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CONTENTS

The Economic Consequences of Wage-Price Guidelines 2

Is Inflation All Due to Money? 8

Are Preliminary Week-to-Week Fluctuations in M1 Biased? 13

A Comparison of Yields On Future Contracts and Implied Forward Rates 21

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The Economic Consequences of Wage-Price Guidelines

MICHAEL E. TREBING

VOLUNTARY wage and price guidelines have now been adopted as a major element in the Government's anti-inflation program. The pricing behavior of firms and wage demands of labor are considered by a large portion of the population to be incompatible with the social objective of reducing inflation. Restraint in wage and price movements is believed to be necessary. Monetary and fiscal restraint alone apparently have been judged as either not being able to accomplish this objective or as carrying too high a cost, in terms of lost output and employment.[1]

Although the guideline approach is popular with the public, remarkably little discussion has been directed toward its implications.[2] In particular, the probable efficiency and distributional consequences of the program have received little public attention.

THE DECELERATION PLAN

Wage and Price Arithmetic

The Administration has set explicit numerical standards for wage and price increases.[3] The basic guidelines specify that annual increases in wage and fringe benefits be held below 7 percent and that price increases be limited to 0.5 percent less than their annual rate of increase during 1976-77.[4] An alternative test for firms is to apply a "profit-test." If a firm cannot meet the price standard, it is requested to limit its pre-tax profit margin on sales to the average of the best two of the past three years. In addition, total profit increases must be below a 6.5 percent ceiling, unless accounted for by volume increases.

The program requires that deceleration of prices be achieved in each market, purportedly with individual firms sharing equally in the burden of lowering inflation.[5] The target for inflation is 6 to 6.5 percent over the first year of the program. In order to reach these objectives, the program's aim is to have prices rise at the same rate as unit labor costs, with average wage increases of 7 percent minus 1.75 percentage points for projected productivity growth yielding an inflation rate of 5.25 percent. The Administration allows an additional 0.5 percent for "legislatively mandated payroll costs" and arrives at a rate of 5.75 percent.[6] The Administration states: "The wage/price standards are designed to serve as guides for the behavior of decision-making agents who have *discretionary power over the prices and the wages* that they receive."[7] [emphasis added]

While the guidelines are "voluntary," the Administration has emphasized its intention to compel firms to comply by manipulating both Federal procurement policy and the Government's broad regulatory authority. The program also encourages that the force of public exhortation be directed at those large firms which exhibit "excessive" price increases.

The Administration has requested that Congress pass a "real wage insurance" program. Under this scheme, workers who meet the pay standard will receive a tax rebate if the rate of inflation exceeds 7 percent. The purpose of the rebate is to reduce workers' fear of cooperation by insuring that they will not have their purchasing power reduced if the rate of inflation is not held to less than 7 percent.[8]

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[1] This conclusion is clearly stated in *White Paper: The President's Anti-Inflation Program* (accompanied the President's announcement of the guideline program on October 24, 1978) pp. 1-4.

[2] A recent public opinion poll demonstrates the popularity of the adopted guideline policy. In a November 1978 Harris Poll 63 percent of the respondents supported the program. See Louis Harris, "Americans Support Anti-Inflation Plan," *St. Louis Globe-Democrat,* October 20, 1978.

[3] In this article the word "standards" is used interchangeably with guidelines and guideposts. For details of the program see U.S. Council on Wage and Price Stability, *Fact Book: Wage and Price Standards* issued October 31, 1978.

[4] Ibid. pp. 20-40. The pay standard applies not to individual workers but to average pay increases for "groups" of workers. The price standards are directed at individual firms and apply to an "overall average price" and not to specific products.

[5] See *White Paper*, p. 7.

[6] *Fact Book*, pp. 15-16. Even with widespread compliance, the Administration concedes that prices will probably rise within the range of 6 to 6.5 percent. This would represent, however, an improvement over the first six months of 1978 when prices rose at a 10 percent annual rate.

[7] Ibid. p. 16. The paragraph continues: "Thus, standards are not directly relevant to pricing behavior in those markets in which prices are determined by the impersonal workings of supply and demand." The program exempts raw materials and auction type markets which include (1) prices of agricultural and industrial raw materials, (2) interest rates, and (3) prices which historically have moved in tandem with an organized open exchange market.

[8] Note that a 7 percent pay increase and a 7 percent inflation rate gives zero increase in real income *before* taxes — even if productivity rises 1.75 percent. Given the progression in the income tax structure, real income (after taxes) declines. See Nancy Jianakopolos, "Paying More Taxes and Affording It Less," this *Review* (July 1975), pp. 9-13.

Incomes Policy and Inflation

Voluntary wage and price standards can be classified as an "incomes policy". This generic term, loosely defined, includes all of those actions taken by a government to affect the level of money incomes or prices by actively participating in wage and price decisionmaking.

Although more popular in European countries, a wide range of incomes policies have been tried in the United States in recent years.[9] Included have been relatively weak attempts to persuade or "jawbone" specific firms and workers to hold down wage or price increases in the spirit of social responsibility.[10] Such a program was adopted during the Kennedy Administration and carried over into the early years of the Johnson Administration. At the other extreme, incomes policies have included former President Nixon's rigid program of mandatory criteria for wage and price behavior throughout the entire economy. Guidelines represent an attempt to achieve a compromise between the two extremes. By strengthening the persuasive element used under the jawboning method while attempting to avoid the harsh consequences of strict wage and price controls, guidelines represent a politically tempting route.

WHAT "CAUSES" INFLATION?

The "Cost-Push" View

The acceptance of voluntary wage and price standards as an alternative prescription for reducing the general rate of inflation stems from the idea that inflation is generated by "cost-push" factors. This view describes how rising wages, the largest component of business costs, continually force prices upward. The resulting inflation is known to the public as a wage-price spiral. A similar version of this view concludes that inflation is the consequence of increases in the market power of firms and labor over the prices they charge. According to this analysis, prices and wages are "administered" by large firms and trade unions without regard to competitive market forces.

The cost-push view has great popular appeal since it depicts the inflation process as a struggle for income shares between capitalists and workers. However, economic theory reveals that many implications of this view of inflation are illogical or, at best, questionable.[11] It is argued that monopoly power exists in the market place and that firms have the ability to push prices above competitive levels and raise the average price level. But this analysis ignores the question of why the monopolies had been charging less than the high monopoly price.

The theory of monopoly pricing predicts that firms which have protection from the entry of competitors into their markets are able to receive prices above those of competitive markets. Once the monopoly price has been achieved, however, further increases are limited to the opportunities provided by the market. If monopoly power is now causing prices to rise, either monopoly power is increasing or monopolists had been behaving irrationally and have just discovered their market advantage. There is little evidence to support either alternative.[12]

Undeniably, many economic groups exhibit enough market power to influence the level of certain prices and wages. These monopoly prices are higher than they would be if the specific market were competitive. But, except for a slight rise due to the resource misallocation, the overall level of prices and wages will remain substantially unchanged.[13] For example, if wages in a particular industry are pushed up above competitive levels less employment will result. Labor will then be released for use in other sectors where a downward pressure on wages will result until a new equilibrium is reached. More importantly, however, this analysis is unable to explain persistent increases in prices, month after month, year after year.

A Monetary View

An alternative theory is that inflation is a monetary phenomenon. This view holds that changes in money growth exert a strong influence on total spending in the economy. When people find that they are holding cash balances which are greater than desired, they spend the excess money on real and financial assets and bid up their prices.

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[9] For historical surveys of incomes policy in the United States and abroad see U.S. Congress, Congressional Budget Office, *Incomes Policies in the United States: Historical Review and Some Issues, May 1977;* Lloyd Ulman and Robert J. Flanagan, *Wage Restraint: A Study of Incomes Policies in Western Europe* (Berkeley, California: University of California Press, 1971); Walter Galenson, ed., *Incomes Policy: What Can We Learn From Europe?* (Ithaca, New York: New York State School of Industrial and Labor Relations, Cornell University, 1973); and Craufurd D. Goodwin, ed., *Exhortation and Controls: The Search for Wage-Price Policy, 1945-1971* (Washington, D.C.: The Brookings Institution, 1975).

[10] These efforts are sometimes referred to as "moral suasion."

[11] See George J. Stigler, *The Organization of Industry* (Homewood, Illinois: Richard D. Irwin, Inc., 1968), pp. 244-45 and Milton Friedman, "What Price Guideposts?", *Guidelines: Informal Controls and the Market Place,* ed., George P. Shultz and Robert Z. Aliber (Chicago: University of Chicago Press, 1966), pp. 17-39.

[12] For a survey of the evidence regarding the relationship between market concentration and price changes see Steven Lustgarten, *Industrial Concentration and Inflation* (Washington, D.C.: American Enterprise Institute for Public Policy Research, 1975).

[13] One purpose of a union monopoly, for example, might be to gain real wage benefits for its rank and file. To accomplish this objective the union has several alternatives available to it. It may try to reduce the supply of labor through restrictive licensing practices or by not allowing non-union workers

The monetary view does not deny the existence of a wage-price spiral, but interprets the cost-push analysis as a confusion of the cause and effect relationships of the inflation process. According to the monetary view, the observed patterns of wage and price adjustments are normal responses to excessive money growth. For inflation to persist, the higher prices, *no matter where they originate*, must be validated by increases in the money supply. With money growth held constant, price increases can be maintained only through reduced production and employment. For such a situation to persist, businesses would have to willingly accept lower profits and labor would voluntarily remain unemployed and refuse to accept employment at lower wages. The empirical evidence does not support such irrational behavior.[14] Only when monetary authorities actively ensure that the spiral is fully augmented through increases in the money supply, will inflation result.

WILL VOLUNTARISM SUCCEED?

The underlying requirement for a successful guideline policy is that firms and wage-earners restrain themselves from acting economically as *individuals*. In a market economy the motive of individual self-interest is crucial. Consumer preferences are revealed through the market by nonrestricted opportunities and/or purchases of goods and services at their market price. These prices reflect not only the costs of production, but also the nature of demand for the good in question. The free movement of prices and the consequent incentives and disincentives that are created assure that resources in the economy will move toward satisfying these individual demands.

An appeal for individual restraint conflicts with a very basic economic observation about human behavior — consumers naturally strive to maximize their individual well-being. Economic self-interest is the major motivating factor behind economic activity. Guidelines, on the other hand, represent rules that substitute "social responsibility" for self-interest. The conflict between the two views is glaring. Economic incentives argue against *individual* compliance with the social motives and wealth is transferred to those who stand apart from the program.

The Kennedy Administration guideposts of 1962-67 represent a prime example of these conflicts. This voluntary program established upper wage limits which were equal to overall productivity gains for the economy.[15] The problem which resulted in the demise of the productivity rule was that the guideline principles did not take into account the fundamental pressure created by accelerated money growth. When the productivity guidelines were initially adopted, the trend of productivity growth was substantially above the rise in consumer prices. Wages based on the productivity rule thus provided for growth in real wages (money wages adjusted for price changes). As money growth accelerated and inflationary pressures intensified in 1965 and 1966, the wage standard became viewed as unfair. Labor, discovering that the purchasing power of their wages was falling, found the argument for holding down wages unacceptable. As key settlements began to exceed the guideposts, the program was abandoned.

The degree of compliance with price guidelines will be associated with the severity of the penalties against those who choose to ignore them. If the controls are truly voluntary and involve no costs for violation, there is little chance that they will succeed since gains from noncompliance can be realized without costs. If economic sanctions are used against violators, however, each firm will weigh the expected costs and benefits involved. If the expected costs of noncompliance are less than the benefits, the firm will choose to ignore the guidelines.[16] Avoidance can also take the form of "black-market" transactions above the controlled price or product quality changes.

Though the burden of the program is intended to be equally shared, this will not be the case. Government penalties through procurement policy will not affect private decisions in a uniform fashion. Some firms are dependent upon either government purchases of their output or are directly influenced by government policies. Other firms, however, may be outside the range of government sanction. Holding down the price of particular goods by penalties benefits the purchasers of these goods and the sellers of unaffected competitive goods. The losers are the sellers of the controlled goods, those prospective buyers of the controlled goods who can no longer

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to obtain jobs. Secondly, the union might seek a higher wage through collective bargaining and thus accept the unemployment forthcoming at this higher wage.

[14] See Denis S. Karnosky, "The Effect of Market Expectations on Employment, Wages and Prices," Working Paper #17, Federal Reserve Bank of St. Louis.

[15] The Council of Economic Advisers, *Economic Report of the President* (Washington, D.C.: United States Government Printing Office, 1962), pp. 185-90.

[16] The same type of "cost-benefit analysis" will occur when labor contemplates compliance with wage guidelines and the rebate scheme which supplement them.

Table I

Productivity Changes for Selected Industries, 1971-76

(Annual Rates of Change)

	Output per Employee-hour[1]
Hosiery	11.1%
Synthetic Fibers	7.4
Wet Corn Milling	7.2*
Aluminum Rolling & Drawing	5.5
Pharmaceutical Preparations	4.3
Paper, Paperboard, & Pulp Mills	2.5
Petroleum Refining	2.1
Steel	1.8
Concrete Products	0.8*
Primary Aluminum	–1.4
Hydraulic Cement	–1.5
Copper Rolling & Drawing	–1.7
Coal Mining	–4.3

*1971-75

[1]The output per employee-hour figure is computed by dividing an output index by an index of aggregate employee-hours for production workers.

Source: U.S. Department of Labor, *Productivity Indexes For Selected Industries,* 1977 edition, p. 5.

Table II

Wages, Prices and Employment by Industry (1971-77)

(Annual Rates of Change)

	Prices[1]	Employment[2]	Wages[3]
Manufacturing	6.0%	1.0%	7.7%
Construction	8.2	1.1	5.7
Services	7.3	3.8	7.7
Trade	6.5	3.1	6.4
Finance	4.9	2.8	6.6
Communications	3.4	0.9	9.9
Transportation	5.9	0.8	7.7
Utilities	8.9	1.1	7.8
Mining	18.2	5.1	9.6
Agriculture	9.5	2.7	6.5

[1]Changes in implicit GNP price deflator by industry.

[2]Full-time and part-time employees.

[3]Labor compensation per full-time equivalent employee.

Source: *Survey of Current Business.*

obtain them, and the purchasers of the competitive goods. The losses exceed the gains because of the misallocation of resources.

The proposed "real wage insurance" plan which would supplement the guidelines, if enacted, serves to shift the burden of compliance among economic groups. If certain workers are guaranteed a constant real wage, the forthcoming rebates could reduce real incomes to the rest of the nation provided there is an increase in the federal deficit. To the extent that these larger deficits are "monetized", inflationary pressures will be supplemented, thereby reducing the wealth of all holders of money and monetary instruments.[17]

The real-wage insurance program is said to be capable of breaking inflationary psychology and be able to bring about more rapidly the achievement of price stability. Lower expectations of inflation in the future, according to this view, would translate into lower demands for wage increases and eventually lower prices. This viewpoint, however, confuses how inflation expectations develop. Expectations *per se* do not cause inflation. Curbing expectations will require controlling of the underlying force which causes them to prevail. If price controls only delay the upward thrust of prices caused by expansive money growth, expectations of future inflation will not be reduced.

