**GRADUATE SCHOOL
OF INDUSTRIAL ADMINISTRATION**
WILLIAM LARIMER MELLON, FOUNDER

REPRINT NO. 803

Inflation and Price Changes: Some Preliminary Estimates and Tests of Alternative Theories

by

Pieter Korteweg and Allan H. Meltzer

1978

Carnegie-Mellon University
PITTSBURGH, PENNSYLVANIA 15213

Graduate School of Industrial Administration

William Larimer Mellon, Founder

Carnegie-Mellon University

Pittsburgh, Pennsylvania 15213

SOME CURRENT REPRINTS

- 680. On Defining Sets of Vertices of the Hypercube by Linear Inequalities by R. G. Jeroslow.
- 681. Risk and Return: The Case of Merging Firms by Gershon Mandelker.
- 682. A Subadditive Approach to the Group Problem of Integer Programming by Claude-Alain Burdet and E. L. Johnson.
- 683. Computing the Natural Factors of a Closed Expanding Economy Model by Gerald L. Thompson.
- 684. Facets of the Knapsack Polytope by Egon Balas.
- 685. Rejoinder on Reid and Honeycutt by Baruch Lev and Gershon Mandelker.
- 686. Multivariate Risk Aversion, Utility Independence by Scott F. Richard.
- 687. Whither the Epidemic? Psychoactive Drug-Use Career Patterns of College Students by Terry C. Gleason, Joel W. Goldstein, and James H. Korn.
- 688. Effect of Perceived Inequity on Salary Allocation Decisions by Paul S. Goodman.
- 689. A Stochastic Model for Auditing by Robert S. Kaplan.
- 690. Bayesian Analysis and Duopoly Theory by Richard M. Cyert and Morris H. DeGroot.
- 691. Optimal Consumption, Investment and Life Insurance Decisions in a Continuous Time Model by Scott F. Richard.
- 692. Interdependence and Complementarity — The Case of A Brokerage Office by Johannes Pennings.
- 693. Planning Horizons for the Dynamic Lot Size Model: Protective Procedures and Computational Results by Rolf A. Lundin and Thomas E. Morton.
- 694. Statistical Sampling in Auditing by Robert S. Kaplan.
- 695. Set Partitioning: A Survey by Egon Balas.
- 696. Experimental Logics and Δ_2^0 Theories. Robert G. Jeroslow.
- 697. Some Comparisons of Tests for Shift in the Slopes of a Multivariate Linear Time Series Model. John U. Farley, Melvin Hinich, and Timothy W. McGuire.
- 698. Experimental Results on Hillier's Linear Search. Robert G. Jeroslow and T. H. C. Smith.
- 699. The Relevance of the Structural Contingency Model for Organizational Effectiveness. Johannes M. Pennings.
- 700. The Effect of Aggregate Economic Variables on Congressional Elections. Francisco Arcelus and Allan H. Meltzer.
- 701. Efficiency of the Natural Rate: A Review Article. Edward C. Prescott.
- 702. Medical Manpower Models: Need, Demand and Supply. Judith R. Lave, Lester B. Lave, and Samuel Leinhardt.
- 703. Improving Subjective Probability Assessment for Planning and Control in Team-Like Organizations. Nicholas J. Gonedes and Yuji Ijiri.
- 704. The Decision Process of 6- and 12-Person Mock Juries Assigned Unanimous +2 and 3's Majority Rules. James H. Davis, Norbert L. Kerr, Robert S. Atkin, Robert Holt, and David Meek.
- 705. Estimation in the Presence of Stochastic Parameter Variation. Thomas F. Cooley and Edward C. Prescott.
- 706. Disjunctive Programming: Cutting Planes from Logical Conditions. Egon Balas.
- 707. Discrete Optimal Control of Production Plans. P. R. Kleindorfer, C. H. Kriebel, G. L. Thompson, and G. B. Kleindorfer.
- 708. The Significance and Investigation of Cost Variances: Survey and Extensions. Robert Kaplan.
- 709. Adaptive Utility. Richard M. Cyert and Morris H. DeGroot.
- 710. Organizational Rewards and Retention of the Hard-Core Unemployed. Paul S. Goodman.
- 711. The Price-Level Restatement and Its Dual Interpretation. Yuji Ijiri.
- 712. An Operator Theory of Parametric Programming for the Generalized Transportation Problem: Part I. Basic Theory. Part II. Rim, Cost and Bound Operators. V. Balachandran and G. L. Thompson.

(continued on inside back cover)

INFLATION AND PRICE CHANGES:
SOME PRELIMINARY ESTIMATES
AND TESTS OF ALTERNATIVE THEORIES

Pieter Korteweg
Erasmus University, Rotterdam

and

Allan H. Meltzer*
Carnegie-Mellon University

In countries experiencing real and nominal shocks, output, relative prices, and the price level do not adjust instantly from one set of long-run equilibrium values to the next. Economists have speculated on the reasons for slow or gradual adjustment without reaching firm conclusions. Currently, the most widely accepted hypothesis to describe the phenomenon is some type of Phillips curve relating the current rate of change of prices to some measure of unemployed resources and to the anticipated rate of price change.

Although there are many versions of the Phillips curve, there is a common theme; see Laidler and Parkin (1975) and Gordon (1976). The rate of price change deviates from the anticipated or equilibrium rate of change in direct relation to the size of aggregate excess demand. The Phillips curve is a price adjustment equation, and is generally treated as an aggregate supply relation, so there is a positive association between the level of output and the rate of price change. In the usual statement of the Phillips curve,

$$(1) \quad \hat{p} = h(y - y_0) + \hat{p}^a,$$

where $\hat{p}$ and $\hat{p}^a$ are the actual and anticipated rates of price change, and $y - y_0$ is the difference between actual (y) and full employment (y_0) output or real income. In some versions, y and y_0 are logarithms of actual and full employment output. At times, the unemployment rate replaces $y - y_0$ as the measure of excess demand.

The Phillips curve is a disequilibrium relation that developed in the attempt to extend Keynesian theory to a world of rising prices and money

* We are indebted to Karl Brunner for many discussions, to Dean Dutton, Martin Feldstein, David Laidler, and Johan Myhrman for their helpful suggestions, and to Dipankar Chakravarti for his assistance.

wages. Conventional Phillips curves make the deviation from full employment output relevant for pricing decisions even if there is no reason to anticipate that full employment will be restored within the period for which price and output decisions are made. A unit of full employment "gap" has the same effect in deep depressions as in mild recessions. A known, or anticipated, gap changes $\hat{p}$ relative to $\hat{p}^a$ instead of changing $\hat{p}^a$ and anticipated output.

An alternative theory of supply starts with a micro supply curve relating price and output. Linear aggregation of the micro supply curves yields a relation between the price level and aggregate output that differs from the Phillips curve. The rate of price change depends on the rate of change of output or income, not on the level of income. Large changes in the rate of change of real income have larger effects than do small changes. If the aggregate supply curve is significantly nonlinear, the level of output, or the gap between actual and anticipated or actual and full employment output, may also affect the rate of price change, though these effects would not be the principal or dominant influences.

The difference between the two theories of supply becomes clearer if (1) is rewritten as:

$$(2) \quad \hat{p}_t = h [(\hat{y} - \hat{y}_0)_t + (\ln y - \ln y_0)_{t-1}] + \hat{p}_t^a,$$

where the $\hat{}$ indicates a relative rate of change and $\ln$ is a natural logarithm. The terms between the brackets are a rearrangement of $\ln y - \ln y_0$ in (1).

In the conventional Phillips curve, y_0 is best thought of as full employment output. Both terms between brackets are treated as equal with respect to their influence on $\hat{p}$. The difference between actual and anticipated rates of price change depends on the full employment gap, as before.

In the alternative theory, y_0 is best taken as representing anticipated output. The first term of (2) dominates the second. The difference, $\hat{p} - \hat{p}^a$, depends mainly on the difference between actual and anticipated rates of growth of output. The gap between the anticipated and past levels of output has its principal effect on $\hat{p}^a$. Once $\hat{p}^a$ is determined, this gap has a minor and much less significant role.

It is useful to regard the alternative theory as an equilibrium theory and the conventional Phillips curve as a disequilibrium theory of the output market. In an equilibrium theory, price and output are determined at the intersection of the aggregate demand and aggregate supply curves. All available

information about the position of the output market affects the anticipated rate of change of output and the anticipated rate of price change. There is no unused information about the rate of price change in the "gap" between current output and full employment output. In contrast, the conventional Phillips curve assigns significance to the current or lagged value of the full employment gap. The gap is a measure of disequilibrium, and the rate of price change depends on the size of the disequilibrium.

The equilibrium theory need not be treated as the limiting case of a standard Phillips curve. An equilibrium relation between the rate of price change and the rate of change of output can be obtained starting from the first-order condition derived from a standard production function. As in Brunner and Meltzer (1976), we rearrange the first-order condition to obtain

$$p = p(y, K, w), \quad p_1, p_3 > 0 \quad p_2 < 0$$

where p , y , K , and w are, respectively, the price level, real output, real capital, and the money wage. Let capacity output y_0 be

$$y_0 = y(K),$$

and let the money wage depend, inter alia, on the anticipated price level p^a , so that

$$w = w(p^a, \dots).$$

Then,

$$p = p(y, y_0, p^a)$$

is a supply curve relating price and output that holds as an equilibrium relation whenever the first-order condition holds.

Suppose that the first-order condition always holds. Measured unemployment is now a consequence of misperception, unforeseen shocks, or incorrect anticipations, as in Lucas's (1975) equilibrium model of the business cycle.

Further, assume that the supply curve is linear in the logarithms of the variables. Differentiating, we obtain

$$(3) \quad \hat{p} = a_0 \hat{y} - a_1 \hat{y}_0 + a_2 \hat{p}^a,$$

which can be further constrained by setting $a_0 = a_1$ and $a_2=1$ to test well-known propositions in economic theory.

Meltzer (1977) compared the equilibrium theory to the standard Phillips curve and concluded that, for the U.S. during this century, the data give more support to the equilibrium theory. In this paper, we test the alternative theories on several sets of data.

Most studies of the Phillips curve treat excess demand as a given to concentrate on the determinants and speed of adjustment of supply. Monetary and fiscal policies, real shocks, and other disturbances are assumed to shift aggregate demand and to set off a process that changes wages, prices, output, and balances of payments or exchange rates. The relative importance of monetary, fiscal, and other impulses on aggregate spending, a major issue in contemporary economics, is left unresolved by these studies.

The monetary theory of the balance of payments takes a different approach; see Mundell (1968) and Johnson (1972). By assumption--the "law of one price"--prices of (tradable) goods and interest rates are equal everywhere, so the principal, and perhaps the only, effect of monetary and fiscal policies and real shocks is on the balance of payments, on the exchange rate, or on the relative price of nontradable to tradable goods. These propositions appear to hold in an approximate way given a long enough period, but, if these propositions were always true, there would be little opportunity to observe differences in rates of inflation across countries. Evidence for annual or shorter periods gives either very weak support, or no support at all, to the law of one price; see Genberg (1976), Pattison (1976), and Cross and Laidler (1976).

In contrast, the recent work of Brunner (1976) and Brunner and Meltzer (1976) analyzes economies with fixed exchange rates in which prices and incomes, interest rates and asset prices may differ from country to country in the short term, but are connected by the reallocation of expenditure, borrowing and lending, and balances of payments. The long-run equilibrium price level and rate of price change for each country reflect the influence of domestic and foreign stimuli, as in the monetary approach. Countries' policies affect the short-term path of economic activity and cause rates of inflation to diverge.

This paper compares the alternative approaches and obtains estimates of the effects of monetary, fiscal, and other influences on the rate of change of prices for several countries and groups of countries called blocs. In the sections that follow, we first introduce a model of anticipations, assume equilibrium in the output market, and solve for the current rate of price change as a function of the anticipated rate of price change. We test the model using a sample drawn from twenty-four countries, differing in size, stages of development, and degrees of openness to foreign trade, but restricted to annual observations for a brief period, the years of the "dollar standard," 1957 to 1972. These data have some limitations. We discuss the data, present some evidence, and draw the implications of our estimates for theory and policy. Then we estimate some alternative models, similar to those proposed in recent literature on the Phillips curve, and compare the equilibrium and disequilibrium theories of supply. Finally, we summarize the results and the conclusions they appear to support.

I. A MODEL OF ANTICIPATED AND MEASURED RATES OF PRICE CHANGE

Economic theory distinguishes between real and nominal shocks and between inflation and one-time adjustments of the price level. Technical change, crop failures, abundant harvests, and changes in the degree of monopoly are among the factors that raise or lower the price level. Such changes are distinct from the maintained rates of price change resulting from sustained growth in the world gold stock or from government policies that maintain the growth of money above the rate of growth of real output.

The model we test against alternatives is adapted from a recent study of rates of price change in the U.S. by Meltzer (1977) and earlier work by McGuire (1976) that separate maintained inflation and once-and-for-all price changes. Some adjustments are made to reflect the influence of foreign monetary and fiscal policies. Others adjust the model to the available data.

Along a steady growth path, the fully anticipated rate of price change remains constant. Economic theory implies that in equilibrium the fully anticipated rate of price change $\hat{p}^a$ is the difference between the maintained rate of monetary expansion μ and the maintained rate of growth of output g . Equation (4) expresses this relation:

$$(4) \quad \hat{p}^a = \mu - g.$$

Departures from long-run equilibrium give rise to an excess demand for, or supply of, money and goods. The anticipated rates of change of prices and output depart from steady state values. The size of the departures varies over time and between countries, and depends on factors such as the source of the disturbance and the speed with which information becomes available. As Lucas (1975, 1977) emphasizes, separation of absolute and relative price changes poses a particularly difficult problem for the decision makers in a market economy who observe rates of change of prices, income, money, and other variables.

