Unreal Estimates of the Real Rate of Interest

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IN the nearly five decades since the publication of Irving Fisher's *The Theory of Interest,*[1] economists have engaged in numerous attempts to measure the *ex ante* real rate of interest. The effort devoted to obtaining these estimates reflects the fact that the ex ante real interest rate conveys information about some fundamental economic relationships. The ex ante real interest rate is the *expected* net rate of increase in wealth arising from additional investment. Alternatively, it can be viewed as the value of present consumption in terms of future income and, consequently, is implicit in the relative price of present consumption in terms of capital goods. Each of these is reconciled with the others by the profit-seeking market activity of individuals.[2]

Like other relative prices, the ex ante real interest rate enters the optimizing calculus of individuals and ultimately affects resource allocation. Each decision an individual makes, to save or invest or to change current consumption relative to either of these, is a choice which, implicitly at least, involves consideration of the ex ante real interest rate.

Changes in the ex ante real interest rate transmit information about changes in the relative values of resources employed in alternative uses and eventually result in a reallocation of resources to higher valued uses. Changes in this interest rate reflect changes in the net demand for present consumption goods relative to future consumption goods. The allocation of present resources to the production of these goods will be redirected in response to the change in their relative values.

Since all goods are more or less durable (i.e., they yield consumption streams which persist over varying lengths of time), the reallocation of present resources resulting from a change in the ex ante real interest rate will pervade all markets. In the absence of information about the movement of the ex ante real interest rate, it is difficult to distinguish "disturbances" (resource reallocation) induced by shifts in the demand for present consumption goods *relative* to future consumption goods from those caused by shifts in *aggregate* demand for both present and future goods. From the point of view of the policymaker, the distinction is crucial. If the disturbance is the result of a shift in relative demands, resources will be reallocated to higher-valued uses and community net wealth will rise. If the disturbance is the result of a shift in aggregate demand, any *temporary* reallocation of resources occurring during the disturbance must be to lower-valued uses causing community net wealth to fall. Policymakers might wish to eliminate the latter result but should not attempt to retard the former.

While information about changes in the ex ante real interest rate is valuable to the policymaker, it is difficult to obtain. The ex ante real interest rate reflects the *expectations* of individuals regarding *future* events. As such it can not be directly observed. It is, of course, possible (and inexpensive) to observe the

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[1]Irving Fisher, *The Theory of Interest and Capital* (New York: Augustus M. Kelley, 1965).

[2]For a more complete discussion see Armen Alchian and William Allen, *Exchange and Production: Competition, Coordination and Control* (Belmont, California: Wadsworth, 1977), pp. 435-36.

consequences of decisions that are made on the basis of these expectations. The wealth consequences associated with any economic decision can always be calculated after the fact. However, this ex post real rate of return does not bear on economic decisions since it is only known after these decisions have been made. Unlike the ex ante real rate of interest, the ex post real rate of return is irrelevant to the process of resource allocation.

Since the ex ante real interest rate can not be observed directly, individuals interested in estimating its magnitude have been led to employ the simple Fisherian relationship that the nominal (market) rate of interest is equal to the sum of the ex ante real rate of interest and the anticipated rate of inflation in the *general level* of prices. The relationship implies that empirical estimates of the ex ante real interest rate can be obtained by subtracting some measure of the anticipated rate of inflation in the general level of prices from the nominal rate of interest. As a result, previous estimates of the ex ante real interest rate have turned on the complicated problem of measuring the anticipated rate of inflation.

Virtually all previous studies have dealt with this problem by modeling the anticipated rate of inflation in the general level of prices as some function of past changes in the consumer price index (CPI) or GNP deflator.[3] If the real rate of interest is not changing, this method may produce "reasonably" accurate estimates of the anticipated rate of inflation in the general level of prices. Unfortunately, if the real rate of interest is itself changing, these commonly used price indices will produce biased estimates of actual changes in the general level of prices. Consequently, use of these indices to proxy *expected future* price level changes in Fisher's equation will prejudice *measurement* of both the level and direction of movement of the real rate of interest.[4]

This particular problem arises in a number of recent articles dealing with the inflationary period since the late 1960s which have reported sharply declining and negative *ex ante* real rates in 1974 and 1975.[5] The theoretical possibility of a negative ex ante real rate of interest is not at issue here.[6] Casual observation suggests that the preconditions for a negative *ex ante* real interest rate do not now exist, nor did they exist in 1974 and 1975.[7] More importantly, however, sharply declining ex ante real rates imply specific kinds of economic adjustments which were contrary to those that actually occurred during this period.