If inflation expectations are not reduced by slower monetary growth, the longer-run objective of reaching price stability will be abandoned. For example, since market pressures will eventually push prices upward, reaching the objectives of wage stabilization in the future will be made more difficult. Following a period of controls, a stable wage structure is far more likely to allow a resumption of moderate rates of wage increase than a structure in which distortions, perpetuated by public policies, require rapid readjustment at the bargaining table. Experience with this type of "wage-price explosion" is well documented from European experience with control programs.[18]

MARKET DISTORTIONS AND CONTROLS

Most economists agree that, for the sake of efficiency, *relative* wages and prices should remain flexible. Relations among the wages of workers of different skills and of workers in different localities, industries or even firms should be allowed to vary according to changes in demand and supply. For example, firms which are growing have an incentive to hire scarce resources (labor and capital) away from other firms. Consequently, if upper limits are imposed upon the payments that can be offered to attract scarce inputs, the firms will not be able to meet the demand for their output. Relative prices, therefore, should be allowed to move in order to allocate resources into their most productive uses.

The dynamic character of the U.S. economy is evident from Tables I and II. The tables display that changes in employment and prices have varied across industries. Some industries have experienced rapid productivity growth; others have not. Employment growth has varied from industry to industry and generally reflects underlying demand conditions. The application of a single price and wage standard to all situations ignores this ongoing adjustment process and confuses movements in relative prices (shifts of resources between economic groups) and the general level of prices. To minimize efficiency losses, it would be necessary to keep a watchful eye on individual wage and price relationships and make exceptions based on individual market situations. A tradeoff is therefore faced by the policymaker. The more stringent the guideline (less exceptions) the greater the efficiency losses. On the other hand, "weak" guidelines are not likely to gain the acceptance of the populace who judge the probable success of the guidelines by the strictness of the program. The program is therefore unlikely to reduce inflation expectations.

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[17]For an analysis of the administrative problem with the "real-wage insurance" program, see Gardner Ackley, "Okun's New Tax-Based Incomes Policy Proposal," *Economic Outlook USA* (Winter 1978), pp. 8-9.

[18]Ulman and Flanagan, *Wage Restraint,* p. 223.

Implicit in the decision of who should be covered by guidelines are important judgments regarding the distribution of income among industries and between the factors of production. In other words, control programs politicize questions of income distribution. In a market economy, relative prices are signals that allocate society's resources into their most productive uses. Reflecting changing market conditions, these relative prices are always in motion and are independent of political criteria for distributing income between economic groups. Any guideline based on a simple percentage price increase for all individual firms, however, is implicitly centered on an acceptance of wage and price relationships (at the time of policy implementation) as stable ones and assumes that the relationships will remain fixed throughout the period of the guidelines.

Direct government controls, therefore, offer little inducement for the efficient development and use of resources, and contain no automatic mechanism for resource adjustments and the alleviation of shortages or excesses in production. Rather than being an aid to growth and vitality, they lead to retardation of economic resiliency and replace market forces by political ones.

The U.S. experience with control programs demonstrates these market misallocations. Price controls during World War II resulted in the substitution of low-quality goods for higher quality goods and black markets were commonplace as individuals developed lack of respect for the law. In later years, subsidies to producers became an increasing part of the control program as fixed prices were insufficient to provide the necessary incentives for production. Recent voluntary programs were also unable to avoid selective scarcities. For example, the Kennedy guideposts were blamed for shortfalls in supply of aluminum and sulfur and potential users were forced into using costly substitutes. Similarly, under the Nixon Administration controls, shortages developed for zinc, lead, steel, fertilizer, petrochemical products and a long list of other products.

Table III

The 1962-66 Guideposts Period

	Annual Percentage Changes		
	M1[1]	WPI[2]	CPI[3]
1962	2.2%	0.3%	1.1%
1963	2.9	−0.3	1.2
1964	4.0	0.2	1.3
1965	4.3	2.0	1.7
1966	4.7	3.3	2.9

[1] Demand deposits plus currency and coin held by the nonbank public.
[2] Wholesale Price Index.
[3] Consumer Price Index.
Source: Department of Commerce.

THE ROLE OF MONETARY ACTIONS

The program is further complicated by the timing of monetary action. In order to validate decelerating inflationary pressures, it will be necessary to supplement the program by tighter monetary action — reducing growth in the money supply. But a problem exists in the timing of monetary actions and the control policy. Relations observed in the past indicate that previous changes in the money supply have effects on current variables — the pattern of aggregate spending is determined by past monetary actions.[19] A perfectly timed effort by monetary and price control authorities will be difficult to achieve.

The apparent failure of the Kennedy and Nixon control programs to reduce inflation can be interpreted in a monetary framework. A monetary explanation for the failure of the 1962 guideposts is evident in Table III. When the guidelines were adopted, consumer prices were rising at a moderate 0.7 percent rate. (The average change in the Wholesale Price Index between 1958 and 1964 was near zero.) Throughout the life of the guideposts (1962-66), however, money growth increased steadily each year. The money stock grew 1 percent per year from 1959 to 1961, but increased steadily each year of the program.[20] Correspondingly, prices and wages moved upward reacting to the more rapid growth of spending. When the program was abandoned in 1966, consumer prices were rising at the rate of 3 percent.

During the Nixon price control period (1971-74), money growth data reveals that the controls camouflage a period of overly expansive monetary policy during the 1970's. Although non-monetary factors (the oil embargo and the shock of controls) temporarily influenced the money-price relationship, the growth of the price level by 1975 paralleled that rate predicted by the trend growth of money.[21]

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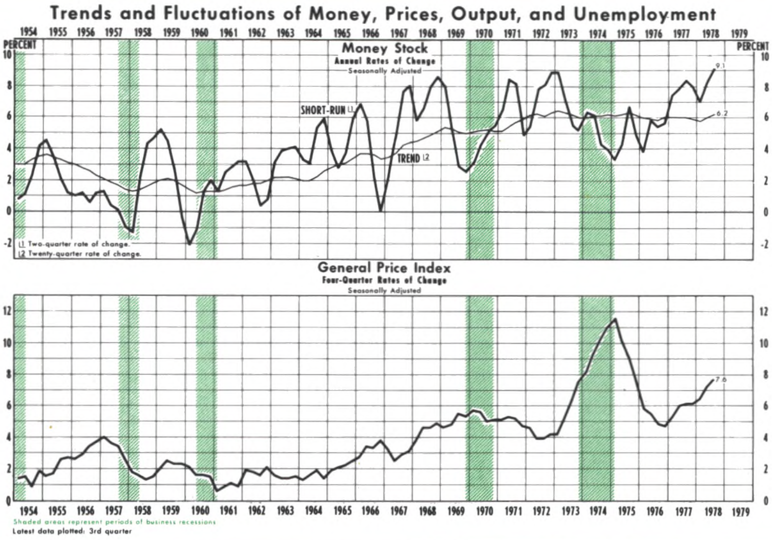
[19] One study which provides a more detailed statement of the theory and evidence supporting these conclusions is Leonall C. Andersen and Keith M. Carlson, "A Monetarist Model for Economic Stabilization," this *Review* (April 1970), pp. 7-25.

[20] Empirical support for the money-price relationship for the period 1955 to 1971 is presented by Denis S. Karnosky's, "The Link Between Money and Prices — 1971-76," this *Review* (June 1976), pp. 17-23.

Movements in the rate of inflation have been closely associated with movements in the trend growth of the money stock. The accompanying chart shows that both U.S. control periods since World War II have been marked by money growth above its long-run trend. Correspondingly, in both cases rates of change in prices eventually moved upward reflecting this long-run trend.


Trends and Fluctuations of Money, Prices, Output, and Unemployment

Shaded areas represent periods of business recessions
Latest data plotted: 3rd quarter

Without curtailing aggregate spending, individual demands will be simply shifted among controlled and uncontrolled goods.[22] Holding prices below their market clearing levels will increase the quantity demanded of controlled goods. If total spending is not reduced through monetary or fiscal actions, those who are unlucky and do not receive the goods that would have been supplied without controls, will shift their spending to other products which represent, in most cases, close substitutes. The increased demand in uncontrolled markets will put upward pressure on these prices.

CONCLUSION

"Voluntary" wage and price guidelines have recently been adopted as an accompanying policy alongside the more traditional economic stabilization tools of monetary and fiscal policy. By establishing rules for pricing behavior, the Administration hopes to dampen a wage-price spiral that appears to be self-sustaining.

According to the monetary view of inflation, the logical foundation of the control program confuses the results and causes of inflation. According to this view, inflation results when money growth persistently exceeds growth in the amount of money demanded. The observed wage and price adjustment (the so-called wage-price spiral) are but parts of the general response in the economy to excessive money growth. Inflation expectations, which are generated by excessive money growth, will be reduced only when the growth rate of money is slowed.

Any short-term benefits received from strict compliance with the guidelines will be costly. The unconstrained market system provides an efficient signaling system for moving resources between alternative uses. Any control framework will probably conflict with these price signals and will cause distortions which reduce the resiliency of the market system to changing market conditions. The emergence of black-markets and disguised price increases through reduced product quality are two examples of devices that have arisen in response to previous programs and may arise in the current program to circumvent the controls.

Past incomes policies in the U.S. have been unable to reduce inflationary pressure because monetary actions remained expansive. If monetary actions remain expansive throughout the current program, accelerated inflation appears inevitable. The fundamental forces of supply and demand cannot be repealed through *any* type of control program.

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[21] Ibid.

[22] The word "controlled" refers equally to those "voluntary" responses that are reactions to government sanctions.

Is Inflation All Due to Money?

ALBERT E. BURGER

INFLATION is an all-pervasive problem which affects everyone's decisions. Individuals must consider the outlook for prices when planning budgets or wage demands, when deciding whether to buy a house or in what form to hold savings, as well as a multitude of other economic decisions. Also, business is increasingly concerned about the outlook for inflation, especially as it relates to planning and capital investment.[1] It is not surprising, therefore, that persistent inflation has led to increased public demands that something be done to correct the problem.

The current Administration has responded to these demands by announcing an anti-inflation program which includes, among other aspects, a promise to intervene in individual price and wage decisions in an attempt to reduce inflationary pressures. But such an approach, at best, has only a very limited chance for success because it fails to distinguish between two key characteristics of the inflation process. First, there are increases (or decreases) in prices which result from nonmonetary factors that cover a gamut of influences such as the effects of weather on agriculture and actions of foreign oil producers. The basic characteristic of all these nonmonetary factors is that they have a transitory influence on inflation. They have their impact on the level of prices in selected periods, but their influence is either reversed in following periods or ceases to be a cause of period-after-period changes in prices in the same direction. It is the second aspect of inflation, the trend or persistent year-after-year increase of prices, that is really "public enemy number one." This is the aspect of inflation to which corrective economic policy must be directed. Otherwise, all other economic programs to stop inflation will end in frustration.

Contrasting Explanations of Inflation

The rate of change of prices can show considerable short-term fluctuation. For example, the implicit price deflator for gross national product rose at a 5 percent rate in the third and fourth quarters of 1977, accelerated to about a 7 percent rate in the first quarter of 1978, rose further to an 11 percent rate in the second quarter, only to recede back to a 7 percent rate in the third quarter of 1978.

In addition to this variation in the general price index, there are also frequent fluctuations in the prices of individual items included in the general price indexes. Since pronounced swings in the prices of specific goods or services sometimes coincide with fluctuations in the general index of prices, specific items are frequently cited as the cause of the current inflation. Also, because the magnitude and timing of price changes vary from item to item, the blame for inflation is often transferred, from period-to-period, from one item to another. Consequently, a number of explanations of the inflation process have been offered, involving at various times the behavior of such diverse items as steel prices, exchange rate movements, union wage demands, agricultural conditions, changes in minimum wages and even the behavior of the periodically elusive anchovy. Such an analysis provides an ever-changing array of inflation villains. The blame for inflation is shifted from Arabs to coffee producers to beef producers to steel producers to specific union leaders to large banks and so on.

Concentration on such short-term oscillations in the various elements of price indexes clouds the issue of the fundamental force behind the persistent increase in the general level of prices. The problem of inflation is much more than an unfortunate sequence of increases in the prices of particular items. Focusing attention on movements in the price of particular items or each wiggle in the general price indexes gives only a *description* of where and when the general inflationary pressures fall in the economy. The important issue is why prices, on average, *continue* to rise over an extended period of time.

An *explanation* of the fundamental source of a continued pressure on prices requires a broader, longer-run perspective that incorporates monetary developments. When the money stock grows too rapidly relative to the rate of increase of goods and services, individuals find themselves holding more money than they demand, given existing income, prices, and yields (including interest rates) on other assets. In the process by which they attempt to pull their holdings of money in line with the quantity demanded, inflation results. To put the matter more simply, when "too much money is chasing too few goods" there will be *persistent* increases in prices. Consequently, analysis of persistent increases in the general level of prices requires consideration of the growth of the money stock. Such a monetary view contends that although prices can periodically rise or fall sharply due to nonmonetary factors, inflation continues only if these nonmonetary factors recur in succeeding periods, or if there is a continued excessive expansion of money.

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[1] John A. Tatom and James E. Turley, "Inflation and Taxes: Disincentives for Capital Formation," this *Review* (January 1978), pp. 2-8.

The emphasis which is placed on the role of monetary actions in the fight against inflation depends very much on which of these two aspects of price changes is the center of attention. Concentration on movements in individual prices or short-term movements in the general price indexes typically leads to assignment of a limited role to monetary actions, a focus of attention on nonmonetary factors, and the recommendation of some form of direct controls on the prices of specific items. In contrast, consideration of why prices continue to increase period after period, pinpoints the rate of monetary expansion as the prime factor in the fight against inflation.

Money and Inflation

To illustrate the difference between inflation caused by monetary factors and short-term movements in price indexes caused by nonmonetary factors, consider the following simple monetary guide to inflation:[2]

> The rate of change of prices over the next year is equal to the average rate of growth of the money stock over the previous five years.

The results of using this shorthand representation of the driving force behind the inflation process and its long-run character are presented in Table I.[3] The information in this table shows that, over the period 1953-71, past or trend growth rates of money were a reasonably good guide to the year-to-year behavior of prices. During this nineteen-year period, the average difference between actual yearly inflation and that indicated by the past rate of monetary expansion was only 0.2 percentage point, and in two-thirds of the years the error was 0.5 percentage point or less. On a quarter-to-quarter basis, the rate of change of prices oscillated around the trend rate of inflation. However, the rate of change of prices returned consistently to that dictated by the rate of monetary expansion.