Similar problems arise for the economy as a whole. Relative prices change permanently as a result of such real shocks as sustained changes in technology, population, real resources, taxes, and tariffs. Monetary shocks and temporary real shocks have short-term effects on relative prices that must be separated from the effects of permanent real shocks. The true value of μ must be inferred from current monetary and fiscal policies. With fixed exchange rates, foreign as well as domestic policies influence μ . Separating once-and-for-all price changes from maintained rates of price change provides additional opportunity for error.¹

Shocks and errors cause current rates of change of prices and income to fluctuate around the long-term path and to induce changes in velocity. The quantity equation, with all terms written as relative rates of change, relates the current rates of change of aggregate expenditure, $\hat{M} + \hat{V}$, to the nominal value of current income, $\hat{p} + \hat{y}$:

$$(5) \quad \hat{M} + \hat{V} = \hat{p} + \hat{y}.$$

Equations (4) and (5) constrain the system to positions of long- and short-run equilibrium. Rational agents know that (4) does not hold always and everywhere. But, (4) contains information about the evolution of the economy that affects the anticipated rate of inflation and, therefore, affects the current demand for money. Departures from long-run equilibrium are fully reflected in the demand for money and, therefore, in monetary velocity.

The demand for nominal money balances depends on the market rate of interest i , on stocks of base money B , and of debt S , on nominal income yp , and on actual and anticipated prices:

¹Changes in a fixed weight price index will reflect some changes in relative prices, as well as real shocks, changes in the degree of monopoly, and maintained inflation.

$$M = L(i, p, p^a, B, S, yp).$$

$$L_1, L_3 < 0, \quad L_2, L_4, L_5, L_6 > 0$$

We assume the demand function is homogeneous of first degree in prices and the value of financial assets. Velocity, the ratio of current income to the demand for money, is then

$$V = v(i, \frac{p^a}{p}, \frac{B}{p}, \frac{S}{p}, y),$$

$$v_1, v_2 > 0, \quad v_3, v_4 < 0, \quad v_5 \geq 0$$

where $i = r + \hat{p}^a$, with r being the market rate of return on physical capital. We postulate that

$$r = \frac{p}{c_0 p^a} n(y - y_0, \frac{B}{p}, \frac{S}{p}, y_0),$$

$$n_1, n_3 > 0, \quad n_2, n_4 < 0$$

where y_0 is capacity output. By assumption, the replacement cost of existing capital is proportional to the anticipated price level. The ratio $p/c_0 p^a$ expresses the effect on measured real rates of return of changes in the price of current production relative to the replacement cost of existing capital.

Taking logarithms of the V and r equations and differentiating both equations, we obtain relative rates of change of V and r , written as $\hat{V}$ and $\hat{r}$. The parameters v_i and n_i are now treated as elasticities. Let $\hat{i} = \hat{r} + \frac{d\hat{p}^a}{\hat{p}^a}$, where the latter term is the expected rate of price acceleration. Substitute for $\hat{r}$ in the $\hat{V}$ equation and combine terms to obtain (6):²

²The coefficients of (6) are elasticities that are formed from linear combinations of the coefficients of the V and r equations. The combinations are

$$\begin{aligned} w_1 &= (1 - n_2 - n_3) v_1 - (v_2 + v_3 + v_4) < 1 \\ w_2 &= (v_2 + v_1) > 0, \text{ if } v_2 > v_1 \\ w_3 &= v_3 + v_1 n_2 < 0 \\ w_4 &= v_4 + v_1 n_3 \\ w_5 &= v_5 + v_1 n_1 > 0 \\ w_6 &= v_1 (n_4 - n_1) < 0. \end{aligned}$$

$$(6) \quad \hat{V} = w_1 \hat{p} + w_2 \hat{p}^a + w_3 \hat{B} + w_4 \hat{S} + w_5 \hat{y} + w_6 g.$$

A small term, the anticipated rate of price acceleration, is omitted; g is the rate of growth of capacity output, $\frac{dy_0}{y_0}$.

The system is assumed to be in short-run equilibrium whenever we observe values of $\hat{p}$, so we substitute (6) into (5) and solve for $\hat{p}$. Current rates of monetary change are given by $\hat{B}$, used as our measure of $\hat{M}$ in (5) and elsewhere. We obtain

$$(7) \quad \hat{p} = \frac{w_2}{1-w_1} p^a + \frac{1+w_3}{1-w_1} \hat{B} + \frac{w_4}{1-w_1} \hat{S} + \frac{w_5-1}{1-w_1} \hat{y} + \frac{w_6}{1-w_1} g.$$

To reduce problems of estimation, let the anticipated acceleration of output $\Delta \hat{y}$ be equal to the difference between current $\hat{y}$ and long-run normal growth g . This assumption avoids the problem of finding measures of capital stock and other variables affecting supply. Clearly, our assumption is not applicable or appropriate for all periods, but we believe it is a useful approximation for many countries during the period used for our estimates. Since w_5 and w_6 are assumed to be approximately equal in magnitude, but have opposite signs, we can now rewrite (7) as³

$$(8) \quad \hat{p} = \frac{w_2}{1-w_1} \hat{p}^a + \frac{1+w_3}{1-w_1} \hat{B} + \frac{w_4}{1-w_1} \hat{S} + \frac{w_7}{1-w_1} \Delta \hat{y} - \frac{1}{1-w_1} g.$$

Below, we introduce additive error terms, define μ , and estimate (4) and (8) for the period 1957-72. Then, we test our hypothesis by comparing estimates obtained using a standard Phillips curve.

³The coefficient of $\Delta \hat{y} = \hat{y} - g$ is $\frac{w_7}{1-w_1}$. The numerator is $(w_5 - 1)$ or $-(w_6 + 1)$. The two terms are equal in magnitude if v_5 and $v_1 n_4$ are both small or are of similar order and opposite sign. (See note 2 above.) The term $\frac{-1}{1-w_1} g$ is included in the intercept below, along with any other variables that affect $\hat{p}$ without affecting the right-hand side of (7).

II. THE DATA

Our data set consists of twenty-four countries that reported most of the variables required for our tests to the International Monetary Fund (IMF) from 1956 to 1972. The countries are listed in note 4.⁴ Seventeen countries were grouped into four major blocs. Five of the original members of the EEC (Luxembourg is included with Belgium) are treated as a bloc; four Nordic countries are a second bloc; three European members of the former Free Trade Area are a third bloc. A more heterogeneous grouping--Australia, Canada, Japan, New Zealand, and the U.S.--are grouped in a "Pacific" bloc.

Each country is treated as an independent entity, and relative rates of change of base money, debt, prices, etc., are computed for the world, for the country, and for the rest of the world as seen from that country. The "rest of the world" consists of the remaining twenty-three countries. Rest-of-the-world variables have a superscript r .

Several conventions were adopted. These affect all of the variables in our analysis and the interpretation of our results.

First, real income and all nominal stocks and flows were converted to U.S. dollars at annual IMF conversion factors before rates of growth were computed. This procedure adjusts country gross real domestic product, our measure of real income, for gains or losses in country purchasing power relative to the world when the world was on a dollar standard. GDP growth after adjustment is closer to a measure of income growth than to a measure of the growth of physical output. Similarly, base money, debt, and our measure of government spending--the cash flow surplus or deficit--are converted to U.S. dollars at current conversion rates before computing growth rates.

Second, the world and rest-of-the-world price levels are weighted averages with weights h_{zt} :

$$h_{zt} = \frac{DG_{zt}}{\sum_z DG_{zt}}$$

The numerator of h_{zt} is real gross domestic product of country z in year t converted to U.S. dollars at the annual conversion ratio. The denominator

⁴The data are taken from International Financial Statistics. Descriptions and detailed statement of sources are available on request. The seventeen countries with complete data have been grouped into blocs. Countries are listed by blocs, followed by the seven countries for which some fiscal measures or debt are not available for all or most of the period. ECC bloc: Belgium, France, Germany, Holland, Italy; Nordic bloc: Denmark, Finland, Norway, Sweden; other Europe bloc: Ireland, Switzerland, U.K.; Pacific bloc: Australia, Canada, Japan, New Zealand, U.S.; ungrouped countries: Austria, Greece, Iceland, Portugal, Spain, Turkey, Yugoslavia.

Table 1

Simple Correlations

*

Range	$\hat{B}, \hat{B}^r$	$\hat{p}, \hat{p}^r$	$\hat{S}, \hat{S}^r$	$\hat{y}, \hat{y}^r$	γ, γ^r	$\hat{\Delta B}, \hat{\Delta B}^r$	$\hat{\Delta p}, \hat{\Delta p}^r$
Negative	1	0	2	1	5	4	4
0 to .20	0	0	3	3	3	5	3
.21 - .40	2	4	5	1	7	5	8
.41 - .60	7	6	5	6	2	1	2
.61 - .80	6	7	1	6	0	2	0
.80 and above	1	0	1	0	0	0	0
Median of 17 countries	0.55	0.53	0.38	0.52	0.30	0.20	0.25
U.S.	0.25	0.68	0.40	0.17	0.51	-0.59	0.42
Denmark	-0.14	0.53	0.29	0.53	0.40	-0.06	0.40
Holland	0.59	0.49	0.51	0.69	0.30	0.26	-0.39

Note: B = monetary base

p = price index (CPI)

S = government debt outstanding

y = gross domestic product (real)

 γ = Δ cash flow deficit/gross domestic product (nominal) of the previous year $\hat{}$ = relative rates of change.

is the sum of the real dollar value of GDP in the twenty-four countries. The world price level is, then,⁵

$$p_t^w = \sum_z p_{zt} h_{zt}$$

The domestic consumer price index is used as the measure of the price level.

Third, relative rates of change are obtained in the usual way. The relative rate of change for the rest-of-the-world price level for country z in year t is denoted $\hat{p}_{zt}^r$, such that

$$\hat{p}_{zt}^r = \frac{(p_t^w - h_{zt}p_{zt}) - (p_{t-1}^w - h_{zt-1}p_{zt-1})}{p_{t-1}^w - h_{zt-1}p_{zt-1}}$$

Similar procedures are used to compute all rest-of-the-world rates of change. The rate of change of domestic prices is $\hat{p}_{zt}$. The rate of acceleration for any variable is obtained by taking the first difference of the relative rate of change.

To obtain some preliminary information about the degree to which the seventeen countries contain information that is not entirely common, we computed simple correlations between the relative rates of change of some principal variables for each of the seventeen countries and for the twenty-three countries comprising the rest of the world as seen from that country. As a standard of comparison, we chose a large country, the U.S., and two small open economies, Holland and Denmark. Table 1 shows frequency distributions of the correlation coefficients for relative rates of change and for accelerations of base money and prices in seventeen countries, and compares the median correlation for the seventeen countries to the measured correlation for the large and the two small open economies.

Contrary to versions of the monetary approach to the balance of payments that do not distinguish short- and long-term adjustment, the data show substantial variability in the relation between domestic and rest-of-the-world rates of growth of monetary and fiscal variables. The median correlation is highest for growth rates of base money and lowest for cash flow deficits. Although the median correlation between domestic and world growth rates

⁵The weights were not constrained to sum to unity. This introduces an error in price levels, but the error has very small effect on the relative rates of price change, the variable we seek to explain.

of base money is relatively high, the greater part of the variance of the growth of the domestic base is not explained by synchronous changes in "world money." Further, there is considerable dispersion in the correlations and very little evidence of systematic association between accelerations and decelerations of the domestic and rest-of-the-world base money.⁶

Comparison of the median correlations with the correlations for the U.S., Denmark, and Holland does not permit any simple conclusions to be drawn. Domestic and rest-of-the-world rates of price change and rates of price acceleration are more highly correlated for the U.S. than for the median country or for the two small open economies. Correlations for rates of change of debt and the cash flow deficit for the U.S. are as high or higher than in the median country. The growth rates of the U.S. and Danish base appear to be relatively independent of the short-term rate of growth of base money in the rest of the world; the growth rate of the base in Holland is more closely related to the rate of change of base money in the rest of the world.

A final comparison suggests that monetary expansion in the rest of the world affects domestic rates of price change through several different variables. Frequently, $\hat{p}$ is most closely related to $\hat{B}^T$. The median correlation of $\hat{B}^T$ and $\hat{p}$ is 0.57 for the seventeen countries, and in thirteen countries, the correlation is 0.50 or above. For the European countries, with one exception, $\hat{p}$ is more closely correlated with $\hat{B}^T$ than with $\hat{B}$, and usually $\hat{B}^T$ is more closely correlated with $\hat{p}$ than with $\hat{B}$. In the countries of the Pacific bloc, relationships differ. $\hat{B}^T$ is often more highly correlated with $\hat{B}$ than with $\hat{p}$. These differences suggest that there is not a simple, uniform mechanism linking foreign money to domestic money and then to prices through the trade account or the base. The short-run effects of foreign variables appear to operate through a number of channels.

III. ESTIMATES AND IMPLICATIONS

To compute the anticipated rate of inflation $\hat{p}^a$, we define μ and g in (4) and use the values predicted by the equation as estimates of $\hat{p}^a$. The actual rate of price change can differ from the anticipated rate of inflation when there are real shocks affecting $\Delta\hat{y}$ or unanticipated changes in government fiscal and monetary policies. The estimated $\hat{p}^a$ is only one of the variables determining the observed rate of price change $\hat{p}$. In this section, we use the

⁶Using the z-transformation with seventeen observations, the 0.95 confidence interval for the correlation coefficients is approximately 0.50. This test implies that $r < 0.50$ is not significantly different from zero.

estimate of $\hat{p}^a$ from (4) with other variables in (8) to separate the effects of sustained and current impulses and to test an equilibrium theory of inflation.

