.22}$ had, on average, a neutral effect on inflation over this period.

There is also little empirical support for the monetarist hypothesis concerning the movement of inflation and monetary stimulus $(DM - Dy)$. Not only was there an absence of an equality between the actual or average values over long periods, but the predicted coincidence in the movements of inflation and lagged monetary stimulus also failed to appear. The lag turned out to be zero or negative. The "irreversible link" between monetary growth and inflation emerges from a "black box" and there is little empirical evidence to support the predicted relation between monetary stimulus and inflation. This empirical regularity remains a piece of evidence in search of a theory. 1

1A more general Keynesian orientation with its focus also on the importance of supply factors and the velocity accommodation of real stimuli was able to provide a more satisfactory (and complementary) explanation of the postwar U.S. inflation experience. Nevertheless, the "post hoc ergo propter hoc" empirical methods used and the evidence generated were unable to throw light on such important issues as the relative potency of monetary and fiscal policies, the relation between monetary and fiscal policies in a regime containing autonomous monetary and fiscal policy reaction functions, the associated transmission mechanisms of monetary and fiscal policies, and apparent monetary non-stabilities generating a dependence between monetary and velocity growth.

The evidence suggests, as acknowledged by Friedman (1970, 1971), that a more satisfactory explanation would have to examine the dynamic chart and long run interde

1Friedman (1946)
Appendix

Figure A1. The Rate of Inflation—Actual and Systematic Components

Figure A2. Money, Inflation and Economic Growth

Figure A3. Inflation and Monetary Stimulus

Figure A4. Inflation and Velocity Growth
References
8. ------, The Optimum Quantity of Money and Other Essays, Chicago, Aldine, 1969.