Table I

Monetary Growth as an Indicator of Inflation

Period	(1) Growth Rate of Money	Period	(2) Growth Rate of Prices	(1) - (2)
1947-52	2.3%	1953	1.5%	0.8
1948-53	2.7	1954	1.4	1.3
1949-54	3.2	1955	2.2	1.0
1950-55	3.3	1956	3.1	0.2
1951-56	2.7	1957	3.4	−0.7
1952-57	1.8	1958	1.6	0.2
1953-58	1.5	1959	2.2	−0.7
1954-59	2.0	1960	1.7	0.3
1955-60	1.3	1961	0.9	0.4
1956-61	1.5	1962	1.8	−0.3
1957-62	1.8	1963	1.5	0.3
1958-63	2.2	1964	1.6	0.6
1959-64	2.2	1965	2.2	0.0
1960-65	3.1	1966	3.3	−0.2
1961-66	3.6	1967	2.9	0.7
1962-67	4.0	1968	4.5	−0.5
1963-68	4.8	1969	5.0	−0.2
1964-69	5.2	1970	5.4	−0.2
1965-70	5.1	1971	5.1	0.0
1966-71	5.5	1972	4.1	1.4
1967-72	6.1	1973	5.8	0.3
1968-73	6.2	1974	9.7	−3.5
1969-74	6.1	1975	9.6	−3.5
1970-75	6.2	1976	5.2	1.0
1971-76	6.0	1977	5.9	0.1

Also during this period, changes in the five-year trend growth of money accurately indicated changes in the year-to-year rate of inflation. As the trend growth of money slowed in the period 1958-63, inflation was reduced. Over the next eight years, the trend growth of money accelerated steadily from less than a 2 percent rate to a 5 percent rate, and inflation rose from less than 2 percent to 5 percent per year.

In contrast to the 1953-71 period, the last six years present some examples of abnormally large differences between changes in the price index and the inflation indicated by past growth rates of money. In particular, 1972 and 1974-75 stand out as glaring exceptions to the previous performance of the monetary guide to inflation. To understand the behavior of inflation since 1971, and how this experience fits into the general monetary explanation of inflation, it is crucial that one clearly understand the effect of nonmonetary factors on the behavior of prices. Specifically, it is very important to realize that, although the level of prices can change, sometimes even for a prolonged period, the rate of change of prices cannot continue to substantially deviate from the rate of monetary expansion.[4]

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[2] For other examples of the use of monetary guides to inflation, see Richard T. Selden, "Inflation: Are We Winning the Fight?," Morgan Guaranty *Survey* (October 1977), pp. 7-13, and Allan Meltzer, "It Takes Long-Range Planning to Lick Inflation," *Fortune* (December 1977), pp. 96-106.

[3] Annual data are calculated as to the average of the four quarters of data in a given year. For example, the growth rate of prices from 1976 to 1977 on an annual basis is computed by comparing the average of the four quarters in 1977 to the average of the four quarters in 1976.

What special nonmonetary factors in 1972 and 1974-75 operated to cause such large deviations of actual changes in prices from those indicated by past growth rates of money?[5] First, 1972 was a year of price controls. By law, reported prices were not allowed to fully reflect market pressures, especially those pushing prices upward. Under such circumstances, the reported change in prices would be expected to be considerably less than inflation indicated by a monetary guide. From the perspective of a monetary interpretation of inflation, the gap in 1972 between price changes consistent with past money growth (about 5.5 percent) and those reported during wage and price controls (about 4 percent) indicates (1) an upsurge of prices when price controls were removed, and (2) an incentive for transactions to take place at prices above posted prices.

Other major differences between reported changes in prices and those indicated by past monetary expansion occur in the more recent period of 1974-75. Over this period, the level of prices was sharply and unexpectedly raised by the now well-known pricing actions of the major oil-producing nations and the nonmonetary effects of weather on agriculture. The actions of the Organization of Petroleum Exporting Countries (OPEC) resulted in a substantial, unexpected rise in the price of energy. Since energy is a basic input into most production processes, these OPEC actions had a widespread, and unexpected upward effect on costs of production. There was a decrease in the effective productive capacity of the economy. With aggregate demand affected to only a minor extent and real output reduced, the *level* of prices rose sharply.[6] Consequently, the rate of change of prices, computed over the period when these sharp upward adjustments in the level of prices took place, would be expected to be substantially, but temporarily, higher than that indicated by past monetary expansion. As their effect was absorbed in the economy, however, the *rate of change* of prices fell back to that dictated by the trend rate of money growth. Although in 1976-77 inflation returned to the rate dictated by monetary expansion, the *level* of prices remained about 4 percent higher, reflecting the effect of the OPEC actions.

Table II

Growth Rates of Selected Components of Consumer Prices

Period	Food Prices	Energy Prices	All Items less Food and Energy	Monetary Rate of Inflation
II/71 — IV/72	3.9%	3.7%	3.1%	6.0%
IV/72 — I/74	19.6	22.3	4.6	6.0
I/74 — III/75	8.8	13.9	9.7	6.0
III/75 — II/78	6.2	6.9	6.6	6.0

Table II shows the movement of prices of selected groups of items during the period from mid-1971 to mid-1978. As shown in the table, price increases of all items other than food and energy were held to about a 3-4 percent rate while general price controls were in effect (August 1971 through April 1974). After controls were removed from most items, prices accelerated to about a 10 percent rate, as shown in the period I/74 — III/75. Table II also clearly shows that the sharp surge in prices from late 1973 into late 1975 was initially led by the sharp rise in agricultural and energy prices[7] and then was reinforced by the adjustment of prices of all other items resulting from the removal of price controls in early 1974. None of these components of consumer prices

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[4] Even here, however, monetary factors still play a role, although indirectly. Autonomous events can have an effect on the demand for money, which, if not matched by a one-time change in the money supply, result in a one-time increase in the *level* of prices. In such instances, prices rise not because of an excessive increase in the money supply but because of excessive money balances created by a decrease in money demand.

[5] For a more complete technical discussion of the effects of special developments in 1972-74, see Denis S. Karnosky, "The Link Between Money and Prices — 1971-76," this *Review* (June 1976), pp. 17-23.

[6] For a technical discussion of the effect of the rise in energy prices, see Karnosky, "The Link Between Money and Prices — 1971-76," pp. 17-23; Robert H. Rasche and John A. Tatom, "The Effects of the New Energy Regime and Economic Capacity, Production, and Prices," this *Review* (May 1977), pp. 2-12; and "Energy Resources and Potential GNP," this *Review* (June 1977), pp. 10-24.

[7] Price controls on agricultural products were removed in September 1973. The initial OPEC rise in oil prices came in late 1973.

(food, energy, all other) continued the sustained double digit rate of increase. Since 1975 the average rate of increase of all these prices has fallen back into line with the sustainable rate indicated by the past rates of monetary expansion.

Implications for Monetary Actions

The above discussion has important implications for assessing the effects of past, current, and prospective monetary actions in the battle against inflation. The experience of the last six years makes it clear that it can be just as misleading to ascribe each and every reported increase in prices entirely to monetary factors as it is to ignore the effect of money on inflation. Consequently, failure to separate the monetary (trend) and nonmonetary (transitory) aspects of inflation can lead to confused demands on policymakers.

To illustrate the importance of this distinction, consider economic developments over the last six years. During the three-year period ended in the second quarter of 1971, the persistent rate of inflation was very much in line with the rate indicated by a monetary guide to inflation. Over the next six quarters, however, prices rose at about a 4 percent rate. Could this fall in inflation be attributed to monetary actions? The answer is no, the fall in *reported* inflation was strictly due to nonmonetary factors, that is, price controls that went into effect in August 1971.

From early 1973 through early 1975 prices rose very rapidly. From a 4 percent rate, inflation accelerated to about an 8 percent rate in the year ended first quarter 1974. Then, over the next four quarters inflation took another sharp leap upward, averaging 11.6 percent. If one attributes all of these increases in prices during this period to the cumulative effect of past monetary actions, then it appears that the Federal Reserve had let things get seriously out of hand. On the other hand, if the short-run influences of nonmonetary developments on prices are taken into consideration, quite a different conclusion emerges. Careful analysis of the effects on prices of weather, OPEC actions, and the removal of price controls would indicate a sharp rise in the level of prices beginning in late 1973 that was not the result of past monetary actions. The basic rate of inflation, the one determined by the cumulative effect of past monetary actions, remained at about 6 percent.

Early in 1975, inflation dropped sharply, and averaged 6.5 percent over the remainder of the year. Then inflation eased further to a 4.4 percent rate over the first three quarters of 1976. Was this substantial slowing in inflation the result of monetary policy actions? Again the answer is no. The slowing in the rate of change of prices from the double-digit pace of 1974 reflected only that the OPEC actions of late 1973 were not repeated in the following years, the general adjustment of other prices to the removal of price controls had been completed, and favorable agricultural conditions resulted in a sharp drop in the rate of increase of food prices. Did the basic inflation slow to a sustained 4.5 percent rate by late 1976? Again the answer is no. From late 1976 to the end of 1977 inflation returned to a 6 percent rate, the same as that indicated by the trend growth of money.

What was the effect of monetary actions, as measured by the growth of the money stock, on inflation over the six-year period 1972-77? In particular, what was the effect of allowing M1 to grow at about an 8 percent rate from late 1971 to early 1973, then cutting M1 growth to 6 percent for a year, further slashing it to 4 percent for a year, and then progressively reaccelerating M1 growth, first to 5 percent for six quarters, and then to almost 8 percent over the two-year period ended in the third quarter of 1978? Did these gyrations in money growth substantially change the basic rate of inflation? Using the past growth pattern of M1 as a guide to inflation, then again the answer is no. Money had grown at a 6 percent rate over the five years (20 quarters) ended in the fourth quarter of 1971, remained at 6 percent in the 20 quarters ended in early 1975 and by the end of the fourth quarter of 1977 the twenty-quarter growth rate of M1 was still essentially 6 percent.

Conclusions

In analyzing the inflationary process, one must be careful to avoid shortsightedness. In particular, short-run gyrations in prices must be distinguished from persistent changes in prices. Monetary policy cannot prevent the quarter-to-quarter fluctuations in the price level that naturally result from the dynamics of economic activity. However, concentrating on only these short-run fluctuations in the level of prices can result in falsely blaming nonmonetary factors for a persistent rise in prices. The analysis of inflation then tends to bounce, month-to-month, quarter-to-quarter from one item or sector of the economy to another. Such an approach diverts attention from the role of monetary actions, results in failure to permanently reduce inflation and ultimately means that inflation will return to plague the economy. The monetary actions of the government must be given a key position in any program to permanently reduce *persistent* inflation.

Over the first half of 1978, prices rose at about a 9 percent rate. Should inflation be expected to continue at this rate? The monetary guide presented in this paper, indicates a persistent inflation of about 6.2 percent for the period III/78 — III/79. Some economists would contend that individuals now adapt their expectations of inflation more rapidly than previously, hence, a five-year trend rate of growth for M1 is too long. If the period for calculating the trend rate of money is shortened to four years, the inflation indicated for III/78 — III/79 rises to 6.4 percent. Shortening the period further to three years, raises the basic inflation rate to 6.8 percent for the next year. Consequently, the lasting rate of inflation indicated by past monetary developments falls in a fairly narrow range of 6.2-7 percent, nowhere near a 9 percent rate.

However, just because a rough monetary guide to inflation, such as the one presented in this article, does not indicate that past monetary actions have yet cumulated into a 9 percent persistent inflation should not be taken as a cause for rejoicing. A persistent inflation of 6.5-7 percent is still at least three times as fast as any lasting inflation the U.S. economy experienced from the end of World War II through 1965. Furthermore, historical evidence indicates that the development of such a persistent inflation is a rather sluggish process that does not adjust immediately to accelerations or decelerations of the growth of money.[8]

Currently, the trend rate of money growth is being held down by the 5 percent growth rate that prevailed from the third quarter of 1973 to the third quarter of 1976. In sharp contrast, over the last two years (III/76 — III/78), the average rate of monetary expansion accelerated to 8 percent. As the effect of the 5 percent growth wears off, if money continues to grow at an 8 percent or faster rate, inflation will rise sharply to a persistent, year-after-year, 8-9 percent rate.

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[8] For example, growth of money (M1) accelerated to about a 7 percent annual rate in 1968, after rising at an average rate of about 4 percent over the previous five years. Inflation did not rise to 7 percent in 1968, instead it was 4.5 percent, about in line with the 4 percent average growth of M1 over the previous five years. However, as the money stock continued to grow rapidly by past standards — at a 6 percent rate in 1969 — the five year average growth of M1 rose to 5.2 percent by the end of 1969 and the rate of inflation moved up to 5.4 percent in 1970. This increase in inflation took place even though the growth of M1 subsequently decreased to about a 4 percent rate in 1970.

Are the Preliminary Week-to-Week Fluctuations in M1 Biased?

COURTENAY C. STONE and JEFFREY B. C. OLSON

THE preliminary seasonally adjusted estimate for weekly M1 — the money stock consisting of currency in the hands of the public and net private demand deposits — released each Thursday afternoon by the Federal Reserve has become one of the most eagerly awaited, widely publicized, and closely watched of all economic statistics. Changes in stock prices, movements in interest rates, variations in the volume of trading on financial markets — even fluctuations in the foreign-exchange value of the U.S. dollar — are frequently cited as consequences of the public's reactions to the week-to-week changes reported for the money stock. The impact attributable to the publication of these weekly money numbers has been described, with only slight hyperbole, by one economist as follows:

Table I

Means and Standard Deviations for Preliminary Seasonally Adjusted Short-Run M1 Growth Rates: 1971-77

	One-Week Growth Rates		One-Month Growth Rates		Two-Month Growth Rates	
Period	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
1971	6.4%	25.2%	6.1%	6.5%	6.3%	5.5%
1972	7.5	24.1	8.0	4.9	7.5	3.2
1973	8.7	35.7	5.6	5.1	5.4	4.1
1974	5.2	29.8	4.9	4.5	5.1	3.0
1975	4.6	25.8	4.7	7.7	4.7	5.4
1976	5.0	26.9	5.6	5.2	5.2	3.3
1977	7.2	29.9	7.2	6.6	7.3	3.8

Sources: The preliminary M1 data series used for computing the one-week growth rates were obtained from the initial estimates published in the Federal Reserve Statistical Release H.6. The one- and two-month growth rates are from Alfred Broaddus and Timothy Q. Cook, "Some Factors Affecting Short-Run Growth Rates of the Money Supply," Federal Reserve Bank of Richmond *Economic Review* (November/December 1977), p. 4.

> Each Thursday has become a Day of Judgement of anticipatory trembling over the latest Fed report on money supplies. Each set of weekly statistics is combed as heralding a new wave of the business cycle, a new round of inflation, a new course of stock prices, and a new state of the economy ahead. Civilization itself appears to hang in the balance.[1]

The attention devoted to these numbers recently motivated the Chairman of the Board of Governors of the Federal Reserve System to wish that "we could get away from the habit in this country of looking at those [money supply] figures every Thursday and assuming that the world is going up or down based on a weekly figure."[2]

The growing popularity of this "habit" is puzzling to many economists for a variety of reasons. First, and perhaps most important, week-to-week fluctuations in M1 are irrelevant for assessing the impact of money growth on employment, output and prices. Only the longer-run variations in M1 growth — over periods of several quarters or more — are generally considered to have significant effects on aggregate economic behavior. One-week growth in the money stock per se simply does not matter unless it can be used as a guide to the longer-term money stock movements.