The effect on the price level of financing fiscal policy by issuing debt is one of the principal issues in recent comparisons of monetarist and Keynesian theories. Christ (1968) finds that the effect of debt finance on prices is ambiguous; Stein (1976) concludes that the effect is small in the U.S. and can be neglected. Brunner and Meltzer (1976) show that, in an open economy, differences in fiscal stimuli are sufficient for devaluation of exchange rates. To compare the long-term effect of sustained changes in debt and base money, we define μ as a weighted sum:

$$\mu = a_1 \hat{B}_{-1} + a_2 \hat{B}_{-1}^r + a_3 \hat{S}_{-1} + a_4 \hat{S}_{-1}^r,$$

where $\hat{B}_{-1}$, $\hat{B}_{-1}^r$, $\hat{S}_{-1}$, $\hat{S}_{-1}^r$ are three-year moving averages of measured rates of growth of the monetary base and the stock of outstanding government debt in each country and in the rest of the world as seen from the country. Each of the components of μ is lagged one year to impose a two-year average lag in the effect of monetary and fiscal impulses on the anticipated rate of inflation. The same procedure is used for $\hat{y}$; a three-year moving average of the rate of change of real income, lagged one year, is taken as the maintained rate of growth, g . A two-year average lag has been found in several studies of recent inflation; see Hamburger and Reisch (1976), Weintraub (1976), and Meltzer (1977). The two-year lag is not a constant of nature, but its use seems preferable to the alternative—using some of our few degrees of freedom to gain the appearance of a better estimate. Substituting for μ and g in (4) and assuming that the true $\hat{p}^a$ is observed with an additive error, we estimate $\hat{p}^a$ for seventeen countries, five blocs, and the twenty-four-country world. Table 2 summarizes the findings.⁷

Five conclusions seem warranted. First, the combined response to B^r and $\hat{B}$ generally falls in the neighborhood of 0.4. Second, the response to $\hat{B}^r$ is the most reliable of the five responses, as measured by the t-statistics. Third, the effect of debt finance is small and insignificant for each of the blocs and for many of the countries. An important exception is the response to $\hat{S}^r$ in the bloc called Other Europe. Fourth, the coefficient on $\hat{y}$ is substantially below unity and occasionally positive. Consequently, this variable gives little support

⁷Individual country regressions can be obtained from the authors.

Table 2
Estimates of $\hat{p}^a$

Group	Intercept	$\hat{B}_{-1}$	$\hat{B}_{-1}^r$	$\hat{S}_{-1}$	$\hat{S}_{-1}^r$	$\hat{y}_{-1}$	$\bar{R}^2/DW$
EEC (80) (t-stat.)	1.24 (1.51)	- 0.01 (0.09)	0.38 (3.21)	- 0.04 (0.80)	1.01 (0.41)	0.09 (0.73)	0.11/
Other Europe (48)	0.11 (0.14)	- 0.12 (1.14)	0.65 (5.62)	0.05 (1.19)	0.55 (2.37)	- 0.05 (0.34)	.51/
Nordic (64)	1.61 (1.82)	0.01 (0.15)	0.42 (3.05)	- 0.01 (0.22)	- 0.07 (0.24)	0.24 (2.24)	.24/
Pacific (80)	2.17 (2.68)	0.15 (2.42)	0.26 (2.56)	0.01 (0.86)	- 0.16 (0.79)	- 0.14 (1.13)	.15/
World (16)	1.70 (1.47)	0.46 (2.84)		- 0.28 (1.01)		- 0.06 (0.21)	.39/1.90
Median of 17 countries	- 0.46	0.07	0.31	- 0.07	0.10	0.25	0.53/1.90

Note: Sample size for countries and blocs is shown after the group name. DW-statistics for blocs are meaningless and are not shown.

to our hypothesis about anticipations. Fifth, no more than half the variance in $\hat{p}$ is explained by the regressions in Table 2. Most of the variation in the rate of price change cannot be explained as a result of past policies or lagged average rates of output change. One reason, consistent with our hypothesis, is that much of the price change may be accounted for by once-and-for-all changes in the price level that do not affect the anticipated rate of inflation.

The estimate of $\hat{p}^a$ obtained from the regressions for each group and country in each year is used to test the hypothesis in (8).⁸ The current rate of price change depends on anticipated inflation, on current domestic policy, and on the current rate of acceleration of output. The effect of the maintained growth rate and all other independent influences on $\hat{p}$ are combined in an intercept. Table 3 shows the responses of $\hat{p}$ to the arguments of (8).

The anticipated rate of price change dominates all other variables. The response of $\hat{p}$ to $\hat{p}^a$ is approximately unity for the median country and for many of the individual countries and the blocs. There is, also, a small negative effect of $\Delta\hat{y}$ on $\hat{p}$. Both $\hat{B}$ and $\hat{S}$ are statistically significant at $t \geq 2.0$ in only a few cases, but both have a positive effect in each of these cases. The small intercept for the world, the median country, and several blocs suggests that there is no unexplained "trend" rate of price change.

The last column of Table 3, labeled Σ , shows the sum of the coefficients of all nominal values to check on the homogeneity of the $\hat{p}$ equation. Most of the countries lie within 10 percent of unity, and for the median country the sum is 0.97. The results support the homogeneity assumption. By far, the largest contribution to the sum comes from the anticipated rate of inflation.

The near unit coefficients for $\hat{p}^a$ and near zero coefficients for $\hat{B}$ and $\hat{S}$ place some strong restrictions on the coefficients of (8) and permit a check of the consistency of the estimates. The coefficient of $\hat{S}$ is close to zero if and only if w_4 is approximately zero. From note 2 above, we see that, for $w_4 = 0$,

$$v_4 = -v_1 n_3 .$$

The response of velocity to the government debt depends on the wealth effect (v_4) and the effect of debt on interest rates (n_3) and of interest rates on velocity

⁸Our procedure treats $\hat{p}^a$ as an instrument variable. The procedure would be equivalent to two-stage least squares if the regressions for $\hat{p}^a$ are taken as the first stage and the regressions in Tables 3 and 5 are treated as the second stage.

Table 3

The Current Rate of Price Change

Group or Country	Intercept	$\hat{p}^a$	$\hat{B}$	$\hat{S}$	$\Delta\hat{y}$	$\bar{R}^2/DW$	Σ
EEC	0.56	0.82*	0.02	-0.01	-0.14*	0.19	0.83
Other Europe	0.19	0.95*	- .02	.08*	- .05	.58	1.00
Nordic	0.69	0.91*	- .04	- .00	- .08*	.35	0.87
Pacific	0.54	0.74*	.05*	.00	- .07*	.25	0.79
World	0.19	0.77	.06	.06	- .15	.54/1.66	0.90
Median of 17 countries	0.02	0.94	0.01	0.01	-0.06	0.72/1.81	0.97
Germany	0.20	0.75*	0.05*	-0.01	-0.05	0.89/1.56	0.79
France	0.35	0.87	.05	.04	- .23	.17/1.81	0.97
Holland	0.02	1.17*	- .10	- .00	.01	.42/2.14	1.06
Belgium	-0.05	1.03*	- .02	.01	.01	.74/2.77	1.02
Italy	-1.45	0.79*	.19*	- .01	- .06	.80/2.36	0.97
U.K.	-0.32	1.10*	- .01	.01	- .12	.74/1.61	1.09
Switzerland	1.56*	0.68*	- .02	.14*	- .28*	.93/2.79	0.80
Ireland	-0.01	1.08*	- .04	.14	- .06	.68/1.63	1.18
Sweden	-0.06	0.73*	.18	.01	- .16	.41/1.63	0.92
Norway	-1.32	0.80	.14	.08	- .30	.32/1.45	1.01
Denmark	0.35	1.00*	- .05	- .02	- .01	.91/2.70	0.93
Finland	0.77	0.89*	- .01	- .02	- .04	.39/1.76	0.85
U.S.	0.08	0.98*	.01	- .02	- .08	.63/0.97	0.96
Canada	-0.23	0.99*	.01	.02	- .04	.88/2.07	1.02
New Zealand	0.34	1.06*	.04*	- .17	- .02	.80/2.44	0.92
Australia	0.21	0.93*	.14*	- .18	- .10*	.72/1.53	0.89
Japan	-0.32	0.94*	0.02	0.01	-0.08	0.60/2.10	0.97

Note: DW = Durbin-Watson statistic.

Detail may not add to sum due to rounding.

* Indicates $t \geq 2.0$.

(v_1). The two effects of debt are offsetting in most countries. From (8), we find that zero coefficients for $\hat{B}$ and $\hat{S}$ occur together only if

$$w_3 = -1,$$

and

$$w_4 = 0.$$

This implies (see note 2) that

$$v_1 = -\frac{1+v_3}{n_2} = -\frac{v_4}{n_3},$$

or, in terms of the elasticities of velocity and the anticipated return, n :⁹

$$\epsilon(V,i) = -\frac{\epsilon(V,S)}{\epsilon(n,S)} = -\frac{1+\epsilon(V,B)}{\epsilon(n,B)}.$$

The finding of near zero coefficients for $\hat{B}$ and $\hat{S}$ does not imply that monetary and fiscal changes have no effect. On the contrary, both $\hat{B}$ and $\hat{S}$ change interest rates and wealth and induce changes in the balance of payments position and, thus, in $\hat{B}^r$. If the wealth and interest rate effects on $\hat{p}$ are offsetting, the direct effect is small. However, maintaining the monetary and fiscal impulses raises the average rates of change, $\hat{B}$ and $\hat{S}$, and in this way domestic policy contributes to $\hat{p}^a$. Further, $\hat{B}^r$ changes. The results, summarized in Table 2, show that the response of $\hat{p}^a$ to $\hat{S}$ is generally small and unreliable, but the response of $\hat{p}^a$ to $\hat{B}^r$ is most reliable.

Our results for debt finance are similar to the results reported by Stein (1976, p.211). Using quarterly data for the U.S., Stein found a small, negative effect of debt finance on the rate of price change, approximately -0.06 to -0.09. We find a coefficient of $\hat{S}$ of -0.02 for the U.S. and +0.01 for the median country, using annual data from a different sample. Moreover, Stein found

⁹A survey by Fase and Kuné (1975) shows a wide range of estimates for interest elasticities of money demand computed from quarterly data. Using estimates for long-term rates and a narrow definition of money (M1), the estimates of v_1 range from -0.07 to -0.86.

that the principal determinant of the current rate of price change is the anticipated rate of inflation, a finding that is entirely consistent with our results, not only for the U.S., but for all countries and blocs.

IV. COMPARISON WITH PHILLIPS CURVES

The inflation augmented Phillips curve has become a standard explanation of inflation. Our hypothesis differs from the Phillips curve hypothesis in several respects. This section discusses the differences and presents some estimates for comparison with Table 3.

Most statements of the Phillips curve make the current rate of price change depend on the anticipated rate of inflation and some measure of excess demand. Common measures of excess demand include the unemployment rate or its reciprocal, and the gap between current and full employment output. Comparable measures of unemployment or full employment output are not available for many countries. Laidler (1974), Cross and Laidler (1976), and Parkin (1977) use deviations from the trend of the logarithm of real output or income as a measure of excess demand. A typical version of equation (2) from Laidler (1974, p.536) is, using our notation,

$$(9) \quad \hat{p}_t = a_0 (\ln y - \ln y_0)_{t-1} - a_1 (\ln y - \ln y_0)_{t-2} + a_2 \hat{p}_{t-1},$$

where $\ln y$ and $\ln y_0$ are natural logarithms of the levels of actual and full employment real income, respectively, and a_0 , a_1 , and a_2 are parameters combining the Phillips curve trade-off and adaptive adjustment of $\hat{p}$; $a_2 = 1$ for $\hat{p}_{t-1}$ defined as anticipated inflation. In practice, Laidler and Parkin have used several alternatives to $\hat{p}_{t-1}$ to summarize past or anticipated inflation. Their measures include the past rate of world inflation and the trend rate of domestic inflation.

One principal difference between our hypothesis, represented by (4) and (8), and a standard Phillips curve, represented by our equation (2) or (9), is in the interpretation given to past price changes. Measured rates of price change combine information about past inflation with once-and-for-all adjustments of the price level. The usual approach treats as equivalent all changes in the price level, whether they result from real shocks, tariffs, taxes, other one-time changes in government policy, or from maintained rates of monetary growth. Every increase in the current price level that contributes to the measured rate of price change becomes part of anticipated inflation.

Our hypothesis attempts to distinguish between one-time changes and maintained rates of price change. Only the latter affect the anticipated rate of inflation. The anticipated rate of inflation at the start of a period (year) depends mainly on past, maintained rates of monetary expansion, but the anticipated rate of price change for the year differs from the anticipated rate of inflation at the start of the year if, for example, money growth deviates from the maintained rate of expansion or there are real shocks.

A second main difference between our hypothesis and standard Phillips curves is the analysis of changes in demand and the effects of current policy. Equation (9) and other standard Phillips curves make no attempt to use information on current policy to alter anticipations of inflation. The only effects of current policy are on excess demand, and these effects are not often shown. The prevailing hypothesis is that the current effect of policy is on excess demand and only later on the rate of price change.

In contrast, we permit current changes in monetary and fiscal policies to affect both current spending and the current rate of price change. Changes in policy change the level of spending and the price level by shifting expenditure along the supply curve of output. Output and prices respond to changes in spending provided money wages do not instantly adjust.

Our hypothesis analyzes the effects on spending and embeds the result in an equilibrium condition, the quantity equation. Output responds to demand. The standard Phillips curve specifies the effect of excess demand on supply price. The gap between current output and full employment output is assumed to be a measure of excess demand, but rarely is there a test for the effect of policies on demand. Nor is there an attempt to explain why the response of prices to the excess demand gap is not fully anticipated. This problem arises with most force when past values of the gap affect the current rate of price change, given the anticipated rate of price change.