The purpose of this article is to demonstrate that the *estimates* of the ex ante real rate obtained by these previous studies are spurious. Following Alchian and Klein,[8] it is first demonstrated that, when real rates of interest are rising, commonly used price indices will overstate changes in the general level of prices. This introduces a downward bias into estimates of the real rate of interest when the estimates depend on measured changes in these price indices. Secondly, evidence is presented which indicates that the ex ante real rate of interest increased during

[3]Recent examples include Albert E. Burger, "An Explanation of Movements in Short-Term Interest Rates," this *Review* (July 1976), pp. 10-22; John A. Carlson, "Short-Term Interest Rates as Predictors of Inflation: Comment," *American Economic Review* (June 1977), pp. 469-75; Michael Echols and Jan Walter Elliot, "Rational Expectations in a Disequilibrium Model of the Term Structure," *American Economic Review* (March 1976), pp. 28-44; Jan Walter Elliot, "Measuring the Expected Real Rate of Interest: An Exploration of Macroeconomic Alternatives," *American Economic Review* (June 1977), pp. 429-44; Eugene F. Fama, "Short-Term Interest Rates as Predictors of Inflation," *American Economic Review* (June 1975), pp. 269-82; Eugene F. Fama, "Inflation Uncertainty and Expected Returns on Treasury Bills," *Journal of Political Economy* (June 1976), pp. 427-48; Martin Feldstein and Otto Eckstein, "The Fundamental Determinants of the Interest Rate," *The Review of Economics and Statistics* (November 1970), pp. 363-75; P. J. Hess and J. L. Bicksler, "Capital Asset Prices Versus Time Series Models as Predictors of Inflation," *Journal of Financial Economics* (December 1975), pp. 341-60; William P. Yohe and Denis S. Karnosky, "Interest Rates and Price Level Changes, 1952-1969," this *Review* (December 1969), pp. 18-38.

[4]This bias exists apart from the tax and uncertainty effects noted by others. See, for example, James E. Pesando and L. Smith, "Tax Effects, Price Expectations and the Nominal Rate of Interest," *Economic Inquiry* (June 1976), pp. 259-69; Michael Darby, "The Financial and Tax Effects of Monetary Policy on Interest Rates," *Economic Inquiry* (June 1975), pp. 226-76; Y. Amihud and A. Barnea, "A Note on Fisher Hypothesis and Price Level Uncertainty," *Journal of Financial and Quantitative Analysis* (September 1977), pp. 525-29.

[5]See for example Elliot, "Measuring the Expected Real Rate of Interest: An Exploration of Macroeconomic Alternatives;" Fama, "Interest Rates as Predictors of Inflation;" Hess and Bicksler, "Capital Asset Prices Versus Time Series Models as Predictors of Inflation;" Pesando, "On the Efficiency of the Bond Market: Some Canadian Evidence," *Journal of Political Economy* (December 1978), pp. 1057-76.

[6]Like Fisher, who discusses negative rates in the context of shipwrecked sailors whose store of figs is deteriorating, we think that "The fact we seldom see an example of zero or negative interest rates is because of the accident that we happen to live in an environment so entirely different . . ." (Fisher, *The Theory of Interest and Capital*, p. 192).

[7]Such preconditions would imply ". . . a world in which the only provisioning for the future consisted in carrying over initial stocks of perishable food, clothing and so forth and if every unit so carried over into the future were predestined to melt away . . ." (Fisher, *The Theory of Interest and Capital*, p. 91).

[8]Armen Alchian and Benjamin Klein, "On a Correct Measure of Inflation," *Journal of Money, Credit and Banking* (February 1973), pp. 173-91.

1974-1975. These results suggest that the previously reported falling and/or negative estimates of the ex ante real rate are statistical artifacts. To put it directly, they are nothing more than the predictably spurious consequences of the method used to generate them.

MEASUREMENT OF THE REAL RATE

The methodology commonly used in measuring the real rate of interest is represented by the following three equations:

(1) $r = i - P_e$

(2) $\hat{P}_e = f(C),\ f' > 0$

(3) $\hat{r} = i - \hat{P}_e.$

Equation 1 states the familiar theoretical relationship developed by Fisher between the *ex ante* real rate of interest (r), the observed nominal rate of interest (i) and the anticipated future rate of inflation (P_e), assuming continuous compounding. Equation 2 characterizes the methodology commonly employed in estimating the anticipated rate of inflation. It indicates that estimates of the *anticipated* future rate of inflation ($\hat{P}_e$) are obtained from observation of past changes in some price index (C).[9]

Finally, equation 3 states that estimates of the ex ante real rate ($\hat{r}$) are derived by subtracting $\hat{P}_e$ from the observed nominal rate of interest.

Since neither r nor P_e is directly observable, the validity of this process for accurately estimating the ex ante real rate depends crucially on whether $\hat{P}_e$ is a reliable proxy for P_e. Typically, $\hat{P}_e$ is regarded as "good" or "bad" depending on how well it predicts the *actual* contemporaneous rate of change in the particular price index being used. The implicit assumption is, of course, that contemporaneous changes in the index reflect true changes in the general level of prices.