Second, as the period decreases over which the money stock growth rates are calculated, the greater is the influence of purely random events on the individual growth rates — and the greater is the likelihood of obtaining misleading results when using these growth rates to estimate the longer-run M1 fluctuations. An illustration of this problem appears in Table I which shows the means and standard deviations for annualized short-run growth rates of preliminary seasonally adjusted M1 for the 1971-77 period. Comparison of the standard deviations, year by year, across the alternative short-run M1 growth rates indicates that the one-week growth rates are more volatile than the one-month growth rates, which, in turn, display greater variation than the two-month growth rates. This greater variation around the mean growth rate demonstrates how the impact of random events, which tends to "wash out" over longer periods, can mislead those who want to use the short-run growth rates to estimate the longer-term growth in M1. For example, the preliminary rate of money growth for 1977 was about 7.2 percent regardless of which short-run money growth estimates are used. Yet, one-third of the week-to-week M1 growth rates during that year were either less than –22.7 percent or greater than 37.1 percent. This wider variation in the one-week growth rates makes it difficult to decipher the underlying longer-run trend growth in M1 using the weekly money data.

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[1] Sidney Weintraub, "Wall Street's Mindless Affair with Tight Money," Challenge (January/February 1978), p. 35.

[2] G. William Miller, "Hearings," *Second Meeting on the Conduct of Monetary Policy*, U.S. Congress, Senate, Committee on Banking, Housing and Urban Affairs, 95th Cong., 2nd sess., April 25, 1978, p. 153.

Finally, preliminary estimates of the money stock are subject to substantial revisions over an extended period of time after their initial public release. Comparison of the means and standard deviations for the finally revised one-week growth rates of seasonally adjusted M1 for 1971-77, shown in Table II, with the equivalent statistics for the preliminary one-week growth rates in Table I provides an initial indication of the impact of the money stock revision process. The average one-week M1 growth rates were revised upward for three of the seven years; four of the seven mean M1 growth rates declined as a consequence of these revisions. Moreover, the volatility displayed by the one-week growth rates was substantially reduced as a result of the revisions. Because of the sizable effect of the revision process on the initially published growth rates for seasonally adjusted M1, the preliminary one-week growth rates for M1 may provide unreliable estimates of the actual movement in the money stock *even on a week-by-week basis.* If the preliminary weekly money growth rates are biased, using them to estimate the longer-run growth in the money stock is even more troublesome.

Table II

Means and Standard Deviations for Finally Revised Seasonally Adjusted One-Week M1 Growth Rates: 1971-77

	One-Week Growth Rates	
Period	Mean	Standard Deviation
1971	6.2%	7.4%
1972	9.0	6.1
1973	5.6	9.1
1974	4.2	6.7
1975	4.5	11.5
1976	6.1	11.0
1977	7.5	9.3

Source: The finally revised M1 series incorporates all revisions up to, and including, those appearing in the September 21, 1978 Federal Reserve Statistical Release H.6.

The purpose of this article is to describe the nature of the bias that exists in using the preliminary money stock fluctuations to estimate the actual money stock movement on a week-to-week basis. As such, it investigates the extent to which the preliminary money stock estimates released each Thursday provide reliable information about the actual *weekly* growth in M1.

This article demonstrates that the most widely cited of the money estimates, those for preliminary seasonally adjusted M1, are generally unreliable guides to the actual weekly growth in the money stock. Therefore, whatever explains the popular mystique associated with the Thursday release of the weekly money estimate, it does not appear to be due to its usefulness in providing accurate information about the actual week-to-week growth in seasonally adjusted money.

Revising the Preliminary Money Stock Estimates

Although many economic data series remain virtually unchanged once they are collected and published, the money stock series are not among these. Exhibit I reproduces the first page of the Federal Reserve Statistical Release H.6 — the initial public source of the preliminary weekly money stock estimates — for Thursday, November 2, 1978 to show one example of how the revision process affects the weekly M1 numbers.

There are several points to consider in Exhibit I. First, although the H.6 release is dated November 2, the most recent weekly money stock figures shown are those for the week ending on Wednesday, October 25; the weekly money stock is reported with a lag of eight days. Second, the H.6 release contains estimates for five different definitions of the money stock, M1 through M5.[3] Because M1 is the most commonly cited money stock in the reports linking weekly money fluctuations to financial market activity, only M1 will be discussed in this article. Third, although financial analysts concentrate primarily on the behavior of the seasonally adjusted money stock, the H.6 release includes estimates for both seasonally adjusted (SA) and not seasonally adjusted (NSA) weekly M1. Both are stud-

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[3] Beginning with the November 16, 1978 H.6 release, an additional money stock measure, M1+, is now being published.

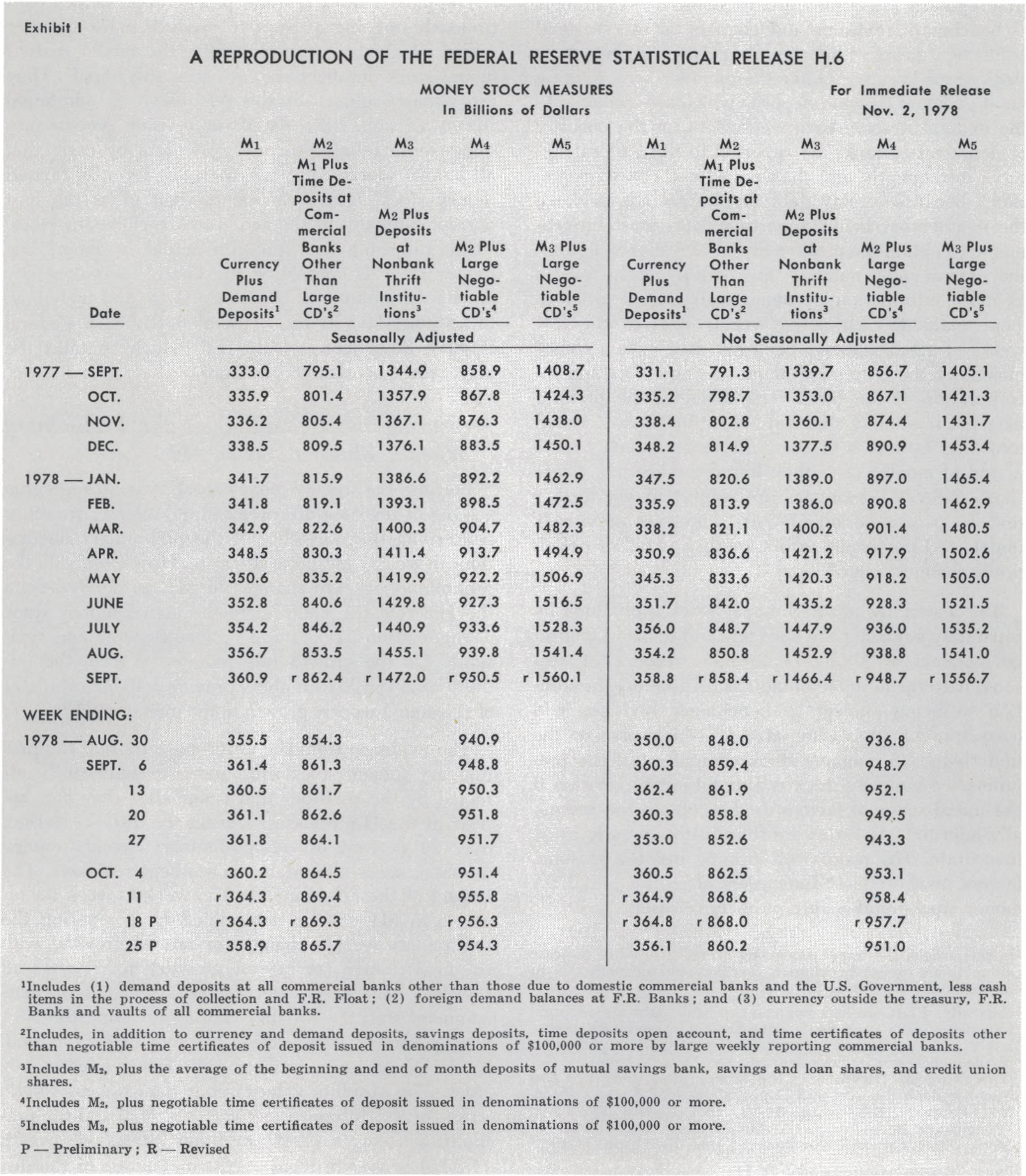

Exhibit I

A REPRODUCTION OF THE FEDERAL RESERVE STATISTICAL RELEASE H.6

MONEY STOCK MEASURES
In Billions of Dollars

For Immediate Release
Nov. 2, 1978

	M_1	M_2	M_3	M_4	M_5	M_1	M_2	M_3	M_4	M_5
Date	Currency Plus Demand Deposits[1]	M_1 Plus Time Deposits at Commercial Banks Other Than Large CD's[2]	M_2 Plus Deposits at Nonbank Thrift Institutions[3]	M_2 Plus Large Negotiable CD's[4]	M_3 Plus Large Negotiable CD's[5]	Currency Plus Demand Deposits[1]	M_1 Plus Time Deposits at Commercial Banks Other Than Large CD's[2]	M_2 Plus Deposits at Nonbank Thrift Institutions[3]	M_2 Plus Large Negotiable CD's[4]	M_3 Plus Large Negotiable CD's[5]
	Seasonally Adjusted					Not Seasonally Adjusted				
1977 — SEPT.	333.0	795.1	1344.9	858.9	1408.7	331.1	791.3	1339.7	856.7	1405.1
OCT.	335.9	801.4	1357.9	867.8	1424.3	335.2	798.7	1353.0	867.1	1421.3
NOV.	336.2	805.4	1367.1	876.3	1438.0	338.4	802.8	1360.1	874.4	1431.7
DEC.	338.5	809.5	1376.1	883.5	1450.1	348.2	814.9	1377.5	890.9	1453.4
1978 — JAN.	341.7	815.9	1386.6	892.2	1462.9	347.5	820.6	1389.0	897.0	1465.4
FEB.	341.8	819.1	1393.1	898.5	1472.5	335.9	813.9	1386.0	890.8	1462.9
MAR.	342.9	822.6	1400.3	904.7	1482.3	338.2	821.1	1400.2	901.4	1480.5
APR.	348.5	830.3	1411.4	913.7	1494.9	350.9	836.6	1421.2	917.9	1502.6
MAY	350.6	835.2	1419.9	922.2	1506.9	345.3	833.6	1420.3	918.2	1505.0
JUNE	352.8	840.6	1429.8	927.3	1516.5	351.7	842.0	1435.2	928.3	1521.5
JULY	354.2	846.2	1440.9	933.6	1528.3	356.0	848.7	1447.9	936.0	1535.2
AUG.	356.7	853.5	1455.1	939.8	1541.4	354.2	850.8	1452.9	938.8	1541.0
SEPT.	360.9	r 862.4	r 1472.0	r 950.5	r 1560.1	358.8	r 858.4	r 1466.4	r 948.7	r 1556.7
WEEK ENDING:										
1978 — AUG. 30	355.5	854.3		940.9		350.0	848.0		936.8	
SEPT. 6	361.4	861.3		948.8		360.3	859.4		948.7	
13	360.5	861.7		950.3		362.4	861.9		952.1	
20	361.1	862.6		951.8		360.3	858.8		949.5	
27	361.8	864.1		951.7		353.0	852.6		943.3	
OCT. 4	360.2	864.5		951.4		360.5	862.5		953.1	
11	r 364.3	869.4		955.8		r 364.9	868.6		958.4	
18 P	r 364.3	r 869.3		r 956.3		r 364.8	r 868.0		r 957.7	
25 P	358.9	865.7		954.3		356.1	860.2		951.0	

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[1] Includes (1) demand deposits at all commercial banks other than those due to domestic commercial banks and the U.S. Government, less cash items in the process of collection and F.R. Float; (2) foreign demand balances at F.R. Banks; and (3) currency outside the treasury, F.R. Banks and vaults of all commercial banks.

[2] Includes, in addition to currency and demand deposits, savings deposits, time deposits open account, and time certificates of deposits other than negotiable time certificates of deposit issued in denominations of $100,000 or more by large weekly reporting commercial banks.

[3] Includes M_2, plus the average of the beginning and end of month deposits of mutual savings bank, savings and loan shares, and credit union shares.

[4] Includes M_2, plus negotiable time certificates of deposit issued in denominations of $100,000 or more.

[5] Includes M_3, plus negotiable time certificates of deposit issued in denominations of $100,000 or more.

P — Preliminary; R — Revised

ied in this article. Fourth, the two most recent weeks' numbers are clearly designated as preliminary (as indicated by the "P" following their dates) to show that they are still being checked for processing errors. Finally, the previous two weeks' M1 numbers have been revised to correct an error detected since the previous H.6 release was published.

Although processing errors in the estimation of M1 occur irregularly, there are two standard revisions that regularly affect the initially reported M1 numbers — benchmark revisions and changes in the seasonal adjustment factors.[4] Benchmark revisions in the money stock occur because, unlike the member bank data on vault cash and demand deposits which are available to the Federal Reserve each week, data for the majority of nonmember banks are reported to the Federal Reserve infrequently and then only for a one-week period.[5] Because weekly data for the periods between the nonmember banks' reporting dates must be estimated to obtain the preliminary weekly money figures, the money stock numbers are "subsequently revised as more information becomes available, in order to 'benchmark' the estimated weekly data to the few weeks of actual nonmember bank data."[6] As a consequence of the correction of processing errors and incorporation of the benchmark changes, the preliminary not seasonally adjusted M1 estimates are revised into final estimates of the NSA money stock over a period of months after their initial publication. These "final" NSA M1 estimates are subject to yet further revision over a period of years whenever previously undetected processing errors are discovered or definitional changes occur.[7]

The seasonally adjusted money stock is obtained by separately adjusting the currency and demand deposit components of NSA M1 to take account of seasonal patterns in money holdings.[8] Therefore, in addition to being subject to benchmark revisions and correction of processing errors (which change the underlying NSA money stock components), the preliminary SA money stock is also subject to revision if the initial seasonal factors used to obtain the seasonally adjusted M1 series are found subsequently to be inaccurate. The process of "firming up" the seasonal factors takes at least four years after the initial SA money stock numbers are publicly released.