In this section, we compare the two approaches. First, we estimate inflation augmented Phillips curves of the type tested extensively by Laidler and Parkin and their University of Manchester colleagues. Their work has produced an impressive body of evidence for many countries, so we stay as close to their equations as our data permit. Then, we compare the results to our equation (8). There are several differences. We attempt to reduce the differences by using our measure of anticipated inflation, $\hat{p}^a$ from (4), to reestimate Phillips-type equations similar to the Cross and Laidler (1976) and Parkin (1977) equations.

To facilitate comparison, we rewrite (9) as

$$(10) \quad \hat{p}_t = a_0 \hat{y}_{t-1} - a_0 \hat{y}_{0,t-1} + (a_0 - a_1) (\ln y - \ln y_0)_{t-2} + a_2 \hat{p}_t^e,$$

Table 4
Inflation Augmented Phillips Curves

Group or Country	Intercept	$\hat{y} - \hat{y}_{-1}$	$(\hat{m}y - \hat{m}y)_{-2}$	$\hat{p}_{-1}$	$\hat{p}_{-1}$	$\hat{p}_{-1}$	$\bar{R}^2/DW$
EEC	- 0.004	0.13	25.80*	- 0.02	0.73*	...	0.15
Other Europe	0.07	.21	4.73	.63*	...	0.40	.50
Nordic	1.35	.22*	24.50*	.49*	...	0.08	.25
Pacific ^a	0.63	.15*	5.70	.50*	0.30	...	.52
World ^a	- 2.46*	.14	70.39*	- .69	1.72*	...	.61/2.18
Median of 17 countries	- 1.41	0.30	40.91	0.38	0.70	0.71	0.53/2.10
Germany	- 2.13	0.24*	23.54*	0.24	1.08	...	0.70/2.10
France	5.26	- 0.25	6.43	- 0.49	...	0.60	.00/1.87
Holland ^a	- 3.02	0.44*	55.92*	- 0.07	...	1.35	.55/2.25
Belgium	- 1.50	0.40*	68.91*	- 0.14	0.71	...	.70/2.15
Italy	- 12.73*	1.33*	222.90*	- 0.60	1.76*	...	.44/1.45
U.K.	- 0.08	0.30	1.51	0.43	...	0.74	.53/1.58
Switzerland	- 1.85	0.48*	40.91	0.54	...	0.38	.55/2.24
Ireland	- 0.41	0.14	19.22	0.49	...	0.73	.35/2.00
Sweden	2.18	0.35	51.84	0.52	- 0.63	...	.02/1.99
Norway	- 0.54	0.24	49.84	- 0.10	0.85	...	.00/1.88
Denmark	- 3.08	0.55*	66.38*	0.60	0.52	...	.52/2.24
Finland	6.39	0.07	12.28	0.38	- 0.62	...	.32/2.22
U.S. ^a	- 1.19	0.34*	45.67*	1.10*	...	- 0.14	.73/2.46
Canada	- 0.27	0.18*	15.91	0.42	...	0.34	.58/1.61
New Zealand	- 1.41	0.18*	0.20	- 0.14	...	1.86*	.70/2.36
Australia	- 1.58	0.30*	22.94	0.39*	...	0.71*	.65/2.29
Japan	- 1.93	0.28*	41.27*	0.02	0.68	...	0.46/1.70

^aIndicates higher $\bar{R}^2$ than Table 3.

* Indicates $t \geq 2.0$.

and use measures of the expected rate of inflation $\hat{p}_t^e$, that differ from our $\hat{p}_t^a$, but are similar to the measures proposed by Cross and Laidler and Parkin.¹⁰

Cross and Laidler argue that the world rate of inflation contributes to the anticipated rate of inflation in countries operating under fixed exchange rates. This effect is assumed to be independent of the effect on the domestic money stock and on domestic excess demand. The apparent reason is that consumers and producers believe that exchange rates will remain fixed, and therefore, domestic inflation is expected to adjust to world inflation. For the Cross and Laidler (1976) hypothesis, we use the lagged rest-of-the-world rate of price change $\hat{p}_{-1}^r$ and the three-year average rate of domestic price change, lagged one year, $\hat{p}_{-1}$. For the Parkin (1977) hypothesis, we use the maintained three-year average and most recent rate of price change, $\hat{p}_{-1}$ and $\hat{p}_{-1}$, as measures of anticipated inflation.

Table 4 shows the results of the test for seventeen countries, four blocs, and the world. Estimates are reported only for the better of the two regressions, judged by goodness of fit. For eight countries, we report on the Parkin version using $\hat{p}_{-1}$, and, for nine countries, we report the Cross and Laidler version using $\hat{p}_{-1}^r$. As before, we denote with an asterisk the coefficients with a t-statistic of at least 2.0.

There are only two countries, Holland and the U.S., for which the Phillips curve explains more of the variance of $\hat{p}$ than does the hypothesis in Table 3. For the Pacific bloc and the twenty-four-country world also, the inflation augmented Phillips curve has a higher $\bar{R}^2$ than do the regressions reported in Table 3. In all other countries and blocs, the inflation augmented Phillips curve explains less, and often substantially less, of the variance of $\hat{p}$. The median $\bar{R}^2$ differs by 0.19.

Comparison of the relative effects of differences in growth rates and in levels of output or income yields mixed results. For seven countries, both differences in levels and differences in rates of growth are significant by the usual standard; in six countries, neither difference is significant. There are only four countries for which the difference between recent and maintained average rates of growth is significant, but the difference in levels is not. The evidence from the blocs is even more mixed than the evidence from the countries.

One problem with the results reported in Table 4 is that the measures of anticipated inflation often do not pass the standard test for statistical significance. Frequently, one of the coefficients is negative, and only rarely

¹⁰ We use $\hat{y}_{t-1}$ as the measure of $\hat{y}_{0,t-1}$ and $\hat{y}_{t-2}$ as the measure of $y_{0,t-2}$.

Table 5

A Test of the Phillips Curve

Group or Country	Intercept	$\hat{p}^a$	$(\hat{y} - \bar{y})_1$	$(\hat{m}y - \hat{m}\bar{y})_2$	$\bar{R}^2/DW$
EEC	0.51	0.82*	0.005	2.41	0.10
Other Europe ^b	- .08	1.01*	.13	0.90	.56
Nordic ^b	- .33	1.12*	- .07	- 6.40	.27
Pacific	- .04	0.99*	.09	1.84	.20
World	- .12	1.01*	.07	1.89	.40/1.77
Median of 17 countries ^b	- 0.12	1.00	0.09	0.96	0.62/1.87
Germany ^b	- 0.12	1.01*	0.09*	0.96	0.89/2.38
France	- 0.52	1.11	.07	0.51	.00/2.34
Holland ^a	- 0.28	0.94*	.11	9.05	.44/2.14
Belgium ^{a,b}	- 0.11	0.97*	.11	4.58	.77/2.64
Italy ^b	0.83	1.12*	.09	- 22.00	.72/2.33
U.K. ^{a,b}	- 0.75	1.11*	.25*	13.80	.78/1.87
Switzerland ^b	0.06	0.99*	.13	- 1.38	.74/2.26
Ireland ^b	- 0.08	1.02*	.09	- 1.92	.62/1.76
Sweden ^b	0.002	1.00*	.005	- 0.37	.28/1.52
Norway ^b	- 0.09	0.98*	.08	0.04	.20/1.79
Denmark ^b	- 0.04	1.00*	.02	0.92	.89/2.74
Finland ^a	- 1.98	1.39	- .08	- 14.03	.40/1.86
U.S. ^b	- 0.13	0.98*	- .04	4.75	.62/1.29
Canada ^{a,b}	- 0.35	0.95*	.08*	8.42	.90/1.66
New Zealand ^b	- 0.03	1.00*	.03	1.64	.71/1.86
Australia	- 0.37	0.91*	.16	14.24	.55/1.22
Japan ^b	- 0.53	1.00*	0.11	5.88	0.58/2.47

^aIndicates higher $\bar{R}^2$ than Table 3.^bIndicates higher $\bar{R}^2$ than Table 4.*Indicates $t \geq 2.0$.

is the sum of the coefficients for the measures of expected inflation near unity. There is, therefore, not much evidence that the $\hat{p}$ -equation is homogeneous of first degree in nominal values. This finding makes evidence drawn from Table 4 difficult to interpret. It is not clear that the results for this version of the inflation augmented Phillips curve have a valid economic interpretation.

A plausible interpretation of the findings in Table 4 is that the measures of anticipated inflation are not properly specified. Given the misspecification, it is possible to find a significant effect of the difference in levels and to accept, or fail to reject, a false hypothesis. To test for the effect of misspecification, we substitute our measure of anticipated inflation, $\hat{p}^a$ as in Table 3, for the measures of anticipated inflation proposed by Cross and Laidler and Parkin. We retain the measures of excess demand in (10). The results are shown in Table 5. Table 5 differs from Table 4 in only one way: $\hat{p}^a$ from (4) replaces $\hat{p}^e$.

The results change markedly. Anticipated inflation is generally significant, and the coefficients of $\hat{p}^a$ are similar to the results reported previously. The difference between current and maintained rates of change of output has a small effect, but the effect is significant in only a few countries. The difference in lagged levels is never significant. There is, therefore, no evidence that the full employment gap has an independent effect on $\hat{p}$.

The small number of degrees of freedom and the possible, and even likely, inaccuracies in the data suggest that the results for the countries should be used cautiously. Many of the same conclusions can be drawn, however, for the blocs, where the data are no better, but the number of degrees of freedom is larger. There is not a single bloc of countries in Table 5 that shows a significant effect of the lagged gap on the current rate of price change.

The results for countries and blocs in Table 5 are marked with superscript a or b to denote the results of comparing $\bar{R}^2$ for Tables 3, 4, and 5. We have previously compared Tables 3 and 4, so we limit current discussion to a comparison between Table 5 and Tables 3 and 4. For thirteen countries and two blocs, $\bar{R}^2$ increases when we use our measure of anticipated rate of inflation as in Table 5. But, there are only five countries, and there are no blocs, that have a higher $\bar{R}^2$ in Table 5 than in Table 3.

The comparison of the two tables is stronger evidence than may at first appear. The number of degrees of freedom is small for the countries, and Table 3 uses an extra degree of freedom. $\bar{R}^2$ would be lower by approximately 0.08, on average, if the unadjusted percentage of the variance explained by the equations is the same. The higher $\bar{R}^2$ for most countries in Table 3 shows that

the hypothesis more than compensates for the extra degree of freedom. The distribution of $\bar{R}^2$ for the seventeen countries summarizes the results for the three hypotheses.

Frequency Distribution of $\bar{R}^2$ for Seventeen Countries

	Table 3	Table 4	Table 5
0.80 to 0.99	6	0	3
0.60 to 0.79	6	5	7
0.40 to 0.59	2	7	4
0.20 to 0.39	2	2	1
0 to 0.19	1	3	2

The evidence in Tables 3, 4, and 5 helps to discriminate between the equilibrium and disequilibrium theories. The hypothesis in Table 3 makes the actual rate of price change depend on the anticipated rate of inflation and on some principal determinants of the relative rate of change of current spending. Spending shifts along a supply curve of output relating prices to output or rates of price change to rates of change of output. The current rate of price change depends mainly on the stimulus provided by past domestic and world rates of growth of money through their effect on anticipated inflation and, to a limited extent, on current fiscal and monetary policies. The effects of past and current policy on the rate of price change also depend on the acceleration of output. Acceleration of output reduces the rate of price change.

The results in Table 3 were obtained from a spending equation and an equilibrium condition for the output market. Supply adjustment is treated as of secondary importance, which is to say that adjustment of supply has no important effect that is independent of its effect on anticipations.¹¹

Disequilibrium theories, like the Phillips curve, assume that deviations from full employment are the result of disequilibrium in the output market. Workers and employers do not anticipate any of the real or nominal shocks that cause current output to depart from full employment, and do not adjust anticipations of prices and output simultaneously. Consequently, the current deviation from full employment--and even past deviations--causes the current rate of price change to differ from the anticipated rate of price change.

The equilibrium view as presented here and the disequilibrium view expressed in standard Phillips curves are both partial explanations. The former analyzes the adjustment of demand and presumes that the dominant influences on the anticipated rate of change of output are incorporated in the adjustment

¹¹This does not imply that wages fully reflect the current anticipated rate of inflation. Complete adjustment of money wages would eliminate any effect of nominal or real changes in output. The absence of complete adjustment of money wages, however, does not imply disequilibrium in the output market. Workers may prefer small fluctuations in employment to changes in money wages and may knowingly enter into contracts that provide for changes in employment rather than in wages.

of anticipated rates of price change. The latter analyzes the supply response on the output market and presumes that the difference between actual and full employment output measures excess demand. At less than full employment, prices rise more slowly because there is aggregate excess supply.

The empirical evidence that we have presented discriminates between the two views. If a choice is to be made between the two explanations, the data favor the equilibrium view for the period of the dollar standard. Of course, a choice between two restricted theories is not the only choice. Many of the empirical analyses of inflation during the period of the dollar standard, however, were based on one of the partial explanations. If our findings are correct, the less relevant partial explanation has dominated discussion of the reasons for inflation and of the appropriate policies toward inflation and unemployment.

V. CONCLUSION

Many empirical studies report the results of extensive search within a given set of data to find parameter estimates that support a given hypothesis. The principal test is often a comparison with a null-hypothesis or a naive hypothesis. Our study reports on two types of tests of a theory of the rate of price change. We use the same equation to explain or predict inflation in many different countries and in groups of countries. Then, we test our hypothesis by comparison with two versions of the inflation augmented Phillips curve.