The money stock revision process represents a continuously ongoing attempt to produce more accurate money stock data. Consequently, the finally revised money stock numbers are not necessarily "final". They are always subject to the possibility of additional future revision. However, if the revision process produces more reliable money stock data by correcting all known sources of error, the most recently revised money stock figures can be thought of as the best current estimates of the actual or "true" money stock. In the following discussion, the actual, or underlying, money stock is defined as the finally revised money stock incorporating all revisions up to, and including, those published in the September 21, 1978 Federal Reserve Statistical Release H.6, which contains the most recent benchmark revisions.

Measuring the Reliability of the Preliminary Weekly Fluctuations in M1

Because the weekly money stock estimates undergo a series of revisions after their initial release, questions concerning the reliability of the preliminary fluctuations in weekly M1 naturally arise. How closely do the preliminary weekly changes in M1, as derived from the H.6 releases, conform to the actual money stock changes after incorporating all corrections and revisions? Do the growth rates computed from the initially reported M1 numbers provide reliable estimates of the actual weekly growth in the money stock?

The evidence from the 1970s suggests that the preliminary money stock estimates are significantly affected by the revisions that occur after they first appear in the H.6 releases. During the 1971-77 period, over 99 percent of the preliminary weekly money numbers were altered by subsequent revisions. The impact of these revisions on the week-to-week fluctuations in M1 can be determined by comparing the preliminary weekly change (or rate of growth) with the final change (or rate of growth) in M1 after all revisions have been incorporated. Table III presents summary statistics for this comparison using the NSA weekly money stock series for the 1971-77 period. Table IV presents similar results for the SA money stock. The absolute value, rather than the arithmetic value, of the difference between the final and the preliminary changes (ΔM) or annual rates of growth ($\% \Delta M$) is used to focus on the magnitude of the discrepancy between the initially reported weekly changes or growth rates in the money stock and their finally revised values.

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[4] In this article, the term "processing errors" is used to indicate all revisions except benchmark revisions and changes due to reestimation of seasonal factors.

[5] Currently, FDIC-insured nonmember bank data are reported four times each year while data for noninsured nonmember banks are reported twice each year. For detailed explanations of the benchmark revision process, see Darwin Beck and Joseph Sedransk, "Revision of the Money Stock Measures and Member Bank Reserves and Deposits," Federal Reserve *Bulletin* (February 1974), pp. 81-89, and Richard W. Lang, "Benchmark Revisions of the Money Stock and Ranges of Money Stock Growth," this *Review* (June 1978), pp. 11-19.

[6] Lang, "Benchmark Revisions," p. 11.

[7] Recently, for example, the money stock was revised back to mid-1975 to correct a bias discovered in the cash items adjustment. See the September 21, 1978 Federal Reserve Statistical Release H.6.

[8] For extended treatment of the seasonal adjustment of the money stock, see Thomas A. Lawler, "Seasonal Adjustment of the Money Stock: Problems and Policy Implications," Federal Reserve Bank of Richmond *Economic Review* (November/December 1977), pp. 19-27.

Table III

Means and Standard Deviations for Absolute Differences Between Finally Revised and Initially Reported Weekly Not Seasonally Adjusted M1 Fluctuations: 1971-77

	NSA M1 Changes (billions of dollars) Final $\Delta M1$ minus Preliminary $\Delta M1$		NSA M1 Growth Rates (annual percentage rates) Final $\%\Delta M1$ minus Preliminary $\%\Delta M1$	
Period	Mean Absolute Difference	Standard Deviation	Mean Absolute Difference	Standard Deviation
1971	$ .38	$ .32	8.6%	7.4%
1972	.36	.30	7.5	6.3
1973	.35	1.25	6.9	24.9
1974	.40	.40	7.5	7.5
1975	.34	.28	6.2	5.0
1976	.35	.32	5.9	5.3
1977	.26	.26	4.1	4.2
1971-77	.35	.55	6.7	10.9

Table IV

Means and Standard Deviations for Absolute Differences Between Finally Revised and Initially Reported Weekly Seasonally Adjusted M1 Fluctuations: 1971-77

	SA M1 Changes (billions of dollars) Final $\Delta M1$ minus Preliminary $\Delta M1$		SA M1 Growth Rates (annual percentage rates) Final $\%\Delta M1$ minus Preliminary $\%\Delta M1$	
Period	Mean Absolute Difference	Standard Deviation	Mean Absolute Difference	Standard Deviation
1971	$ .74	$ .67	17.1%	15.7%
1972	.83	.66	18.1	14.3
1973	1.16	1.16	23.3	23.7
1974	1.17	.81	21.8	15.1
1975	.95	.64	16.9	11.5
1976	1.03	.79	17.6	13.5
1977	1.28	.83	20.6	13.2
1971-77	1.02	.82	19.4	15.7

Comparison of the results shown in Tables III and IV yields two general conclusions about the effects of the revision process on the initially published week-to-week fluctuations in M1. First, the mean absolute differences are sufficiently large enough, given their standard errors, to be significantly different from zero.[9] Therefore, the revisions in the money stock series have had a significant impact on the initially reported weekly movements in M1.

Second, the money stock revisions have had a more substantial impact on the SA money stock fluctuations than on the NSA money stock movements. The mean absolute difference between the final and the preliminary weekly changes or rates of growth in SA M1 ranges from approximately two to five times the equivalent difference in NSA M1, depending upon the year of comparison.

For the 1971-77 period as a whole, the mean absolute difference between the final and preliminary week-to-week changes in SA M1 was $1.02 billion; between the final and preliminary weekly growth rates, the mean absolute difference was 19.35 percent. Thus, during this period, the final weekly change in SA M1 differed in absolute value from its preliminary estimate by slightly more than $1 billion, on average, each week. Similarly, the final weekly growth in SA M1 varied, on average, about 19 percent each week from the preliminary growth rate.

Over the same period, these differences for the NSA money stock fluctuations were roughly one-third as large. The mean absolute difference for week-to-week changes in NSA M1 was $.35 billion; for weekly growth rates, it was 6.67 percent.

Another assessment of the reliability of the preliminary changes reported for M1 can be obtained from the estimation of the following equation:

$$\Delta M1_t = \alpha_0 + \alpha_1 \Delta M1P_t \tag{1}$$

where $\Delta M1_t$ designates the actual change in M1 from week t-1 to week t based on the most recently revised M1 data and $\Delta M1P_t$ designates the preliminary weekly change derived from the weekly M1 numbers initially reported for week t-1 and week t. If the preliminary week-to-week changes in M1 ($\Delta M1P$) provide unbiased estimates of the underlying changes in the money stock ($\Delta M1$), we would expect the estimates to show that $\alpha_0 = 0$ and $\alpha_1 = 1$, or, alternatively, that $\Delta M1_t = \Delta M1P_t$.

A similar test for growth rates can be obtained by estimation of the equation:

$$\%\Delta M1_t = \beta_0 + \beta_1 \%\Delta M1P_t \tag{2}$$

where $\%\Delta M1_t$ designates the actual annualized percentage growth rate in M1 from week t-1 to week t based on the most recently revised M1 data and $\%\Delta M1P_t$ designates the preliminary annualized percentage growth rate derived from the weekly M1 numbers initially reported for the respective weeks.[10] Again, if the preliminary growth rates yield unbiased estimates of the underlying growth rates, we would expect the estimates to show that $\beta_0 = 0$ and $\beta_1 = 1$, or, alternatively, that $\%\Delta M1_t = \%\Delta M1P_t$.

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[9] Standard errors are obtained by dividing the standard deviations by the square root of the number of weeks in the year. The mean absolute differences are all significantly greater than zero at the 5 percent level.

Finally, if the preliminary changes in M1 are to be useful in estimating the actual changes in the money stock, the closer these two variables are related, the better. The $\bar{R}^2$ statistic calculated from the estimated relationship represents one measure of the closeness between the preliminary and the actual fluctuations in M1.[11] Each $\bar{R}^2$ shows, approximately, the proportion of the total variation in the actual M1 fluctuations that is associated with the fluctuations in the preliminary M1 series. To the extent that the initially published M1 fluctuations closely parallel the actual movement in the money stock after all computational errors have been corrected and the necessary revisions have been incorporated, the $\bar{R}^2$ would be expected to have a value close to one. If the preliminary M1 fluctuations do not closely anticipate the actual changes in M1 after all necessary adjustments have taken place, the $\bar{R}^2$ will have a value closer to zero. Thus, the closer the value of the $\bar{R}^2$ is to one for the estimated relationship, the closer these variables are correlated.

Assessing the Reliability of the Preliminary Not Seasonally Adjusted M1 Fluctuations

Table V shows the results obtained from estimating the above relationships between preliminary and final weekly NSA M1 fluctuations over the period 1971-77. What do these tell us about the reliability of the preliminary changes reported for weekly NSA M1? First, the preliminary weekly changes and rates of growth in the initially reported NSA M1 appear to provide reasonably reliable estimates of the actual weekly changes occurring in the NSA money stock — despite the existence of various processing errors and benchmark revisions. The estimated coefficients for NSA M1 over the entire 1971-77 period, displayed in the next to the last row in Table V, show that, if the one-week change in NSA M1 was initially reported as \$5 billion, for example, after all processing errors are corrected and benchmark revisions have been made, the actual change would be estimated to be \$5.04 billion. Similarly, if the one-week growth in NSA M1 was initially reported as 10 percent, for example, the estimate for the actual rate of growth in NSA M1 is 9.82 percent.[12]

Table V

Tests for Bias in the Preliminary One-Week Not Seasonally Adjusted M1 Fluctuations

	Equation 1: $\Delta M1_t = \alpha_0 + \alpha_1 \Delta M1P_t$			Equation 2: $\%\Delta M1_t = \beta_0 + \beta_1 \%\Delta M1P_t$		
Period	α_0	α_1**	$\bar{R}^2$	β_0	β_1**	$\bar{R}^2$
1971	.00	1.01	.95	.02	.98	.95
1972	.08	1.03	.97	1.58	1.00	.97
1973	– .11	.94	.79	–2.08	.93	.78
1974	– .07	1.04	.97	–1.36	1.04	.97
1975	– .01	1.03	.98	– .19	1.03	.98
1976	.04	1.02	.99	.60	1.02	.99
1977	.03	1.00	.99	.50	.99	.99
1971-77	– .01	1.01	.96	– .18	1.00	.96
Unbiased Values	0.00	1.00	1.00	0.00	1.00	1.00

**All α_1 and β_1 coefficients are significantly different from zero at the 5 percent level.

#Denotes α_0 or β_0 coefficient significantly different from zero at the 5 percent level.

* Denotes α_1 or β_1 coefficient significantly different from one at the 5 percent level.

The reason that the preliminary changes and growth rates in the NSA M1 so closely match the actual changes and growth rates is that the estimated coefficients do not differ significantly from those values necessary to assure that the initially reported fluctuations in M1 are unbiased (repeated in the bottom row of Table V). All of the α_0 and β_0 estimates are numerically close to zero and none is significantly different from zero statistically. Similarly, all of the α_1 and β_1 estimates are numerically close to one and none is significantly different from one. Overall, the results indicate that the week-to-week changes between the revised NSA M1 numbers remain essentially the same as those initially calculated from the preliminary NSA money stock numbers.

The $\bar{R}^2$ statistics for the NSA weekly money stock relationships over the 1971-77 period indicate that the initial changes and growth rates reported for NSA M1 closely track the actual movements in NSA M1 despite the existence of processing errors and benchmark revisions. Roughly 96 percent of the variation in the actual week-to-week changes in NSA M1 are anticipated by the movement in the preliminary changes reported for NSA M1 for the 1971-77 period as a whole. Similarly, the fluctuations in the initially reported annualized growth rates for NSA M1 account for 96 percent of the actual movement in the rate of growth of NSA M1 over the entire period. Year-by-year analysis confirms the closeness of the relationship between the initial and the final NSA M1 fluctuations. These results indicate that the preliminary changes and growth rates reported in NSA M1 provide reasonably accurate estimates of the actual changes occurring in the money stock.

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[10] $\%\Delta M1_t = 5200 (\Delta \ln M1_t)$ and $\%\Delta M1P_t = 5200 (\Delta \ln M1P_t)$.

[11] The $\bar{R}^2$ statistic is the coefficient of determination adjusted for degrees of freedom.

[12] $\Delta M1 = -.01 + 1.01(5) = 5.04$; $\%\Delta M1 = -.18 + 1.00(10) = 9.82$.

On the Reliability of the Preliminary Seasonally Adjusted M1 Fluctuations

The results from estimating the relationships for changes and rates of growth between preliminary and final seasonally adjusted M1, as shown in Table VI, indicate that the initially published SA money fluctuations do not provide accurate estimates of the actual movements occurring in the money stock after all revisions have been made. Using the results for the entire 1971-77 period, presented in the next to last row of Table VI, if the preliminary change in SA M1 was $5 billion, for example, the estimate of the actual change that will be reported, after all processing error corrections, benchmark revisions and seasonal factor changes have been incorporated, is only $1.12 billion. Similarly, if the initially reported growth rate in SA M1 was 10 percent, for example, the estimate for the actual rate of growth in weekly SA M1 is only 6.73 percent.

What accounts for the wide disparity between the preliminary changes and the final changes in the SA money stock? First, compare the estimated coefficients for the SA money stock relationships in Table VI with the values necessary to assure their reliability as shown in the bottom row of Table VI. Not only are the various estimates of α_0 and β_0 numerically greater than zero, they are all statistically significantly different from zero. This means that, even if the preliminary M1 change was reported as zero, the estimate of actual change that will be reported after all revisions have been made is not zero, but rather ranges from $.18 to $.40 billion, depending upon the year of comparison, with an estimate of $.27 billion for the period as a whole. Similarly, if the weekly growth rate was initially announced as zero percent (that is, the preliminary SA money stock was unchanged from the previous week), the estimate is that M1 had actually grown by more than 5 percent for that week, using the results for the 1971-77 period. Second, none of the α_1 and β_1 estimates is close to one numerically and all are significantly less than one statistically. Thus, it is clear that the final changes (or growth rates) in weekly SA M1 are only slightly related to the preliminary changes (or growth rates).

Table VI

Tests for Bias in the Preliminary One-Week Seasonally Adjusted M1 Fluctuations

	Equation 1: $\Delta M1_t = \alpha_0 + \alpha_1 \Delta M1P_t$			Equation 2: $\% \Delta M1_t = \beta_0 + \beta_1 \% \Delta M1P_t$		
Period	α_0	α_1**	$\bar{R}^2$	β_0	β_1**	$\bar{R}^2$
1971	.24 #	.12 *	.13	5.48 #	.11 *	.14
1972	.40 #	.08 *	.07	8.42 #	.07 *	.06
1973	.24 #	.10 *	.13	4.71 #	.10 *	.13
1974	.19 #	.12 *	.29	3.53 #	.12 *	.29
1975	.18 #	.28 *	.39	3.17 #	.28 *	.38
1976	.29 #	.24 *	.34	4.89 #	.24 *	.34
1977	.38 #	.21 *	.44	5.99 #	.21 *	.44
1971-77	.27 #	.17 *	.28	5.13 #	.16 *	.25
Unbiased Values	0.00	1.00	1.00	0.00	1.00	1.00

**All α_1 and β_1 coefficients are significantly different from zero at the 5 percent level.

# Denotes α_0 or β_0 coefficient significantly different from zero at the 5 percent level.

* Denotes α_1 or β_1 coefficient significantly different from one at the 5 percent level.

The relatively poor correspondence between the preliminary and the final fluctuations in SA M1 is also shown by the value of the $\bar{R}^2$ statistics for the relationships which range from .06 to .44, depending upon the year of comparison. Only about 28 percent of the actual fluctuations in the changes in M1, and only 25 percent of the actual movement in M1 growth rates, are associated with the movements in the respective preliminary SA money stock estimates over the entire period. Put somewhat differently, more than 70 percent of the actual variations in weekly SA M1 changes and growth rates are *not* directly related to the variations in the preliminary M1 estimates for the 1971-77 period as a whole.

Since the seasonal adjustment process requires at least four years before the seasonal factors are considered final, only the earlier years, 1971-73, can be considered "fully" revised for seasonal purposes. Thus, it can be argued that the more recent of these $\bar{R}^2$ statistics are misleadingly high — that the finally revised changes and growth rates in SA M1 are even less closely related to the preliminary SA M1 movements than these $\bar{R}^2$ estimates indicate. Note that the

$\bar{R}^2$ statistics for the earlier years are the lowest in Table VI. The SA M1 estimates for the later years, 1974-77, are still undergoing seasonal revisions and will continue to do so for several more years. Therefore, the $\bar{R}^2$ value shown in Table VI for each of these later years are likely to be reduced when additional revisions occur. Consequently, the values of $\bar{R}^2$ shown for the later years, and for the 1971-77 period taken as a whole, probably overstate the closeness of the relationship between the initial movements and the finally revised SA M1 fluctuations.

Why are the preliminary weekly SA M1 fluctuations unreliable while the preliminary NSA M1 changes accurately forecast the actual week-to-week changes in the NSA money stock? One approach to answering this question is to assess the importance of the different factors which cause the revisions in the preliminary money stock numbers. The preliminary SA M1 numbers are affected by the same processing errors and benchmark revisions that affect the preliminary NSA M1 numbers. In addition, they are affected by revisions of the seasonal factors. Since the preliminary NSA M1 fluctuations do not generally appear to be unreliable, the problem with the initial SA M1 numbers apparently is created by the revisions produced in reestimation of seasonal factors.

The differential impact of processing errors and benchmark revisions, compared to those errors resulting from reestimation of seasonal factors, can be determined by analyzing the error associated with using the preliminary rate of growth in weekly SA M1 as an estimate of the actual rate of growth in the SA money stock. Defining the "estimation error" to be the difference between the actual and the preliminary weekly rates of growth, the estimation error for SA M1 can be shown to equal the sum of the estimation errors for NSA M1 and the seasonal adjustment factors. Analysis of these errors for the 1971-77 period shows that the estimation error associated with the preliminary weekly growth rates in the seasonal factors accounts for approximately 70 percent of the estimation error in SA M1 growth rates.[13] The preliminary weekly SA M1 fluctuations provide generally unreliable guides to the movement in the actual money stock for any given week because the reestimation of seasonal factors introduces considerably more erratic revisions than do the correction of reporting errors and benchmark revisions.

Conclusion

The week-to-week fluctuations in the preliminary seasonally adjusted M1, as reported each Thursday by the Federal Reserve, provide biased and generally unreliable information about the underlying weekly growth in the seasonally adjusted money stock. Earlier studies have commented on this problem for the preliminary monthly and quarterly seasonally adjusted money stock estimates.[14] Moreover, the Federal Reserve is sufficiently troubled by the lack of correspondence between the preliminary and actual money growth rates that it has recently established a committee to study the seasonal adjustment process.

Economists, by and large, have tended to ignore this issue because these extremely short-run variations in money are irrelevant for assessing the impact of money growth on employment, output and prices. It is only the longer-run fluctuations in money growth — over a period of several quarters or more — that generally are considered to influence these economic variables.

The unreliability of the preliminary weekly growth rates in the seasonally adjusted money stock only poses a problem if financial market traders and monetary policy authorities believe these rates accurately portray the underlying longer-term growth in money. Whatever explains the current fascination with the preliminary week-to-week fluctuations in the seasonally adjusted money numbers, it clearly does not result from their usefulness in detecting the actual week-to-week growth in the seasonally adjusted money stock.

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[13] If ESAM1, ENSAM1, and ESF represent the estimation errors for SA M1, NSA M1, and the seasonal factors, respectively, it can be shown that $ESAM1 = ENSAM1 + ESF$. Consequently, $VAR(ESAM1) = VAR(ENSAM1) + VAR(ESF) + 2\ COV(ENSAM1, ESF)$. For the 1971-77 period, the latter equation had the following values: $623.7 = 164.4 + 556.6 + 2(-48.7)$.

[14] See, for example, William Poole and Charles Lieberman, "Improving Monetary Control," *Brookings Papers on Economic Activity*, (2: 1972), pp. 293-335; Report of the Advisory Committee on Monetary Statistics, "Improving the Monetary Aggregates," Board of Governors of the Federal Reserve System (Washington, D.C., 1976); Alfred Broaddus and Timothy Q. Cook, "Some Factors Affecting Short-Run Growth Rates of the Money Supply," Federal Reserve Bank of Richmond *Economic Review* (November/December 1977), pp. 2-18; Herbert M. Kaufman and Raymond E. Lombra, "Short-Run Variations in the Money Stock," *Southern Economic Journal* (April 1977), pp. 1515-27; and Robert D. Laurent, "Effects of Seasonal Adjustment on the Money Stock," Federal Reserve Bank of Chicago *Economic Perspective* (September/October 1978), pp. 12-17.

A Comparison of Yields On Futures Contracts and Implied Forward Rates

RICHARD W. LANG and ROBERT H. RASCHE

SINCE the introduction of futures trading in 3-month Treasury bills in 1976, yields on these futures contracts have been examined for clues as to market expectations of the future course of interest rates. Although there are difficulties in isolating these expectations, the yields on futures contracts do embody information about market expectations of future interest rates.[1] However, similar information is also embodied in the forward rates of interest that are implicit in the spot market yield curve.

Yields on Treasury bill futures contracts (futures rates) are essentially the market counterpart to the implied forward rates embodied in the Treasury yield curve. The correspondence between yields on financial futures contracts and forward rates derived from a yield curve is readily apparent in the work of Sir John Hicks. Hicks interpreted the term structure of interest rates as a futures market for loans in formulating his theory about the relationship of long- and short-term interest rates.[2] To the extent that futures rates and forward rates represent the yield on the same type of loan contract, market traders will arbitrage between yields in the futures market and yields in the spot market (from which implied forward rates are derived) if profitable trading opportunities exist. In this case, it would not be surprising to find yields on Treasury bill futures contracts to be closely related to implied forward rates embodied in the Treasury yield curve. This paper compares yields on 3-month Treasury bill futures contracts with forward rates derived from spot yields on Treasury securities, for comparable periods, to examine how closely these interest rates are related. Specifically, this paper tests the hypothesis that futures rates are equal to implied forward rates, and finds that this hypothesis must be rejected. Various explanations as to why the rates are not equal are then examined.

Recently, William Poole and others have argued that the yields on 3-month Treasury bill futures contracts can be expected to be less than the corresponding implied forward rates, that these futures rates are unbiased market estimates of future Treasury bill spot rates, and that it is not necessary to allow for risk premia when using yields on futures contracts to measure market expectations of future interest rates.[3] If these arguments are correct, a great deal of empirical work in economics that includes variables on interest rate expectations will be greatly simplified. In addition, such conclusions would allow policymakers to easily assess the differences between their own interest rate forecasts and the market's expectations of the future course of interest rates. As Poole notes, policymakers face difficult problems when market interest rate forecasts differ from the policymakers' forecasts, since they then must decide whether their own estimates of economic activity are incorrect or whether the market is misinterpreting the policymakers' plans.[4] Unfortunately, the results reported in this paper do not support these conclusions about the relationship between futures rates and forward rates for futures contracts, except for the ones closest to delivery, which were the ones investigated by Poole. Extrapolation of Poole's conclusions to other futures contracts is therefore unwarranted, and other explanations for the relationship between forward and futures rates must be explored. One factor considered here is the possibility of default risk affecting yields on futures contracts.

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[1] For a discussion of these difficulties, see Albert E. Burger, Richard W. Lang and Robert H. Rasche, "The Treasury Bill Futures Market and Market Expectations of Interest Rates," this *Review* (June 1977), pp. 2-9.

[2] J. R. Hicks, *Value and Capital: An Inquiry into Some Fundamental Principles of Economic Theory*, 2nd ed. (Oxford: Clarendon Press, 1946), pp. 144-47.

[3] William Poole, "Using T-Bill Futures to Gauge Interest-Rate Expectations," Federal Reserve Bank of San Francisco *Economic Review* (Spring 1978), pp. 7, 14 and 15; and Kenneth Froewiss and Michael Gorham, "Everyman's Interest Rate Forecast," Federal Reserve Bank of San Francisco *Weekly Letter* (September 8, 1978), p. 1.

[4] Poole, "Using T-Bill Futures to Gauge Interest-Rate Expectations," pp. 16-17.

EXPECTATIONS OF INTEREST RATES AND FORWARD RATES

Expectations of future interest rates play an important role in many areas of economics; topics in both micro- and macroeconomics deal with interest rate expectations. Since such expectational variables generally are not observable, researchers have only been able to proxy them by using various substitutes, such as by constructing expectational variables on the basis of the past history of each variable. This approach is problematical in that when such expectational proxies are used in empirical research, a joint test is made: both the hypothesis and the assumed expectations-formation mechanism are tested.

One alternative to such joint tests is to survey a specific group (such as financial consultants) as to their expectations of interest rates for various future periods. Such a survey has been reported since 1969 in the Goldsmith and Nagan *Bond and Money Market Letter*.[5] However, such surveys are subject to problems that may limit their usefulness. One problem is basically statistical, but another deals with the *timing* of the survey. The Goldsmith-Nagan survey is quarterly, which makes its use for shorter periods very difficult.

An alternative approach that allows the use of daily data focuses upon *changes* in interest rate expectations rather than *levels*, and is based upon changes in the shape of the yield curve from one date to another. A yield curve relates the yields-to-maturity of a group of securities to their terms-to-maturity, for securities with similar characteristics other than maturity. In particular, all of the securities used in constructing a yield curve have similar default risk. For example, yield curves are usually drawn for Treasury securities, or for corporate Aaa bonds, as of a particular date. The yield curve indicates the structure of interest rates on a given date for securities with the same risk of default and different terms-to-maturity.

Changes in the shape of the yield curve from one date to another involve changes in implied forward rates. A forward rate is the yield on a loan or investment over some period beginning at a specified future time. Such a forward rate can be obtained by an appropriate combination of buying and selling bonds outstanding. For example, by selling a 1-year bond and buying a 2-year bond, a 1-year investment is effectively made that will begin 1 year hence at a rate of interest established by the difference in the spot market yields for the 1- and 2-year bonds. The forward rate on this loan is defined by:

$$(1+{}_1F_1) = \frac{(1+R_2)^2}{(1+R_1)^1}$$

where ${}_1F_1$ is the forward rate on a 1-year loan to begin in 1 year, R_2 is the spot rate on 2-year bonds, and R_1 is the spot rate on 1-year bonds.

More generally, for a 1-period investment to begin n–1 periods in the future the forward rate is:

$$(1+{}_{n-1}F_1) = \frac{(1+R_n)^n}{(1+R_{n-1})^{n-1}}$$

where ${}_{n-1}F_1$ is the forward rate on a 1-period loan to begin in n–1 periods, R_n is the spot rate on n-period bonds, and R_{n-1} is the spot rate on (n–1)-period bonds.

Thus, the yield curve at any given point in time implies a set of 1-period forward rates to prevail on forward (or future) transactions. Such forward rates have economic content, however, only if the implied transactions are possible in the market, and can be carried out by market traders.[6]

In theories of the term structure of interest rates, the forward rates (${}_{n-1}F_1$) are often decomposed into a 1-period expected rate (${}_{n-1}E_1$) plus a premium (a liquidity premium associated with interest-rate risk or a term premium associated with investors' preferences for bonds with specific ranges of maturities).[7]

$${}_{n-1}F_1 = {}_{n-1}E_1 + \text{Premium}$$

For a set of 1-period forward rates on a given date, there is then a set of 1-period expected rates stretching out into the future. Under the assumption that the premia are stable over time, changes in the structure of interest rates (measured by changes in the yield curve) reflect changes in interest rate expectations. Thus, by examining the changes in the implied forward rates contained in the term structure, researchers can obtain an estimate of the *changes* in interest rate expectations, even though the *level* of expected interest rates is not readily estimable.

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[5] Other interest rate surveys have been collected by various researchers, but are not regularly published. For example, see Edward J. Kane and Burton G. Malkiel, "The Term Structure of Interest Rates: An Analysis of a Survey of Interest-Rate Expectations," *The Review of Economics and Statistics* (August 1967), pp. 343-55.

[6] For a thorough discussion of yield curves, forward rates of interest, and the term structure, see Burton Gordon Malkiel, *The Term Structure of Interest Rates: Expectations and Behavior Patterns* (Princeton: Princeton University Press, 1966), Chapters I and II.

[7] Malkiel, p. 26; Franco Modigliani and Richard Sutch, "Debt Management and the Term Structure of Interest Rates," *Journal of Political Economy* (Supplement: August 1967), pp. 571-73; Charles R. Nelson, *The Term Structure of Interest Rates* (New York: Basic Books, 1972) pp. 20 and 28-31.

However, such calculations are time consuming and costly — in terms of both data collection and computer time. One must obtain quotations on securities outstanding (e.g. Treasury issues), fill in missing data points by estimating a yield curve, then calculate forward rates. This is a difficult task if done monthly, and expensive to do weekly or daily. As a result, it is expensive to use yield curve data to assess the effect of new information about economic policies or of the state of the economy on expectations of future interest rates.

FUTURES MARKETS IN FINANCIAL INSTRUMENTS

Starting in the fall of 1975, the difficulties of examining changes in market expectations of future interest rates on a weekly or daily basis have been alleviated. Trading in futures contracts in financial instruments began to develop in late 1975, and currently there are futures markets in seven financial instruments.[8] This paper focuses on the futures market in 3-month Treasury bills.

Futures markets in 3-month Treasury bills allow us to observe directly the yields or prices on 3-month bills to be delivered at certain dates in the future. Thus, they are the market counterpart of the implied forward loans or investments which can be constructed from Treasury yield curve data. But instead of requiring large efforts at data collection, estimation, and calculation, these yields are readily available from daily quotations in *The Wall Street Journal* and other newspapers.