Although our tests are based on crude data that may contain more than the usual numbers of errors, the hypothesis passes both tests. The data suggest considerable uniformity for the individual countries during the period of the dollar standard. Current rates of price change depend mainly on anticipated inflation, and the latter depends mainly on maintained average rates of monetary expansion. Domestic monetary policy and foreign fiscal policy appear to have substantially larger effects on the rate of price change in several countries than does domestic fiscal policy. The effect of domestic fiscal policy is generally small.

All of our results are obtained using data from the period of the dollar standard. Our procedure is, therefore, open to the criticism that tests using the seventeen countries or four multi-country blocs are not independent experiments. Advocates of the monetary approach to the balance of payments often talk about the "law of one price" as a truth that is expected to hold always and everywhere. We find very little support for this form of the "law of one price," using annual observations. Neither rates of change of money and prices nor rates of acceleration are highly correlated.

A principal difference between our equilibrium model of spending and the Phillips curve is that the usual Phillips curve is a disequilibrium theory. In the typical version, producers or purchasers choose equilibrium prices or rates of price change only at full employment. Elsewhere, prices respond to the gap between actual and full employment output. In an equilibrium theory, the deviation from full employment affects both the anticipated rate of price change and the anticipated supply of output.

The policy implications differ for the two approaches. If the disequilibrium approach is correct, policies that increase spending change actual output without raising the anticipated rate of inflation. Reducing disequilibrium raises the actual toward the anticipated rate of price change without changing the anticipated rate. In the equilibrium model of the output market, policies that stimulate spending also affect supply. Producers and purchasers respond to stimulus by increasing inventory accumulation in anticipation of higher prices and higher rates of inflation. The full-employment equilibrium rate of inflation increases when stimulus is maintained at a higher level and falls if stimulus is reduced.

Our findings suggest that the equilibrium theory is the more relevant of the two. These findings apply, strictly, to the period of the dollar standard used for our study. Nevertheless, we believe our findings have implications for the present and future as well as for the past. The anticipated rate of inflation will be generated in a different way, but the influence of anticipation on actual rates of inflation, and the influence of the actual rate of inflation on the growth rate of spending, should not change markedly. Our finding that foreign monetary and fiscal policies were the dominant impulses on anticipations of inflation--and on inflation--in most countries is a statement about the past. The consistency of this finding with monetary theory gives reason to expect, but does not establish, that the dominant impulses are now domestic policies.

References

- Brunner, K. (1976), "A Fisherian Framework for the Analysis of International Monetary Problems," in Inflation in the World Economy, eds. M. Parkin and G. Zis. Manchester: Manchester University Press.
- Brunner, K., and Meltzer, A.H. (1976), "Monetary and Fiscal Policy in Open, Interdependent Economies with Fixed Exchange Rates," in Recent Issues in International Monetary Economics, eds. E. Claassen and P. Salin. Amsterdam: North-Holland.
- Christ, C. (1968), "A Simple Macroeconomic Model with a Government Budget Constraint," Journal of Political Economy, 76: 53-67.
- Cross, R., and Laidler, D. (1976), "Inflation, Excess Demand and Expectations in Fixed Exchange Rate Open Economies," in Inflation in the World Economy, eds. M. Parkin and G. Zis. Manchester: Manchester University Press.
- Fase, M.M.G., and Kuné, J.B. (1975), "The Demand for Money in Thirteen European and Non-European Countries: A Tabular Survey," Kredit und Kapital, 3: 410-19.
- Genberg, H.A. (1976), "Aspects of the Monetary Approach to Balance of Payments Theory: An Empirical Study of Sweden," in The Monetary Approach to the Balance of Payments, eds. J.A. Frenkel and H.G. Johnson. London: Allen and Unwin.
- Gordon, R.A. (1976), "Recent Developments in the Theory of Inflation and Unemployment," Journal of Monetary Economics, 2: 185-220.
- Hamburger, M.J., and Reisch, R. (1976), "Inflation, Unemployment and Macroeconomic Policy in Open Economies: An Empirical Analysis," Carnegie-Rochester Conference Series, 4, eds. K. Brunner and A.H. Meltzer. Amsterdam: North-Holland.
- Johnson, Harry G. (1972). Inflation and the Monetarist Controversy. Professor F. de Vries Lectures, Amsterdam.

- Laidler, D. (1974), "The Control of Inflation and the Future of the International Monetary System," American Economic Review, 64: 535-43.
- Laidler, D., and Parkin, J.M. (1975), "Inflation: A Survey," Economic Journal, 85: 741-809.
- Lucas, R.E., Jr. (1975), "An Equilibrium Model of the Business Cycle," Journal of Political Economy, 83: 1113-44.
- _____ (1977), "Understanding Business Cycles," Carnegie-Rochester Conference Series, 5, eds. K. Brunner and A.H. Meltzer. Amsterdam: North-Holland.
- McGuire, T.W. (1976), "On Estimating the Effects of Controls," Carnegie-Rochester Conference Series, 2, eds. K. Brunner and A.H. Meltzer. Amsterdam: North-Holland.
- Meltzer, A.H. (1977), "Anticipated Inflation and Unanticipated Price Change: A Test of the Price-Specie Flow Theory and the Phillips Curve," Journal of Money, Credit and Banking, 9 (2): 182-205.
- Mundell, R.A. (1968). International Economics. New York: Macmillan.
- Neumann, M.J.M. (1977), "Offsetting Capital Flows," multilithed, Freie Universität Berlin.
- Parkin, M. (1977), "A 'Monetarist' Analysis of the Generation and Transmission of World Inflation, 1958-71," American Economic Review, 67: 164-71.
- Pattison, J.C. (1976), "International Inflationary Linkages and the Recent Experience in Individual Countries," in Bank Credit, Money and Inflation in Open Economies, eds. M. Fratianni and K. Tavernier. Berlin: Duncker and Humblot.

Stein, J.L. (1976), "Inside the Monetarist Black Box," in Monetarism, ed. J.L. Stein. Amsterdam: North-Holland.

Weintraub, R. (1976). The Impact of the Federal Reserve System's Monetary Policy on the Nation's Economy, Subcommittee on Domestic Monetary Policy, U.S. House of Representatives. Washington, D.C.: U.S. Government Printing Office.

713. An Operator Theory of Parametric Programming for the Generalized Transportation Problem: Part III. Weight Operators. Part IV. Global Operators. V. Balachandran and G. L. Thompson.
714. Monetary and Fiscal Policy in Open, Interdependent. K. Brunner and A. H. Meltzer.
715. The Effects of Sampling Variation on Sales Forecasts for New Consumer Products. Robert Shoemaker and Richard Staelin.
716. Optimal Portfolio Revision with Proportional Transaction Costs: Extension. George M. Constantinides.
717. Least Squares Estimation for Models of Cross Sectional Correlation. Alexander Lebanon and Howard Rosenthal.
718. Optimal Planning Under Transaction Costs: The Demand for Money and Other Assets. Milton Harris.
719. Bivalent Programming by Implicit Enumeration. Egon Balas.
720. Comment on Chen, Kim and Kon. George M. Constantinides.
721. The Effects of Economic Policies on Votes for the Presidency: Some Evidence from Recent Elections. Allan H. Meltzer and Marc Vellrath.
722. Stochastic Cash Management with Fixed Proportional Tr. Costs. George M. Constantinides.
723. The Evaluation and Choice of Internal Information Systems Within a Multiperson World. Stanley Balman.
724. The 'Fisher Effect' for Risky Assets: An Empirical Investigation. Jeffrey F. Jaffe and Gershon Mandelker.
725. The Value of the Firm Under Regulation. Jeffrey F. Jaffe and Gershon Mandelker.
726. Logically Consistent Market Share Models II, by Timothy W. McGuire and Doyle L. Weiss.
727. Guilt Beyond a Reasonable Doubt: Effects of Concept Definition and Assigned Decision Rule on the Judgment of Mock Jurors, by Norbert L. Kerr, Robert S. Atkin, Garold Stasser, David Meek, Robert W. Holt, and James H. Davis.
729. Analysis and Control of Nurse Staffing, by Robert S. Kaplan.
730. Forecasting the Consumption Effects of Stabilization Policies, by Walter Dolde.
732. Prediction Analysis in Political Research, by David K. Hildebrand, James D. Laing, and Howard Rosenthal.
733. Set Partitioning: A Survey, by Egon Balas and Manfred W. Padberg.
734. The Continuing Courtship: Wage-Price Policy Through Five Administrations, by Arnold R. Weber.
735. Estimation of Environmental Effects on the Pattern of IQ Scores Over Time. Joseph B. Kadane, Timothy W. McGuire, Peggy R. Sanday, and Richard Staelin.
736. Reprocessing as a Recognition Cue. J. Edward Russo and Robert A. Wisher.
737. The Staff Salary Structure of a Large Urban University. Nancy M. Gordon and Thomas E. Morton.
738. Monetary and Other Explanations of the Start of the Great Depression. Allan H. Meltzer.
739. Optimal Impulse Control of a Diffusion Process with Both Fixed and Proportional Costs of Control. Scott F. Richard.
741. Dimensions of Organizational Influence and Their Effectiveness Correlates. Johannes M. Pennings.
742. Self-Managed Learning of Mathematics — Operations Research. Gerald L. Thompson.
743. Discounting, Ergodicity, and Convergence for Markov Decision Processes. Thomas E. Morton and William E. Wecker.
744. Anticipated Inflation and Unanticipated Price Change: A Test of the Price-Specie Flow. Allan H. Meltzer.
745. Coalition Structure in a Labor-Managed Market Economy. Tatsuro Ichishi.
746. Critical Cutsets of Graphs and Canonical Facets of Set Packing Polytopes. Egon Balas and Eitan Zemel.
747. Monetarism: The Principal Issues, Areas of Agreement, and the Work Remaining. Karl Brunner and Allan H. Meltzer.
748. An Aggregative Theory for a Closed Economy. Karl Brunner and Allan H. Meltzer.
749. Hamiltonian Paths in Rectangular-Lattice Graphs. Gerald L. Thompson.
750. The Eventual Failure of Price Fixing Schemes. Robert M. Townsend.
751. A Behavioral Mode of Coalition Formation: The French Appartements. Mushin Lee and Howard Rosenthal.
752. Durability of Capital Goods, Taxes and Market Structure. Artur Raviv and Eitan Zemel.

(continued on back cover)

The present series contains articles written by the faculty of the Graduate School of Industrial Administration. Publications began in the 1962-63 academic year and continue through to date. You may request copies and receive them from: Reprint Secretary, GSIA, Carnegie-Mellon University, Pittsburgh, Penna. 15213.

753. Organizing Multiple-Function Professionals in Academic Medical Centers. Martin P. Charns, Paul R. Lawrence, and Marvin R. Weisbord.
754. The Value of Unit Price Information. J. Edward Russo.
755. Ability Factor Differentiation, Grades 5 Through 11. Robert Atkin, Robert Bray, Mark Davison, Sharon Herzberger, Lloyd Humphreys, and Uzi Selzer.
756. Computational Performance of Three Subtour Elimination Algorithms for Solving Asymmetric Traveling Salesman Problems. T. H. C. Smith, V. Srinivasan, and G. L. Thompson.
757. Determining Cost vs. Time Pareto-Optimal Frontiers in Multi-Modal Transportation Problems. V. Srinivasan and G. L. Thompson.
758. Tools: Efficiency and Equity Issues for Inland Waterways. Leland S. Case and Lester B. Lave.
759. Managing Exchange Risks in a Floating World. Alan C. Shapiro and David P. Rutenberg.
760. Rules Rather Than Discretion: The Inconsistency of Optimal Plans. Finn E. Kydland and Edward C. Prescott.
761. Portfolio Selection with Transactions Costs. Michael J. P. Magill and George M. Constantinides.
762. A Lifo Implicit Enumeration Search Algorithm for the Symmetric Traveling Salesman Problem Using Held and Karp's 1-Tree Relaxation. T. H. C. Smith and G. L. Thompson.
763. An Eye Fixation Analysis of Multialternative Choice. J. Edward Russo and Larry D. Rosen.
764. Partial Orderings in Implicit Enumeration. V. Joseph Bowman, Jr. and James H. Starr.
765. A Note on Duality in Disjunctive Programming. Egon Balas.
766. Some valid inequalities for the set partitioning problem. Egon Balas.
767. Cutting-Plane Theory: Disjunctive Methods. R. G. Jeroslow.
768. Investment Banking: An Economic Analysis of Optimal Underwriting Contracts. Gershon Mandelker and Artur Raviv.
769. Cost Operator Algorithms for the Transportation Problem. V. Srinivasan and G. L. Thompson.
770. Algorithms for Minimizing Total Cost, Bottleneck Time and Bottleneck Shipment in Transportation Problems. V. Srinivasan and G. L. Thompson.
771. Recommendation for the Overall Size of the Strategic Petroleum Reserve. Egon Balas.
772. Multilocation Plant Sizing and Timing. Ram C. Rao and David P. Rutenberg.
773. Monetarist, Keynesian and Quantity Theories. Allan H. Meltzer.
774. A simplex-like algorithm for the continuous modular design problems. Timothy L. Shaftel and Gerald L. Thompson.
775. Sequential Strategies in Dual Control Problems. Richard M. Cyert and Morris H. DeGroot.
776. Organization environment: antecedent for normative statements on organization design. Johannes M. Pennings.
777. The Evaluation of Preventive Care Programs. Lester B. Lave and Judith Lave.
778. The Explanation of Inflation: Some International Evidence. Karl Brunner and Allan H. Meltzer.
779. Cutting-planes for complementarity constraints. R. G. Jeroslow.
780. Spatial Models of Voting in the French Fifth Republic, 1977. Howard Rosenthal and Subrata Sen.
781. Highway Congestion and Congestion Tolls. Anthony E. Boardman and Lester B. Lave.
782. Graph Substitution and Set Packing Polytopes. E. Balas and E. Zemel.
783. Facets of the Knapsack Polytope from Minimal Covers. Egon Balas and Eitan Zemel.
784. A Reply to McCann, Miller and Moskowitz: Dynamic Multivariate Decision Processes are Even More Complex than They Seem. Eduard J. Fidler and Robert S. Atkin.
790. Does Air Pollution Cause Mortality? Lester B. Lave and Eugene P. Seskin.
791. A Node Covering Algorithm. Egon Balas and Håkon Samuelsson.

★

Management Information Systems: Progress and Perspectives (Carnegie Press, 1971).
Editors: C. H. Kriebel, R. L. Van Horn, and J. T. Heames. Price: \$11.50.

The Effects of EFT on the Instruments of Monetary Policy*

Using a model incorporating the explicit effects of EFT on monetary policy, the author drew 12 main conclusions about its possible impacts.

Allan H. Meltzer
Carnegie-Mellon University

Proper understanding of the effects of changes in the technology of making and receiving payments and on the role of monetary policy has been marred by failure to observe three distinctions. One is the distinction between changes in technology that overcome regulatory and legal restrictions and changes that would occur in the absence of these restrictions. A *second* distinction is between money and credit, or more properly the distinction between technical changes or innovations that increase borrowing and lending and innovations that change the demand and supply for money. A *third* distinction is between the immediate or impact effect on a particular type of institution and the full equilibrium effect on the economy. In this section, I discuss the first of these issues. The following sections distinguish between money and credit and analyze the impact and final effect of innovation on both money and credit.

I use the terms technical change and innovations as synonyms, but I distinguish two types of technical change. One is the substitution of capital for labor. The other is the growth of less-regulated institutions relative to the growth of heavily regulated institutions. For both types of technical change, there is a need to distinguish some particular features of technical change in the arrangements for making and receiving payments or for borrowing and lending that give these changes distinctive characteristics.

In financial markets and in the payments system generally, a principal form of capital is electronic equipment and the principal type of substitution discussed is called electronic funds transfer or EFT. I accept this convention, although it should be pointed out that many of the changes that have occurred recently or are expected to occur in the future differ little in broad aspects from the changes that have occurred when other means of communication improved during the past century. Financial innovation is an old process. It is useful to keep this in mind when judging the accuracy of predictions about the future effects of innovations such as EFT.

RISING WAGES: INDUCEMENT TO INNOVATION

Since making payments remains a labor-intensive activity, one inducement to innovation is a rising real wage rate. When there is technical progress in nonfinancial sectors, wage rates rise in the economy. Financial firms compete in the labor market and pay the prevailing wage rates for labor.

If there were no opportunities to substitute EFT for more labor-intensive means of making and receiving payments, the cost of making payments would increase as wages rise, so fewer payments would be made per unit of income produced.

By reducing the cost of making payments, EFT encourages individuals and firms to relate payments more closely to purchases. As examples, we have recent plans to deposit paychecks directly to bank accounts, to transfer payments to the seller at the time of purchase (point of sale) and to speed the settlement of interbank transfers.

In a competitive economy, the market directs resources to efficient uses. Producers of goods and services cannot forever pay more than the value of the marginal product of labor. Workers are attracted by wage rates to those uses where marginal products rise and deterred from entering occupations with falling marginal product. Capital is substituted for labor in those uses where cost reduction can be achieved.

In a non-inflationary economy much of the technical change in the payments system is induced by rising real wage rates. Technical progress of this kind will not come suddenly, but will occur gradually or, more accurately, will continue to occur gradually but sporadically, as it has done for more than a century. Gradual introduction does not imply steady progress at a constant rate of adjustment. It conveys evolutionary adaptation, often in response to changes in real wage rates.

Computers and automation did not spread through the economy in a "cybernetic revolution" as some prophesied in the late 1950s or early 1960s. I find no reason to expect a sharp increase in the rate of labor-saving technical progress in banking if the principal innovations continue to be the introduction of labor-saving, computer-based technology that has been available in nonfinancial firms for a decade or more.

The second type of innovation, entirely distinct from the first, is the result of legislation, regulation and inflation. Some of the principal regulations that induce innovation are:

1. prohibition of the payment of interest on demand deposits;
2. maximum or ceiling rates of interest on time and savings deposits at banks and nonbank financial institutions;
3. differences in reserve requirements for types of deposits and institutions;
4. nonpayment of interest on required reserves; and
5. restrictions on lending and borrowing powers.

Each of these restrictions encourages the development of substitute institutions; much innovation is a way of circumventing regulations and legislation that prohibit the above practices (and others) at specific institutions. The benefit to individuals or institutions from finding or developing substitutes rises with the rate of inflation.

If banks and other financial institutions were permitted to pay interest on demand deposits and if there were no ceilings on rates paid on time and saving accounts, we would not have money market funds and would have fewer NOW accounts and other close substitutes for demand deposits. If there were smaller differences in reserve requirements, less effort would be devoted to supplying substitutes for commercial bank demand and time deposits. Fewer resources would be used to staff financial institutions and to circumvent regulations.

When examining the pace of innovation, we must separate those innovations that are induced by the high return available to developers of unregulated substitutes for regulated activities. To assess the effect of EFT on the instruments of monetary policy and the speed with which the changes occur, we must recognize that regulation can eliminate particular types of institutions or financial assets by producing unregulated substitutes. Much of the effect of innovation on the instruments of monetary policy depends on the type of regulation carried into the future and on the rate of inflation.

One reason there has been an increase in the extent of substitution of unregulated for regulated financial assets is that the cost of holding demand deposits rises with the rate of inflation. The higher rate of return to holders of deposits in unregulated institutions induces a shift of deposits to such institutions and away from banks and regulated thrift institutions that are prevented from raising rates. The growth of credit unions is one of many examples.

Some assumptions about regulation and inflation are required to analyze the long-run response to innovation in financial markets. If regulations are removed or limited, interest rate payments on demand, time and saving deposits change with the rate of inflation. Interest rate changes are a substitute for portfolio changes and for the development of substitutes that are less regulated. At the opposite extreme, maintenance of current regulations and continued inflation induce a decline in the relative size and importance of existing institutions and a rise in less-regulated institutions such as credit unions and money market funds. Extension of regulation to credit unions and money market funds will, with continued inflation, raise the return to developing new forms or types of institutions that offer substitutes for existing assets. I assume we will not move to an ever-growing list of regulations and prohibitions, but I recognize this assumption does not have a strong basis in experience.

An efficient financial system does not require owners of assets to shift them to avoid regulation. Changes in interest rates are a more efficient means of adjusting to changes in economic conditions. Ceilings on time deposits and savings deposits and the prohibition of interest payments on demand deposits are inappropriate instruments of monetary policy and should be eliminated.

Technical Change in Banking

A bit of evidence on the speed and variability of technical change in banking and financial markets helps put the discussion in perspective. Innovation in financial markets reduces the amount of money—both currency and demand deposits—held per unit of in-

come. Thus, it increases the amount of money produced per unit of base money—currency of the public and total reserves of the banking system. When the public shifts from non-interest-bearing demand deposits to time deposits and negotiable certificates of deposit, banks are able to produce more deposits and loans with the same dollar volume of reserves. If the use of credit cards increases transactions per dollar of currency and deposits, income at market prices rises relative to base money. Base velocity—net national product per dollar of base money—changes for reasons unrelated to financial innovation, but a rapid increase in innovation raises the rate of growth of base velocity.

The annual percentage growth of base velocity for most of the years of this century is shown in Table 1. The data for the 21 years 1954-1974 show less variability than the data for the earlier years. The average rate of change is now higher but more consistent. These data suggest that technical change in financial markets has been gradual.

Table 1

**Distribution of 62 Annual Positive and Negative
Percentage Rates of Change in Base Velocity**

Range	1900-40		1954-74	
	+	-	+	-
.000-.010	3	4	2	1
.011-.020	2	2	5	1
.021-.030	4	1	2	1
.031-.040	0	0	6	0
.041-.050	3	0	1	0
.051-.060	0	0	0	0
.061-.070	1	1	1	0
.071-.080	2	2	1	0
.081 +	7	9	0	0
Total	22	19	18	3

A MODEL OF CREDIT AND MONEY¹

In this section, I discuss the markets for money and credit on the assumption that rates of interest on time and saving deposits are permitted to respond to prevailing economic conditions. The principle governing the adjustment of portfolios in response to innovation is that rates of return are equated by the market process for given degree of risk. Since the instruments of monetary policy are used to respond to fluctuations in output and to determine the rate of inflation, I do not assume that the economy is always at a long-run equilibrium. Further, I assume that fluctuating exchange rates are freely floating rates, so I am able to ignore any effects of the balance of payments on monetary policy and on money. Where the assumption of flexible rates is misleading, the difference in implications is mentioned. The principal difference, of course, is the restriction on long-run monetary and fiscal policy imposed by fixed exchange rates. With fixed exchange rates, no country can pursue for long independent monetary policies inconsistent with those of the rest of the world.

Many of the institutional details of the money and credit markets and most of the effects of policy instruments differ for the stocks of money and credit. This section provides a framework that distinguishes the two stocks. Later sections use the framework to analyze the effects of policy instruments on the two stocks and to discuss the effects of innovation.

The model presented in this section differs from more usual models in that intermediation is considered explicitly. The discussion starts from a simple framework that contains many of the features of a more complex system discussed below. Wealth consists of three assets, base money (B), government debt (S), and real capital including durables, inventories and assets used in the process of production (K). Debt is valued at the current rate of interest, so vS is the current market value of debt. Capital is valued at a price (P). W_n is wealth at market prices. The balance sheets of the economy are shown in Figure 1.

Figure One

Public		Central Bank and Government	
B			B
vS			S
PK	W_n		

The amount of base money and debt outstanding is a record of past fiscal and monetary policies. Government deficits are financed by issuing base money or by selling bonds to the public. Usually the deficit is financed by selling bonds; then some portion of the bonds is bought by the Federal Reserve, so the net effect is to issue bonds and base money to finance budget deficits and to withdraw bonds and base money to finance surpluses. In addition, the monetary base records the cumulated balance of payments deficit or surplus, the history of past balance of payments positions. Balance of payments surpluses add to the base, and balance of payments deficits reduce the base.

Open market operations are exchanges of base money for bonds. When the Federal Reserve purchases in the open market, base money increases and securities are reduced. When the Federal Reserve sells, base money is reduced and the stock of securities held by the public increases. On the consolidated balance sheet of the government sector, shown in Figure 1, open market operations can be shown as offsetting changes in B and S.

As long as the government finances its operations by issuing or withdrawing bonds and money, there are changes in the stocks of base money and bonds. As long as there are stocks of bonds and money outstanding, the central bank can continue to engage in open market operations—purchases and sales—to change interest rate and asset prices and to affect output and the price level.

To analyze the effects of open market operations and to provide a framework that can be extended to analyze other policies, additional content must be added to the framework. I assume that the demands for base money, debt and capital have the following properties:

1. $B = B(\bar{i}, p, \dots, \bar{e})$
2. $vS = S(i - \pi, P, \dots, \bar{e})$
3. $K = K(\bar{i} - \pi, \bar{P}, \dots, \bar{e})$

The plus and minus signs above the variables in the three demand functions indicate the response of B, vS and K to the variables with which we are concerned. Two additional variables have been introduced: π , the anticipated rate of inflation, and e , the anticipated return to real capital per unit of capital. Once any two of the stocks, the asset price level and the interest rate are determined, the third asset can be obtained using the market value of wealth. I use Equations 1 and 2 to solve i and P and the equilibrium values of B and vS. The right side of Figure 2 shows the solution.

Figure 2

The solution of Equations 1 and 2 yields an equilibrium interest rate and price level of existing real assets. The MM curve of Figure 2 shows the combinations of interest rates and asset prices at which a constant amount of base money is willingly held. The curve is positively sloped to reflect the fact that higher interest rates offset the effect of higher asset prices on the demand for base money. The CM curve of Figure 2 shows the combinations of interest rates and asset prices at which the outstanding stock of government debt is willingly held. The curve is negatively sloped to show that interest rates must fall as asset prices rise to induce the public to hold a given stock of government securities.

The asset markets are in equilibrium at i_0 and P_0 . At these prices, given anticipations of inflation, the stocks of base money, government debt and capital are willingly held in portfolios. Open market purchases or sales change the position of the CM and MM . The position of the system is shown, after an open market purchase, by the lines MM_1 and CM_1 .

The increase in the base shifts and the reduction in the outstanding stock of debt shifts CM. The new short-run equilibrium position is at i_1 and P_1 . Interest rates fall and asset prices rise.²

The intersection of CM_1 and MM_1 , relative to the intersection of CM_0 and MM_0 , shows the impact effect of an open market purchase; the reverse movement shows the impact of an open market sale. The initial impact is followed by a change in the difference between current output and full employment output and a change in the price level. A rise in the price level reverses the movements of the two curves. Higher prices, following an open market purchase, raise interest rates and lower asset prices. The terminal equilibrium is in the neighborhood of the initial equilibrium but differs because the stock of base money increases relative to the stock of debt. With a fixed stock of real capital, interest rates are lower and asset prices higher after adjustment of prices and output.

The basic framework shown in Figure 2 can be extended to include the principal instruments of monetary policy. These include reserve requirement ratios, interest rate ceilings, the rediscount rate and the various rules and regulations affecting reserve computation and discounting. The latter can be expressed as part of the reserve requirement or part of the price of discounting, so in the interest of simplicity the regulations are ignored.