As new information about the economy or economic policy becomes available to market traders, this information is incorporated into the market prices and yields of Treasury bill futures contracts. To the extent that such new information changes market expectations of interest rates, it is reflected in changes in the Treasury bill futures rates. Yields on futures contracts could also be broken down into expectational and premium components, just as in the case of forward rates implicit in the yield curve. Again, the *level* of expected future interest rates may not be readily estimable, but *changes* in market expectations of future interest rates can be observed from changes in yields on futures contracts, under the assumption that the premia are stable.[9]

YIELDS ON FUTURES CONTRACTS AND IMPLIED FORWARD RATES FROM YIELD CURVES

Since implied forward rates calculated from the yield curve are, in theory, rates on forward loans or investments such as those actually made in the Treasury bill futures market, the question arises as to whether yields on 3-month Treasury bill futures contracts are equal to 3-month forward rates calculated from the Treasury yield curve. It would be convenient if the two sets of yields were equal, so that we would not have to be concerned with any separate informational content of either data set (especially since yields on Treasury bill futures are easier to obtain).

A test for the equality of the two yields, as of a quotation date, can be made by comparing yields on Treasury bill futures contracts with yields on implied forward contracts for the same periods. First, we choose a set of quotation dates. Then, we obtain the yields on Treasury bill futures contracts on those dates for each available delivery date. Next, we obtain quotations on U.S. Treasury securities outstanding on those same quotation dates. From these data we calculate implied 3-month forward rates that match the 3-month Treasury bill futures contracts. Finally, we calculate the difference (in absolute value) between the two sets of rates to determine whether they are significantly different from each other.

The Data

The selection of quotation dates for yields on Treasury bill futures contracts and yields on outstanding Treasury securities were obtained by random selections of thirty quotation dates from each of three periods of roughly equal length — eight to nine months.[10] The first thirty quotation dates were taken from the period March 1, 1976 to November 30, 1976 (Period I); the second thirty quotation dates were taken from the period December 1, 1976 to July 31, 1977 (Period II); and the last thirty quotation dates were taken from the period August 1, 1977 to March 31, 1978 (Period III). Yields on the available futures contracts for each quotation date were based on the settlement prices obtained from the "Daily Information Bulletin" of the International Monetary Market of the Chicago Mercantile Exchange. Yields on outstanding U.S. Treasury securities used to construct forward rates for each quotation date were obtained

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[8] Currently there are futures markets in 3-month and 1-year Treasury bills, 15-year Treasury bonds, 3-month commercial paper, and three GNMA instruments. A number of other futures markets in other financial instruments have also been proposed.

[9] Burger, Lang, and Rasche, "The Treasury Bill Futures Market and Market Expectations of Interest Rates," pp. 4-5.

[10] The random numbers were obtained from The Rand Corporation, *A Million Random Digits with 100,000 Normal Deviates* (Glencoe, Illinois: The Free Press, 1955).

Table I

Summary Statistics for Absolute Differences: Futures Rates Less Forward Rates

	Categories[1]							
	1	2	3	4	5	6	7	8
Period I (3/1/76 - 11/30/76)								
Mean, $\bar{X}$	0.13	0.16	0.35	0.58	0.58	0.51		
Standard Deviation, S	0.11	0.12	0.21	0.34	0.45	0.31		
Number of Observations, N	30	30	30	29	23	11		
t-statistic[2]	6.47	7.30	9.13	9.19	6.18	5.46		
Period II (12/1/76 - 7/31/77)								
Mean, $\bar{X}$	0.09	0.14	0.34	0.37	0.63	0.88	0.97	1.43
Standard Deviation, S	0.06	0.11	0.20	0.26	0.35	0.34	0.26	0.44
Number of Observations, N	30	30	30	30	30	29	12	12
t-statistic[2]	8.22	6.97	9.31	7.79	9.86	13.94	12.92	11.26
Period III (8/1/77 - 3/31/78)								
Mean, $\bar{X}$	0.19	0.26	0.16	0.34	0.48	0.56	0.55	1.01
Standard Deviation, S	0.13	0.15	0.11	0.22	0.29	0.27	0.31	0.36
Number of Observations, N	30	30	30	30	30	30	30	28
t-statistic[2]	8.01	9.49	7.97	8.46	9.07	11.36	9.72	14.85

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[1] Category 1 includes futures rates for the futures contract closest-to-delivery; Category 2 includes futures rates for the futures contract next nearest-to-delivery, and so on.

[2] All t-statistics are significantly different from zero at the 1 percent level.

from the Federal Reserve Bank of New York's "Composite Closing Quotations for U.S. Government Securities." All yields were converted from a discount basis to a bond equivalent yield basis.

Forward rates were calculated for each quotation date to match up with each available Treasury bill futures contract. Thus, if a futures contract were to be delivered in 30 days, at which time the delivered Treasury bills would have 90 days to maturity, a forward rate was calculated using the yields on an outstanding Treasury bill maturing in 30 days and an outstanding Treasury bill maturing in 120 days. If no bills were outstanding with the exact number of days to maturity, say 120, then the yield was estimated by linearly interpolating from the yields on two securities with maturities surrounding 120 days — say one with 130 days and one with 115 days. The resulting forward rate is the implied yield on a loan or "security" that begins in 30 days and has 90 days to maturity — the same time frame as the futures contract.[11]

Once the forward rates matching the available futures contracts were calculated for each quotation date, they were compared to the yields on the futures contracts (futures rates) by taking the absolute difference between the two. For each quotation date, these differences were categorized as being associated with the futures contract nearest-to-delivery (Category 1), next nearest-to-delivery (Category 2), and so on. All the available contracts for each quotation date were categorized in this way. When the market was first formed in 1976, only four contracts were traded, extending out one year into the future. As trading in Treasury bill futures has increased, the number of contracts has been extended. By March 1978, the end of the third sample, there were eight contracts traded,

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[11] Spot rates used to calculate forward rates were the average of the bid and asked yields in the spot market. For futures contracts to be delivered more than one year in the future, yields on Treasury coupon securities were used (since Treasury bills are not available) to calculate the forward rates. (This introduces a slight measurement error in the calculation of the forward rates since the formulae given below and in the text assume that the spot rates used are for non-coupon securities.) The formula used to calculate the forward rates is that given by Richard Roll, *The Behavior of Interest Rates: An Application of the Efficient Market Model to U.S. Treasury Bills* (New York: Basic Books, Inc., 1970), p. 16:

$${}_{n-91}F_{91} = \frac{nR_n - (n-91)R_{n-91}}{91}$$

A comparison of the above formula's estimates of forward rates with estimates based on the traditional formula given in the text showed only minor differences. Consequently, the above formula was used for computational ease.

extending out two years into the future. Consequently, the number of observations in Categories 4 through 8 are not always equal to 30 for each sample, and the first sample does not have as many categories as the last two samples.

Results

Summary statistics for the futures rates minus the associated forward rates are given in Table I for each category in each sample period. The mean of the absolute value of the differences between the rates are given for each category, as well as the standard deviation and the number of observations. For each category in each sample, the hypothesis that the futures rate is equal to the associated forward rate was tested by determining whether the mean absolute difference in each category is significantly different from zero. The t-value for each test is also given in Table I.

The two futures contracts nearest to delivery (Categories 1 and 2) tended to have the smallest mean absolute differences between the futures and forward rates, while the contracts furthest from delivery tended to have the largest mean absolute differences. All of the mean absolute differences were significantly different from zero at the 1 percent level. Thus, although the mean absolute differences between the futures and forward rates for the two futures contracts closest to delivery (Categories 1 and 2) were generally less than 20 basis points, the hypothesis that the rates are equal is rejected in each sample.

Samples were taken from three different time periods in order to determine whether the differences between the futures and forward rates have narrowed over time. Such an observation would suggest that in its first year of trading the futures market might have been poorly developed, or "thin," in terms of the number of traders in the market and the availability of information about the market. We could then expect that as the volume of trading in this market increased and information about possible arbitrage opportunities between futures and spot markets was more effectively utilized, the differences between the futures and forward rates would decrease between the first and second samples, and would decrease further between the second and third samples.

Neither casual observation of the data in Table I nor statistical tests for significant differences across sample periods support the hypothesis that the differences between futures and forward rates have consistently narrowed over time. Table II presents the results of statistical tests to determine whether the mean absolute difference in each category of a sample was significantly different from the mean absolute difference in the same category in the other two samples.[12] The results shown in Table II do not present a consistent pattern over time.

Table II

Test Values of Comparisons of Mean Absolute Differences Across Samples

	Comparison of Periods		
Categories	I and II	II and III	I and III
1	−1.75[1]	3.83[1, 2]	1.93[3]
2	−0.67	3.53[1, 2]	2.85[2]
3	−0.19	−4.32[1, 2]	−4.39[1, 2]
4	−2.66[2]	−0.48	−3.21[1]
5	0.44	−1.81[3]	−0.93[1]
6	3.28[2]	−3.99[2]	0.47
7	—	−4.47[2]	—
8	—	−2.91[2]	—

[1] Indicates that critical value of the significance test was determined using Cochran's approximation to the Behrens-Fisher problem, see footnote 12 of text.

[2] Significantly different from zero at the 1 percent level.

[3] Significantly different from zero at the 5 percent level.

For example, a comparison of the mean absolute differences between the first and second samples for Categories 1, 2, and 3 indicates that the means are not significantly different from each other at the 5 percent level. Thus, the slight declines in the mean absolute differences for the first three categories nearest to delivery between the first and second samples do not represent statistically significant differences in the relationship of the futures and forward rates. On the other hand, the increases in the mean absolute differences between the second and third samples for the first two categories are statistically significant, as is the decrease for the third category.

On the basis of this evidence, we cannot conclude that the differences between the futures and forward rates have been narrowing consistently over time as the futures market for Treasury bills has become more developed. Other explanations for the statistically sig-

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[12] A t-test for the difference between two means generally requires the assumption that the variances of the two samples are equal. When this assumption cannot be made, one is faced with what has been called a "Behrens-Fisher problem." An approximation to the t-test due to Cochran that provides a solution is given in George W. Snedecor and William G. Cochran, *Statistical Methods*, 6th ed. (Ames, Iowa: Iowa State University Press, 1967), pp. 114-16. This method was used in calculating the t-values and their significance in Table II for the cases where an F-test of the equality of the variances of the samples being compared rejected the hypothesis of equality.

Table III

Summary Statistics for Arithmetic Differences: Futures Rates Less Forward Rates

	Categories[1]							
	1	2	3	4	5	6	7	8
Period I (3/1/76 - 11/30/76)								
Mean, $\overline{X}$	−0.12	0.01	0.35	0.48	0.49	0.45		
Standard Deviation, S	0.12	0.21	0.22	0.48	0.55	0.40		
Number of Observations, N	30	30	30	29	23	11		
t-statistic[2]	−5.48	0.26[3]	8.71	5.39	4.27	3.73		
Period II (12/1/76 - 7/31/77)								
Mean, $\overline{X}$	−0.08	0.04	0.32	0.37	0.62	0.88	0.97	1.43
Standard Deviation, S	0.08	0.17	0.23	0.27	0.38	0.34	0.26	0.44
Number of Observations, N	30	30	30	30	30	29	12	12
t-statistic[2]	−5.48	1.29[3]	7.62	7.51	8.94	13.94	12.92	11.26
Period III (8/1/77 - 3/31/78)								
Mean, $\overline{X}$	−0.19	−0.23	0.08	0.33	0.47	0.56	0.52	1.01
Standard Deviation, S	0.13	0.19	0.18	0.24	0.31	0.27	0.37	0.36
Number of Observations, N	30	30	30	30	30	30	30	28
t-statistic[2]	−8.01	−6.63	2.43	7.53	8.30	11.36	7.70	14.85

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[1] Category 1 includes futures rates for the futures contract closest-to-delivery; Category 2 includes futures rates for the futures contract next nearest-to-delivery, and so on.

[2] All t-statistics are significantly different from zero at the 1 percent level, except for those with footnote 3 references.

[3] Not significantly different from zero at the 5 percent level.

nificant spreads between the futures and forward rates must be explored.

EXPLANATIONS OF THE DIFFERENTIAL

Given that there are significant differences between futures and forward rates that have not declined over time, the question arises as to whether or not these differences are systematic. If the differences are systematic, can we identify some factor or factors that would cause such systematic differences? A further issue is to re-examine the argument that market traders will arbitrage away differences between futures and forward rates. This argument was based on the assumption that a futures contract is essentially identical to an implied forward contract. If a futures contract is substantially different from an implied forward contract, then market traders will not necessarily drive futures rates to equality with forward rates. However, even if a futures contract is essentially identical to an implied forward contract, the existence of transactions costs in trading spot and future Treasury bills may provide few profitable arbitrage opportunities to traders. In this case, trading in spot and futures markets will not necessarily result in equalizing futures and forward rates.

To examine whether there are systematic differences between futures and forward rates, the mean arithmetic difference for each category in each sample period is given in Table III. The arithmetic differences are systematically negative in all periods for Category 1, zero or negative for Category 2, and systematically positive in all periods for Categories 3 through 8. With the exception of Category 2 in Periods I and II, all of the arithmetic differences are significantly different from zero. Thus, futures rates for contracts closest to delivery are generally lower than their associated forward rates, while futures rates for later-dated contracts are generally higher than their associated forward rates. Explanations of the spread between futures and forward rates must be able to account for both the spread itself and its change in sign as the delivery date is extended into the future.

Transactions Costs: Poole's Approach

In a recent article, William Poole hypothesizes that futures and forward rates should not be equal because of the effect of transactions costs on these yields.[13] He argues that transactions costs are basically zero for futures contracts but positive for trades in the spot market. Other factors affecting futures and forward rates (such as term or liquidity premia and interest rate expectations) are assumed to be about the same, while the effect of transactions costs would tend to increase forward rates. Consequently, Poole concludes that futures rates should be lower than forward rates.[14]

Poole obtains empirical support for his hypothesis by examining the futures contract closest to delivery (our Category 1). He finds that the mean (arithmetic) difference between futures and forward rates is indeed negative, indicating that futures rates are lower than forward rates. The mean difference also tends to be significantly different from zero; a result consistent with that reported in our Table III.

In Poole's subsequent discussion of the policy implications of the Treasury bill futures market, he assumes that his findings apply to all futures maturities (i.e., all categories in Table III), not just to the contract closest to delivery.[15] This assumption is not supported by our data. The results shown in Table III indicate that Poole's hypothesis holds only for Categories 1 and 2 (the two contracts closest to delivery). For the other contracts that are delivered further in the future, the futures rates are higher than the forward rates — contrary to Poole's hypothesis.

Poole seems to argue that futures rates are close to being equivalent to the market's expectations of future interest rates.