A principal difference between the previous analysis and the more complete framework is the absence of banks and nonbank financial intermediaries in the simplified description of the assets and liabilities of the public in Figure 1. Figure 3 adds time deposits and loans from banks and intermediaries. L_b is bank loans and L_{nb} is loans from intermediaries. Mortgages and consumer credit are examples. B is the volume of bank reserves; A is the amount of borrowing from the central bank; C is the stock of currency; D is the stock of demand deposits; and T_b and T_{nb} are time or saving deposits at banks and nonbanks, respectively. The subscript p denotes the public.

One benefit to the public of having intermediaries is apparent: the public has a larger range of assets from which to choose. The intermediaries function by buying assets and issuing liabilities. We can increase the number of liabilities and assets by introducing many specialized intermediaries, but no analytic benefits are gained to offset the increased complexity.

Intermediaries hold demand deposits at banks (D_{nb}) and a small amount of currency (C_{nb}) in their tills. Most of their reserves are held as government debt (vS_{nb}). The wealth or net worth of banks and intermediaries is the market value of their charters. Since governments

do not permit free entry into the industry, there are some potential monopoly profits accruing to banks and financial institutions. W_b and W_{nb} summarize these values.

Figure 3

Public		Banks		Non-Bank Intermediary		Central Bank and Government	
C_p	L_b	R	D_p	C_{nb}	T_{nb}		$B - A$
			D_{nb}	D_{nb}			
D_p	L_{nb}	L_b	T_b	vS_{nb}			S
T_b		vS_b	A	L_{nb}	W_{nb}		
			W_b				
T_{nb}							
vS_p	W_p						
PK							
W_b							
W_{nb}							

The underlying structure of the economy remains as in Figure 1. The public has greater utility from a given market value of wealth because there are more options available. The wealth of the public is the same after consolidation as before. The stock of base money, net of bank borrowing, $B-A$, is now divided between currency and reserves.

$$4. \quad C_p + C_{nb} + R - A = B - A,$$

and the stock of government debt is

$$5. \quad S_p + S_b + S_{nb} = S.$$

The structure of claims and debts is built on these financial assets.

The presence of nonbank intermediaries increases the detail without adding any new elements. Decisions of the public to shift deposits from banks to nonbanks can occur only if the nonbanks are capable of paying higher returns. This can occur if there is increased demand for the type of assets acquired by the intermediaries (L_{nb}) or if the public accepts higher risk along with higher return. Since no new types of assets or liabilities are introduced on the nonbanks' balance sheets, we can neglect the nonbank intermediaries for a time and analyze in-

teraction between the public and the banks using a model of the money-credit process.

A model of the money-credit process differs in four principal ways from the model in Equations 1 to 3. *First*, the monetary base consists of currency and reserves. Shifts between the two components alter the stocks of money and credit in different degree. *Second*, banks offer types of deposits that differ in maturity, turnover, and the rate of interest paid to holders. Shifts from one type of deposit to another, commonly called intermediation and disintermediation, change the stocks of money—defined as currency and demand deposits—and bank credit in opposite directions. *Third*, partly as a consequence of differences in interest rates paid on different types of deposits, changes in the level of interest rates affect credit and money in different ways. *Fourth*, differences in reserve requirement ratios and the nonpayment of interest on required reserves encourage substitution between types of deposits. Banks and other financial institutions are encouraged to develop substitutes for demand deposits that have many properties of demand deposits but are subject to lower reserve requirements.

From the balance sheet of the consolidated banking system, we have, in the absence of nonbank intermediaries, bank credit (E).

$$6. \quad E = L_b + vS_b = D_p + T_b - (R - A) + W_b$$

Money is defined as:

$$7. \quad M = C_p + D_p.$$

Since the monetary base (B^a) in the absence of nonbank intermediaries is $C_p + R - A$, from Equation 4,

$$8. \quad E = M + T_b - B$$

Equation 8 shows that from the definitions of credit and money, we obtain the implication that growth of time deposits (intermediation) increases credit relative to money. A simplified framework for analyzing the monetary system brings the role of institutional arrangements and the effects of policy instruments into sharper focus.

The banks' holding of reserves depends on the reserve requirement ratios and the distribution of deposits between type and size of deposits, location of bank, and status of membership in the Federal Reserve System. The total required reserve is a weighted average with weights dependent on these characteristics. Let r^d and r^t be the weighted average reserve requirement ratios for demand and time deposits, respectively. Banks satisfy these requirements by holding deposits at Federal Reserve Banks and by holding currency. (Nonmember banks and nonbanks hold currency, also; some of these details are subsumed.)

Required reserves (R^r) are defined by

$$R^r = r^d D_p + r^t T_b = \bar{r}(D_p + T_b)$$

and total reserves include excess reserves (x).

$$R = \bar{r}(D_p + T_b) + x(i) (D_p + T_b) \quad x_i < 0$$

The amount of excess reserves held depends on the rate of interest.

Member banks are permitted to borrow from reserve banks. The amount of borrowing depends on the discount rate, including all terms and conditions (d), on the market rate of interest and on the size of the bank. Increases in the discount rate or terms reduce discounts, and increases in market interest rates increase discounting.

$$A = b(i, d) (D_p + T_b) \quad b_i > 0; b_d < 0$$

The public's holding of time deposits relative to demand deposits rises when interest rates increase on time deposits and falls when market rates increase. The volume of time deposits rises relative to demand deposits as income or wealth increases. The prohibition of interest payments on demand deposits increases the effect of changes in interest rates and wealth (W_p) on the ratio of time to demand deposits.

$$T_b = t(i^t, i, W_p) D_p \quad t_w, t_{it} > 0; t_i < 0$$

The rate of interest paid on time deposits responds to market rates in the absence of legal restrictions.

Division of money balances between currency and demand deposits depends on current income and perhaps on wealth, the age distribu-

tion of the population, the volume of illegal transactions and the like. The currency ratio depends on each of these factors.

$$C_p = kD_p$$

Combining the equations for C_p , T_b , R , and A permits the money and credit stocks to be described in terms of multipliers that depend on policy instruments— $\bar{r}$, m , and d —the monetary base B^a , the decisions of the public (expressed by k and t) that depend on technical changes affecting the payments system, and x , which depends on technical changes affecting the cost of transferring reserves.

By substituting in Equation 4 and rearranging terms, we first obtain

$$D_p = \frac{1}{(\bar{r} + x - b)(1 + t) + k} B^a$$

Then, by substituting in Equations 7 and 8, the stocks of money and bank credit can be expressed as the product of a multiplier and the monetary base.

$$M = mB, \text{ and} \\ E = aB$$

The money and credit multipliers are rational expressions denoted by m and a .

$$9. \quad m = \frac{1 + k}{(\bar{r} + x - b)(1 + t) + k}$$

$$10. \quad a = \frac{(1 + t) [1 - (\bar{r} + x - b)]}{(\bar{r} + x - b)(1 + t) + k}$$

Policy instruments other than the base affect the stocks of money and credit by changing m and a . The reserve requirement ratios are included in $\bar{r}$; the discount rate affects the borrowing ratio (b); interest ceilings affect the time deposit ratio (t); all policy operations change market rates of interest, asset prices and eventually output and the price level. The ratios b , t and x depend on interest rates, whereas k and k depend on wealth and income, so the responses to policy feed impulses back to money and credit.

The detail incorporated in the multipliers extends the simpler framework of the money-credit process described by Equations 1 to 3 to include money of the institutional arrangements that characterize

the United States financial system. These equations determine the stock of money, currency and demand deposits, and the stock of bank credit demanded by banks. The stock of money supplied replaces the fixed amount of base money in Equation 1. The demand for earning assets by banks replaces the demand for government debt in Equation 2.

The public's demand for money and supply of earning assets to banks complete the analysis of the money and credit market. The demand for money is

$$M^d = \lambda(\bar{T}, P, p, \dots, \bar{e})$$

where the signs of the responses are again shown above the variables. The supply of earning assets to banks is the sum of loans from banks (L_b) and the stock of government securities absorbed by banks.³ The latter is $vS - vS_p$, and the public's supply of earning assets to banks (σ) is

$$L_b + v(S - S_p) = \sigma(i^-, \pi^-, P, \dots, e^+, S^+)$$

For the stocks of money and bank credit, we now have Equations 11 and 12 in place of Equations 1 and 2.

$$11. \quad m(i^+, k^-, \bar{r}, i^-, d)B = \lambda(i^-, P^+, p^+, \dots, \bar{e})$$

$$12. \quad a(i^+, k^-, \bar{r}, i^-, d)B = \sigma(i^-, \pi^-, P, \dots, e^+, S^+)$$

In addition, we have the price-setting equation for the equilibrium interest rate on time deposits, Equation 13.

$$13. \quad i^t = i + \text{constant}$$

MONEY, CREDIT AND THE INSTRUMENTS OF MONETARY POLICY

The framework for analyzing the money and credit markets contains all the principal instruments of monetary policy. Open market operations change the stocks of base money and government debt; changes

in reserve requirement ratios or the discount rate change the money and credit multipliers (m and a). Ceiling rates of interest for time and saving deposits restrict the banks' choice of it. This section shows the responses to policy instruments.

Figure 4

Figure 4 shows Equations 11 to 13. The MM and CM curves in the right panel are similar to the curves in Figure 2. The difference is that the curves now include policy instruments that were omitted previously. The MM curve shows the combinations of interest rates and asset prices that equate the demand for money to the stock of money supplied. The CM curve shows the combinations of i and P at which the credit market is in equilibrium.

The left side of the diagram shows the relation between interest rates on time deposits and rates available on the open market, Equation 13.

Whenever the open market rate of interest is above the rate paid on time deposits, owners of time deposits seek higher yields. They reduce time deposits and purchase debt for their portfolios. Banks or

other financial institutions lose time deposits and, as the public acquires a larger share of the stock of outstanding securities, the banks' holding of securities declines. In the terminology that has become common, there is disintermediation. Disintermediation continues as long as the rate on time deposits, i , is held below the level consistent with the market rate (i).

An equilibrium position is shown in Figure 4. The rate i_0 makes wealth owners indifferent whether they own securities directly or hold time deposits at banks or financial institutions. Interest rate i_0 and asset price P_0 sustain the distribution of assets among money, debt and capital and the distribution of wealth between assets and liabilities.

OPEN MARKET OPERATIONS

An open market purchase increases the base and reduces the stock of debt held by banks and the public. Both changes lower interest rates, and the combined effect of the operation increases asset prices. The broken lines show the rate of interest and the asset price level following the open market purchase. These are initial or impact effects that help to show how EFT affects the response to policy.

Rates of interest on time deposits are unchanged at i_0 , so the public acquires time deposits and sells securities on the market. The increase in money, the fall in the rate of interest and the rise in the asset price level increase expenditure and encourage borrowing at the lower rate of interest. Increased borrowing in response to increased spending shifts the CM curve to the right, raising interest rates and asset prices. This process continues and produces the familiar cyclical pattern in output and the price level if the increased borrowing is financed in whole or part by increasing the monetary base and the stock of money.

Open market sales have opposite effects to open market purchases. The movement from $P_1 i_1$ to $P_0 i_0$ in Figure 4 shows the impact effect of an open market sale. If interest rates on time deposits had been fully adjusted to i_1 , time deposit rates are low relative to i_0 . The public reduces borrowing from banks, acquires securities in the open market and reduces time deposits. A ceiling rate on time deposits, if effective, prevents the adjustment of time deposit rates to prevailing market conditions. The effect of the ceiling is analyzed below.

Conclusions drawn about the response to open market purchases and sales are similar to the conclusions reached earlier. The qualitative conclusions do not depend on institutional arrangements and do not change with innovation in the financial system. The conclusions de-

pend on the change in the distribution of wealth among money, bonds and real capital and not on the structure of financial markets.

Changes in Reserve Requirement Ratios

The initial response to a change in reserve requirement ratios is qualitatively similar to the initial response to an open market operation. Increases in the average reserve requirement ratios reduce the money and credit multipliers, raise interest rates and lower asset prices. The banks sell securities on the open market and reduce loans; the public must absorb securities from banks. Reductions in reserve requirement ratios increase the money and credit multipliers, permitting banks to hold more securities and loans at a given monetary base and stock of debt. Interest rates fall and asset prices rise following the change.

The long-run effects of changes in average reserve requirement ratios are on the relative wealth of owners of banks and other assets. The higher are reserve requirement ratios, the smaller is the value of a bank charter relative to a charter in a competing financial institution that is subject to a lower reserve requirement ratio.

A similar conclusion is reached if we analyze changes in the reserve requirement ratios for time and demand deposits. An increase in the reserve requirement ratio for demand deposits relative to the reserve requirement ratio for time deposits lowers the flow of services that banks are willing to offer depositors to hold a dollar of demand deposits. The public shifts from demand to time deposits and to deposits in nonbanks that are subject to lower reserve requirement ratios. Banks encourage the substitution by offering higher interest payments and more services on the deposits subject to lower reserve requirements. The rate it rises. Banks gain from the substitution of time deposits for demand deposits by reducing the amount of required reserves and increasing earning assets. The effect of the shift as seen by the banks is the same as a reduction in the weighted average reserve requirement ratios. The reduction partially offsets the higher reserve requirement ratio for demand deposits posited at the start of the discussion.

Prohibition of interest payments on required reserves leads banks and financial institutions to seek substitutes for existing deposits. Payment of interest on required reserves at market rates equal to the rate on federal funds would reduce the incentive to supply substitutes but would not eliminate the incentive if the public, banks and financial institutions evaluate risks differently in periods of expansion and contraction. To avoid shifts from one type of deposit to an-

other, required reserve ratios should be uniform for all types of deposits at banks and nonbank institutions, and interest should be paid at the federal funds rate on required reserves.

In Figure 3 above, the net worth positions of banks and nonbanks (W_b and W_{nb}) are assets on the balance sheet of the public. Reserve requirements for banks and nonbanks are a tax on the profitability of banks and therefore on the wealth of owners of banks and nonbank financial institutions. Differences in reserve requirement ratios can, in the long run, eliminate one type of institution and replace it with another, but the differences do not eliminate the demand function or service. The service is provided in response to demand.

Changes in reserve requirement ratios are blunt tools that have effects on allocation of wealth and the production of substitutes for financial assets. These effects can be avoided at least in part by financial innovation. The development of substitute means of providing services is a type of innovation to avoid regulation.

Setting Rediscount Rates

Changes in rediscount rates also affect money and credit by changing the multipliers of money and bank credit. The qualitative effects of changes in the rediscount rate are much the same as the responses to open market operations and changes in reserve requirement ratios. Increases in the discount rate (or in the eligibility requirement for the paper discounted) lower the volume of discounts and reduce the stocks of money and bank credit.

Discounting is relatively small, and changes in discount rates are infrequent. However, the opportunity to discount is reserved to commercial banks that are members of the Federal Reserve System. This distinction is of limited importance but has some value, particularly when rediscount rates at Federal Reserve Banks are below the rates on open market paper.

As long as there are member banks of the Federal Reserve System, changes in rediscount rates induce or deter borrowing from the Federal Reserve Banks. Borrowing increases the monetary base and the stocks of money and credit, reduces market rates of interest and raises asset prices. Reductions in borrowing have the opposite effects. These responses are qualitatively similar to the responses shown in Figure 4.

CEILING RATES ON DEPOSITS

Ceiling rates of interest on time deposits under Regulation Q or simi-

lar restrictions for nonbanks prevent banks and financial institutions from adjusting to market conditions. Suppose an open market sale, increase in the reserve requirement ratios or other policy action to reduce money and credit has been undertaken. Interest rates rise and asset prices fall from i_1P_1 to i_0P_0 in Figure 4.

The public responds to higher interest rates by withdrawing from time deposits and purchasing securities, contracting bank credit relative to the money stock. The bank credit multiplier declines and the money multiplier expands as time deposits decline relative to demand deposits. The net effect is to raise interest rates on the credit market and to encourage financial institutions to develop less restricted substitutes. The growth of Euro-dollars, commercial paper, money market funds and other substitutes for time deposits is evidence of the working of this process in recent years.

In the absence of a ceiling rate on time deposits, the time deposit rate would increase in Figure 4. Existing financial institutions would lose fewer time deposits.

Regulation of interest rates on deposits may provide some short-run protection to particular deposit institutions at the expense of their depositors. Regulation of interest rates is not compatible with the long-run survival of these institutions if market rates for equivalent risks are, on average, higher than the rates paid to depositors.

Zero rates of interest on demand deposits are in all relevant respects similar in their effect to ceiling rates on time deposits. The long-run effects of the prohibition of interest payments are encouragement of alternatives that avoid the restriction and decline in the institutions that are unable to offer substitutes.

Ceilings for interest payments on time deposits and prohibition of interest payments on demand deposits encourage the development of deposits not subject to regulation. These restrictions encourage depositors to shift from insured to non-insured deposits, increasing risk.

SOME COMMENTS ON INNOVATION

For many of the same reasons that the innovations we observe depend on the types of regulation we impose, the response to labor-saving innovation depends on regulation. A main conclusion of this study is that as the costs of regulation rise, substitutes develop that circumvent regulations. Hence, if the most efficient financial institution is a diversified institution offering a wide range of services, diversified financial institutions will develop. This does not mean that all institutions will be identical. Specialization will remain because

the costs of providing identical services at all financial institutions exceeds the revenues that can be earned by suppliers.

By assuming that regulation does not continue to distort the allocation of reserves in the financial sector, we can draw some tentative conclusion about the effects of innovation. There are four major effects of innovation on the model of money and credit in previous sections. In this section, I briefly discuss the four effects and their implications for monetary policy.

FOUR EFFECTS OF INNOVATION

Reduction of Risk

A major reason for financial innovation is to reduce risk. Current technology reduces the cost of storing information and thereby permits lenders to classify risks more accurately. In the future, risk will be reduced further if EFT is used to transfer payments from buyer to seller at time of sale. The cost of maintaining computer access for every seller and current information on every buyer is not negligible. These costs limit the rate of innovation.

EFT does permit centralization of information, storage of borrowing and commitments, etc. Records of past payments experience reduce potential losses from nonpayment. Those who benefit from assignment to a lower risk class find their costs of borrowing lower; in part, at least, their increased borrowing is offset by the reduced borrowing of those whose risk class is appraised as higher. There is no presumption that the aggregate volume of borrowing and lending increases or decreases.

Changes in the Reserve Ratio and Float

In the present payments system, there is a lag between the time checks are drawn and the time they are deposited at the account of the payee, and a further lag before they are deducted from the account of the payer. The clearing of checks gives rise to float.

Faster clearance reduces float. Since Federal Reserve float is an interest-free loan from the Federal Reserve Banks to the member banks, float changes the monetary base. Reductions in float reduce the variability of the monetary base. Faster clearing reduces float.

Banks hold reserves in excess of requirements partly to accommodate check clearing. If automated clearing reduces the variability of deposit flows, banks reduce their demand for excess reserves.

A reduction in excess reserves relative to deposits raises the multipliers of money and bank credit and the stocks of money and credit. For the ratio of excess reserves to deposits to fall, excess reserves must fall proportionally more than deposits. Excess reserves are small relative to deposits, and a substantial reduction in the average ratio is unlikely.

Changes in the Currency/Deposit Ratio

Credit cards and other forms of borrowing at time of sale are substitutes for consumer credit, bank loans and more traditional forms of borrowing. Credit cards substitute for currency payments and for check payments, so they change both the numerator and denominator of the currency ratio.

There are costs of using credit cards and transferring deposits, and these costs assure that some transactions will be made with currency in the future. If the distorting effect of a prohibition of interest payment on deposits were removed, the ratio of currency to deposits would not have risen as much as it has. A plausible argument can be made that if interest had been paid on demand deposits, currency would have declined relative to deposits. As the use of credit cards increases, the currency ratio will decline secularly if restrictions on interest payments are removed. A decline in the currency ratio raises the multipliers of money and credit, for a fixed monetary base. Bank credit rises relative to money. The effect is an increase in the market interest rate and most likely a decline in asset prices.

Changes in the Time Deposit Ratio

EFT lowers the cost of transferring assets. A principal effect is to permit owners of assets to hold a large share of their wealth in the form of interest-bearing deposits (or at higher interest rates if interest is paid on demand deposits). In the absence of restrictions and differences in reserve requirement ratios, term to maturity becomes a main reason for differences in rates of interest paid on demand and time deposits. To the extent that EFT substitutes lower cost capital for higher cost labor in the payments process, the cost of managing assets falls. The maturity of deposits—demand and time together—increases. The effect of more time relative to demand deposits is to increase bank credit and reduce the money stock—currency and demand deposits. The increase in credit is large relative to the decline in money, so interest rates and asset prices fall, the return to time deposits declines, and equilibrium is restored at a lower market rate of interest.

To these effects on risk and on the ratios that determine the values of the multipliers, some writers add an effect on overdrafts. An overdraft privilege is a type of credit—not money. Overdrafts become money when they are used to make payments.

My analysis reaches the conclusion that improvements in payments technology and an upward-sloping yield curve are likely to reduce the equilibrium stock of money relative to the stock of credit. The substitution of overdrafts for deposits is one of the ways in which the adjustment of the two stocks occurs.

SUMMARY AND CONCLUSION

My analysis of the effects of EFT on the usefulness of the instruments of monetary policy reaches 12 main conclusions. Many of these are drawn from a model that incorporates explicit effects of the instruments and of intermediation.

1. Distinctions between labor-saving technical change and technical changes that circumvent existing regulation are not always observed in discussions of the effects of electronic funds transfer on the economy and on the instruments of monetary policy. Automated clearing houses are labor saving; NOW accounts and money market funds are principally a means of circumventing regulation.
2. Labor-saving technical changes reduce the cost of making and receiving payments. Technical changes that circumvent regulations are a waste of resources because they duplicate facilities that would be provided in the absence of regulation. They are the market's response to regulation, but resources could be saved if the regulations were removed.
3. Much of the effect of EFT on particular institutions and on particular instruments of monetary policy depends on regulations, current and future. Some choices are necessary here. Prohibition of interest on demand deposits, regulation of interest on time and saving accounts, and differences in reserve requirements can eliminate particular assets or institutions. Conversely, reduction or elimination of regulation will reduce the number and kinds of financial institutions and financial liabilities.
4. The speed of innovation depends on the rate of inflation. As the rate of inflation rises, the gain to consumers and business from substituting assets with unregulated returns for assets with regulated returns rises. Some assumption about future inflation is required if ceilings on interest payments are retained. Public policy should remove regulations that encourage the type of innovation that circumvents regulation. Prohibition of interest payments on demand deposits and ceilings on time deposits and savings deposits at regulated institu-

tions penalize existing financial institutions and should be removed.

5. Financial innovation occurred sporadically for more than a century. Open market operations remain effective. This suggests that EFT will not eliminate responses to open market operations. The central banks can engage in open market purchases and sales and continue to have effects on the price level and on output by open market operations.
6. Differences in reserve requirement ratios encourage substitution of one type of deposit for another. Banks and nonbanks offer lower interest rates and/or fewer services on deposits that are subject to higher reserve requirement ratios and more interest and services on deposits subject to lower reserve requirement ratios. Differences in reserve requirement ratios encourage growth of those institutions and deposits subject to the lowest reserve requirement ratios relative to other instruments and institutions.
7. The effectiveness of reserve requirement policy as an instrument of monetary policy is reduced in the long run by the tendency for deposits to increase at institutions subject to the lowest reserve requirement ratios. Reduced effectiveness is a consequence of innovation to avoid regulation. The public chooses deposits that offer the highest return in interest and services; the banks and financial institutions offer higher returns and services where costs, including reserve requirements, are lowest.
8. Payment of interest on deposits and interest on required reserves would reduce innovation to avoid regulation. Differences in reserve requirement ratios, however, would continue to foster differences in the relative growth of deposits subject to different reserve requirement ratios unless interest payments on required reserves are adjusted frequently to reflect changes in the federal funds rate.
9. A simpler alternative is to make reserve requirement ratios the same for all types of deposits at banks and financial institutions, to pay interest on required reserve balances and to maintain reserve requirement ratios unchanged. Portfolio restrictions and tax rates should be the same for all institutions, also.
10. Rediscounting is now a privilege of member banks of the Federal Reserve System. Generally, the volume of rediscounting is small, and rediscounting is of limited importance. Changes in rediscount rates are not an important or frequently used instrument of monetary policy. EFT will not greatly alter the effectiveness of changes in rediscount rates. As long as some banks retain membership in the Federal Reserve System, reserves can be supplied or withdrawn by changing the rediscount rate relative to the market rate of interest.
11. Ceilings for interest payments on time deposits and saving deposits and the prohibition of interest payments on demand deposits

encourage innovation that has as its principal purpose avoidance of the restrictions. Many of the substitutes are less familiar to the public and are not insured, so risk increases. Restrictions on interest payments should be removed to avoid waste of resources and increased risk and uncertainty.

12. Overdrafts are a form of credit, not money. Innovation that improves payments technology and an upward-sloping yield curve increase credit relative to money. The use of overdrafts (borrowing) as an alternative to holding money (deposits) is one of the ways in which the adjustment is made.

FOOTNOTES

*This article was originally prepared for the National Commission on Electronic Funds Transfers, November 1976.

1. The analysis follows the Brunner-Meltzer framework as presented in a number of papers.
2. The rise in asset prices reflects a restriction in the solution of the Brunner-Meltzer model from which these results are obtained. The interest response of the CM curve exceeds the interest response of MM.
3. In an open economy, adjustment should be made for purchases of foreign securities and sales of securities to foreigners.
4. The increase in P occurs only if the interest response of the credit market is larger than the interest response of the money market. This appears to be true where empirical studies have been made.

REFERENCES

Brunner, Karl and Meltzer, Allan H. "An Aggregative Theory for a Closed Economy," Chapter 2 in J. Stein, ed., *Monetarism* (Amsterdam, North Holland, 1976).

_____. "Monetarism The Principal Issues, Areas of Agreement and the Work Remaining," in J. Stein, ed., *Monetarism* (Amsterdam, North Holland, 1976).

_____. *An Alternative Approach to the Monetary Mechanism*, House Committee on Banking and Currency (1964).

Flannery, Mark J. and Jaffee, Dwight M. *The Economic Implications of an Electronic Monetary Transfer System* (Lexington, Mass.: Lexington Books, 1973).

Friedman, Milton. *A Program for Monetary Stability* (New York: Fordham University Press, 1960).

Hess, Alan C. "An Explanation of Short-Run Fluctuations in the Ratio of Currency to Demand Deposits," *Journal of Money, Credit and Banking* (August 1971).

Karni, Edi. "The Value of Time and the Demand for Money," *Journal of Money, Credit and Banking* (February 1974).

Marty, Alvin. "Comment," *Journal of Finance* (May 1972).

National Commission on Electronic Funds Transfer. "The Economics of Electronic Funds Transfer," Internal Document 25 (October 1976).

_____. "Electronic Funds Transfer and Monetary Policy," Internal Document 23 (August 1976).

Niblack, William C. "Development of Electronic Funds Transfer Systems," Review, Federal Reserve Bank of St. Louis (September 1976).

Poole, William and Liberman, Charles. "Improving Monetary Control," *Brookings Papers on Economic Activity* (1972).

Silber, William, ed. *Financial Innovation* (Lexington, Mass.: Lexington Books, 1975).