> Quotes on the nearest maturity in the bill futures market can, therefore, be interpreted for all practical purposes as the market's unbiased estimates of the future spot rates on 13-week bills.[16]
>
> If the findings in the previous section apply to all future maturities, then the differences between the futures rates and the realized spot rates over the last two years reflect genuine expectational errors rather than term premiums attached to the futures rates.[17]

The evidence presented here indicates that it is misleading to extrapolate from the evidence on the futures contract closest-to-delivery to the later-dated contracts. Futures rates on the later-dated contracts are generally 50 to 100 basis points higher than their associated forward rates, which suggests the existence of some substantial differences between the factors affecting the futures and forward rates.

A Digression — Arbitrage Opportunities

The relatively large and statistically significant differences in Table III between the futures and forward rates for the later-dated futures contracts raises the issue of whether substantial arbitrage opportunities exist for these contracts. Poole investigated this issue for the contract closest to delivery and found that few arbitrage opportunities exist.

Poole defined upper and lower critical points for profitable arbitrage for the futures rate given the spot yields, taking into account transactions costs. Values of the futures rates that lie between these upper and lower critical points indicate that profitable arbitrage opportunities do not exist. Poole calculated upper and lower arbitrage points using daily data between January 6, 1976 and June 23, 1977 for the contract closest to delivery. He found that profitable arbitrage opportunities rarely existed, and were small in magnitude when they did exist.

By converting Poole's formulae for the upper and lower arbitrage points to a bond equivalent yield basis (from his discount yield basis), we applied his approach to our three samples of data. In doing so, the formulae are not exact since the transactions costs associated with arbitraging the futures contracts further from delivery are larger than for the contracts closest to delivery. This is because maturities for securities in the spot market do not exactly match up with the maturities associated with the futures contract. In addition, for futures contracts to be delivered more than one year out, yields on Treasury coupon securities were used to calculate forward rates (see footnote 11). Consequently, transactions costs associated with arbitraging the later-dated contracts would be higher than the ones used in Poole's formulae. This means that our adoption of Poole's formulae understates the upper arbitrage point, and overstates the lower arbitrage point. The spread between the upper and lower points is therefore understated, so that there may appear to be arbitrage opportunities which would not in fact be profitable if we took all the transactions costs into account.

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[13] Poole, "Using T-Bill Futures to Gauge Interest-Rate Expectations," pp. 7-19.

[14] Ibid., p. 14.

[15] Ibid., p. 15.

[16] Ibid.

[17] Ibid.

Nevertheless, the application of Poole's formulae will at least indicate the extent of arbitrage opportunities using a conservative estimate of the transactions costs involved. For each category of contract in each sample period, Table IV shows the number of futures rates that are above the upper arbitrage point, below the lower arbitrage point, or within the upper and lower points. Table IV also shows the number of futures rates that are within or "close" to (defined as within .10 of) the upper or lower arbitrage points.

Table IV

Futures Rates Relative to Arbitrage Points

	Category[1]							
	1	2	3	4	5	6	7	8
Period I								
(3/1/76 - 11/30/76)								
Number of Futures Rates:								
Below Lower Point	10	6	0	1	0	0		
Above Upper Point	0	1	19	18	12	5		
Within Points	20	23	11	10	11	6		
Within or "Close"[2]	28	27	18	11	13	8		
Number of Observations	30	30	30	29	23	11		
Period II								
(12/1/76 - 7/31/77)								
Number of Futures Rates:								
Below Lower Point	5	2	1	0	0	0	0	0
Above Upper Point	0	5	20	14	18	26	12	12
Within Points	25	23	9	16	12	3	0	0
Within or "Close"[2]	29	26	14	19	15	6	1	0
Number of Observations	30	30	30	30	30	29	12	12
Period III								
(8/1/77 - 3/31/78)								
Number of Futures Rates:								
Below Lower Point	21	17	4	0	0	0	0	0
Above Upper Point	0	0	5	8	12	15	17	27
Within Points	9	13	21	22	18	15	13	1
Within or "Close"[2]	17	17	28	23	22	18	14	2
Number of Observations	30	30	30	30	30	30	30	28

[1] Category 1 includes futures rates for the futures contract closest-to-delivery; Category 2 includes futures rates for the futures contract next nearest-to-delivery, and so on.

[2] Includes futures rates that are within the upper and lower arbitrage points as well as those that are "close" in that they are within .10 of the upper or lower points.

Aggregating over all three sample periods, the results for Categories 1 and 2 tend to support Poole's findings. Over 75 percent of the futures rates in Categories 1 and 2 are within, or "close" to, the upper and lower arbitrage points, taking all three periods as a whole. However, the percentage for Period III alone is considerably lower than for Periods I and II. Furthermore, the percentage tends to decline as the delivery date extends further into the future. For categories 6, 7, and 8 over all three sample periods, the number of futures rates within, or "close" to, the upper and lower arbitrage points are only 45, 36, and 5 percent, respectively. Of course, the calculation of the arbitrage points for these later-dated contracts are most likely to be subject to error since they are based on yields on Treasury coupon securities rather than Treasury bills, and since the spot maturities of the securities used do not match up exactly with the later-dated futures contracts. Nevertheless, there are still some puzzling features about the results.

First, when the futures rate falls outside the upper and lower arbitrage points for the two contracts closest to delivery (Categories 1 and 2), it is almost always *below* the lower arbitrage point. Futures rates for later-dated contracts, on the other hand, are almost always *above* the upper arbitrage point when they fall outside the upper and lower bounds. Second, when the futures rate is above the upper arbitrage point for the later-dated contracts, the difference between the futures rate and the upper bound ranges from less than 10 basis points to over 100 basis points (one full percentage point), and generally averages over 30 basis points in each category. Thus, unless the calculations of the upper arbitrage points for the later-dated contracts are substantially underestimated, it appears that systematic arbitrage opportunities frequently existed for the later-dated futures contracts during our sample periods.[18]

If profitable arbitrage opportunities exist but are not acted upon by market traders, then we should not expect futures and forward rates to be as closely related as we had earlier suggested, and we certainly should not expect them to be equalized. Such a situation could explain the results obtained earlier, that futures rates and forward rates are not equal. However, such a situation implies that there is a market inefficiency or failure present. Such inefficiency or failure could be due to lack of information about trading opportunities or to institutional constraints on trading. Since information about trading in futures markets is likely to improve over time, and since institutional constraints encourage innovations that reduce their effectiveness, such a situation of market inefficiency or failure will probably be reduced over time.

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[18] That frequent arbitrage opportunities have existed in the futures market has also been argued in two other papers. See Donald J. Puglisi, "Is the Futures Market for Treasury Bills Efficient?" *The Journal of Portfolio Management* (Winter 1978), pp. 64-67; and Anthony J. Vignola and Charles J. Dale, "Is the Futures Market for Treasury Bills Efficient: A Comment," *The Journal of Portfolio Management* (Winter 1979), forthcoming.

If transactions costs are substantially larger than those used here, it may be that profitable arbitrage opportunities rarely existed despite the large spreads between the futures and forward rates for the later-dated contracts. In this case, we again should not expect futures and forward rates to be as closely related as was earlier suggested. Given transactions costs, futures rates and forward rates may not be equalized.

However, Poole's argument based on transactions costs led him to conclude that futures rates should be lower than forward rates. Even though transactions costs might explain why futures rates and forward rates are not equalized, it is still puzzling that futures rates are substantially higher than their associated forward rates for the later-dated contracts, contrary to Poole's argument. This suggests that factors other than transactions costs may affect futures rates differently than forward rates, and we now turn to a consideration of these other factors.

Default Risk

Poole implicitly assumes that factors other than transactions costs have the same effects on both futures and forward rates. Thus, since transactions costs are expected to increase forward rates, and since transactions costs are close to zero for futures contracts, Poole concludes that futures rates will be less than their associated forward rates.[19] That this conclusion is not supported by evidence for the later-dated futures contracts suggests that there are other factors embodied in futures and forward rates that have effects *in the opposite direction* to the transactions-cost effect discussed by Poole. Furthermore, this effect is stronger for the later-dated futures contracts than for those close to delivery.

Both futures rates and forward rates can be broken down into expectational and premium components. Since one-period expectations of future interest rates should be the same in both rates, we must consider the premium components of these rates. The premium associated with a forward or futures rate is generally considered to be a liquidity premium associated with interest-rate risk, or a term premium associated with investors' maturity preferences.

For a liquidity premium embodied in a futures rate to be different from the liquidity premium embodied in a comparable forward rate implies that the interest-rate risk associated with the futures contract is different than that associated with the comparable implied forward contract. For futures rates to be higher than forward rates for the later-dated contracts as a result of differences in liquidity premia, a given rise in interest rates would have to generate a larger risk of capital loss in the futures contract than in the implied forward contract. It is not obvious why this would be the case.

For a term premium embodied in a futures rate to be different from the term premium embodied in a comparable forward rate implies that investors' maturity preferences vary both across maturities and across financial instruments. It is again not obvious why this would be the case.

One factor that has been ignored in the discussion of futures contracts is default risk. Treasury bills traded in the spot market are considered to be default free. Hence, implied forward rates would not embody premia related to default risk. However, a futures contract is not guaranteed by the U.S. Government, but is rather guaranteed by the exchange on which it is traded. Although the futures contract involves delivery of Treasury bills that are default free, the contract itself is not default free. Consequently, the futures rate may contain a risk premium associated with default risk.

This default risk factor would be more important for the futures contracts that are further from delivery, those for which Poole's hypothesis fails to be supported in our samples. The furthest-dated futures contracts involve delivery of Treasury bills which have not yet been issued; they do not exist. The possibility exists, although it may be small, that there would not be a sufficient amount of 3-month Treasury bills available to meet the deliveries required by the number of open futures contracts held for delivery. Although the Chicago Mercantile Exchange guarantees that a settlement would be made, at least a monetary settlement, the item promised for delivery (3-month Treasury bills) may not be delivered.[20]

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[19] Poole, "Using T-Bill Futures to Gauge Interest-Rate Expectations," p. 14.

[20] Defaults on futures contracts for commodities are rare, but result in quite an uproar when they do occur. A recent example was the May 1976 default on the delivery of Maine

This risk of default, or risk of non-delivery of the Treasury bills, would tend to make yields on the later-dated futures contracts higher than the yields on the two contracts closest to delivery (where Treasury bills that can be used for delivery have been issued), other things constant. The results shown in Table III are consistent with this hypothesis. However, whether or not the size of the spreads between the futures and forward rates for the later-dated contracts can be accounted for solely by default risk is an open question.

SUMMARY AND CONCLUSIONS

Since yields on futures contracts are the market counterpart of implied forward rates of interest derived from the yield curve, the hypothesis that futures rates and forward rates are identical was tested using data from the Treasury bill futures market and the spot market for Treasury securities. The results indicate that futures rates are significantly different from the associated forward rates. Furthermore, the differences between the two rates have not narrowed consistently over time. Thus, it is difficult to attribute the significant differences between the two rates as being due to the initial "thinness" in the development of the Treasury bill futures market.

Poole's argument that the two rates should not be equal, but that the futures rate should be below the forward rate, was also examined. Poole's results were based on the effect of transactions costs on forward and futures rates, and were supported by evidence using the futures contract closest to delivery. Results from our samples for later-dated futures contracts do not support Poole's hypothesis. Instead, we find that the futures rates are consistently above the forward rates for the later-dated contracts. Thus, Poole's results on the contract closest-to-delivery should not be extrapolated to other futures contracts.[21]

An explanation which is consistent with the empirical results is that there is a default risk premium that affects and is embodied in the futures rates (since the futures contracts themselves are not obligations of the U.S. Government) but that does not affect the forward rates. The default risk would be greater for the later-dated contracts, which involve delivery of Treasury bills not yet issued, than for the contract closest to delivery, which Poole investigated. Although further testing and examination is required to fully explore the implications of the evidence given here, the consideration of the default risk of futures contracts should be a useful starting point.

The results of this study imply that we cannot interpret yields on later-dated 3-month Treasury bill futures contracts as the market's unbiased expectations of future spot rates on 3-month Treasury bills. Futures rates do not necessarily reflect the expected *level* of future interest rates. However, these results do not conflict with the proposition that *changes* in market expectations of future interest rates can be inferred from *changes* in futures rates.

The examination of interest rate expectations embodied in futures rates is therefore more complicated than Poole's results suggest. Furthermore, if default risk is a significant factor affecting futures rates, then estimates of term or liquidity premia in forward rates will not be comparable to the premia embodied in futures rates. This would make the estimation of the *levels* of expected future interest rates even more difficult. Consequently, policymakers who want to compare their own interest rate forecasts to the market's expectations should use caution in employing futures rates to measure market expectations.

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potato futures. Recently a bill was introduced in Congress that would ban all futures trading in potatoes.

[21] Poole, "Using T-Bill Futures to Gauge Interest-Rate Expectations," p. 15.

REVIEW INDEX — 1978

Issue	Title
Jan.	*Inflation and Taxes: Disincentives for Capital Formation*
	International Reserves and the Role of Special Drawing Rights
	Outlook for Food and Agriculture
Feb.	*The Mechanics of Intervention in Exchange Markets*
	A Tax-Based Incomes Policy (TIP): What's It All About?
	Does the St. Louis Equation Now Believe in Fiscal Policy?
Mar.	*The Federal Open Market Committee in 1977*
	Bank Reserve Requirements and Their Enforcement: A Comparison Across States
Apr.	*The Recent U.S. Trade Deficit — No Cause for Panic*
	Have Multibank Holding Companies Affected Commercial Bank Performance?
	Operations of the Federal Reserve Bank of St. Louis — 1977
May	*A Perspective on the Economy: Three Years of Expansion*
	Comparing Per Capita Output Internationally: Has the United States Been Overtaken?
	Rising Farmland Prices and Falling Farm Earnings: Is Agriculture in Trouble?
June	*Imports and Jobs — The Observed and the Unobserved*
	Benchmark Revisions of the Money Stock and Ranges of Money Stock Growth
July	*Pitfalls to the Current Expansion*
	Does the Federal Reserve Invest Member Bank Reserves?
	Coordinated International Economic Expansion: Are Convoys or Locomotives the Answer?
Aug.	*Oil Imports and the Fall of the Dollar*
	An Explanation of Movements in the Labor Force Participation Rate, 1957-76
	Money-Income Relationships and the Exchange Rate Regime
Sept.	*Inflation, Unemployment, and Money: Comparing the Evidence from Two Simple Models*
	Does the Stage of the Business Cycle Affect the Inflation Rate?
	Effects of State Reserve Requirements
Oct.	*Taxation of Capital Gains: Principle Versus Practice*
	Budget Deficits and Trade Deficits: Is there a Link?
	Economic Growth and Unemployment: A Reappraisal of the Conventional View
Nov.	*Movements in the Foreign Exchange Value of the Dollar During the Current U.S. Expansion*
	Commentary on Monetary Economics: An Interview with Karl Brunner
Dec.	*The Economic Consequences of Wage-Price Guidelines*
	Is Inflation All Due to Money?
	Are Preliminary Week-to-Week Fluctuations in M1 Biased?
	A Comparison of Yields On Future Contracts and Implied Forward Rates