Fama's justification of his use of the CPI is fairly typical. He comments:

> The Bureau of Labor Statistics Consumer Price Index (CPI) is used to estimate ΔP, the rate of change in the purchasing power of money from the end of month t–1 to the end of month t. The use of any index to measure the level of prices of consumption goods can be questioned. There is, however, no need to speculate about the effects of shortcomings of the data on the tests. If the results of the tests seem meaningful, the data are probably adequate.[10]

Several authors have questioned whether functions of past rates of change in the CPI, or GNP deflator, serve as reliable predictors of expectations regarding future price level change.[11] Others have commented on how measurement errors in the indices must be taken into account when estimating real interest rates.[12] None, however, have tried to confirm the validity of the estimates by observing economic relationships known to depend on the real rate of interest.

Alchian and Klein have noted a significant difficulty in using changes in common price indices as measures of changes in the general level of prices, or "purchasing power of money." In particular, they argue that changes in the purchasing power of money are determined by changes in the prices of both present consumption goods and long-lived assets, not just changes in the prices of present consumption goods alone. They comment:

> The analysis . . . bases a price index on the Fisherian tradition of a proper definition of intertemporal consumption and *leads to the conclusion that a price*

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[9]The index most frequently used is the CPI. See Burger, "An Explanation of Movements in Short-Term Interest Rates;" Elliot, "Measuring the Expected Real Rate of Interest: An Exploration of Macroeconomic Alternatives;" Fama, "Inflation Uncertainty and Expected Returns on Treasury Bills;" Hess and Bicksler, "Capital Asset Price Versus Time Series Models as Predictors of Inflation;" Yohe and Karnosky, "Interest Rates and Price Level Changes, 1952-1969." The GNP deflator has been used less frequently. See Feldstein and Eckstein, "The Fundamental Determinants of the Interest Rate." The procedure used to estimate expected inflation for period t from the observation of past levels of some price index is, roughly, the following: An estimate of the period t price level is made in period t–1. This estimate is a weighted average of past price levels. That is,

$$\hat{C}_t = \sum_{i=t-1}^{t-n} W_i C_i;$$

where the left-hand term is the estimate and the W are the weights assigned to past price levels. The estimated change in the price level is obtained by subtracting the price level in period t–1 from the estimate for period t as follows

$$\Delta\hat{C}_t = {}_{t-1}\hat{C}_t - C_{t-1}.$$

Last, the estimated change in the price level is defined to be the estimate of expected inflation for period t,

$$\Delta\hat{C}_t \equiv \hat{P}_{e_t}.$$

[10]Fama, "Short-Term Interest Rates as Predictors of Inflation," p. 247.

[11]See Carlson, "Short-Term Interest Rates as Predictors of Inflation," Edward J. Kane and Burton G. Malkiel, "Autoregressive and Nonautoregressive Elements in Cross-Section Forecasts of Inflation," *Econometrica* (January 1976), pp. 1-16.

[12]See Fama, "Inflation Uncertainty and Expected Returns on Treasury Bills;" Feldstein and Eckstein, "The Fundamental Determinants of the Interest Rate;" Kane and Malkiel, "Autoregressive and Nonautoregressive Elements in Cross-Section Forecasts of Inflation;" C. Nelson and G. Schwart, "Short-Term Interest Rates as Predictors of Inflation: On Testing the Hypothesis that the Real Rate of Interest is Constant," *American Economic Review* (June 1977), pp. 478-86.

> *index used to measure inflation must include asset prices* (italics added). A correct measure of changes in the nominal money cost of a given utility level is a price index for wealth. If monetary impulses are transmitted to the real sector of the economy by producing transient changes in the relative prices of service flows and assets, (i.e., by producing short-run changes in 'the' real rate of interest), then the commonly used, incomplete, current flow price indices provide biased short-run measures of changes in the 'purchasing power of money.'[13]

The CPI and GNP deflator largely exclude the prices of long-lived goods and existing capital assets.[14] Consequently, changes in these price indices will depend on changes in the real rate of interest because of the well-known difference in the interest elasticities of the market prices of short- and long-lived goods.

THE MEASUREMENT PROBLEM

Our criticism of the methodology currently used to measure the ex ante real rate of interest rests on two interrelated points. First, the quantity weights used in calculating the CPI and GNP deflators do not accurately reflect the mix of goods actually available to individuals. As a result, changes in these commonly used price indices produce biased estimates of actual changes in the general level of prices when the real interest rate is changing. Second, given that it is the *expectation* of market participants concerning the future rate of inflation in the general level of prices that is relevant in Fisher's theory of the nominal rate of interest, *estimates* of the real interest rate that employ past changes in a commonly used price index as a proxy for expected inflation will be biased when the real rate is changing. Each of these points is demonstrated below.

Point 1: Changes in the General Level of Prices versus Changes in Commonly Used Price Indices

Assume initially that an increase in the real rate of interest occurs and that both the quantity of money and its velocity are unchanged.[15] If the quantity of output is also unchanged, there will be no change in the general level of money prices or the level reflected in a Fisherian price index (i.e., one which includes asset prices). However, since the prices of short-lived goods *rise* relative to the prices of long-lived goods when the real interest rate rises, the money prices of short-lived goods (long-lived goods) will rise (fall) relative to the general level of money prices. Thus, when the real interest rate is rising, commonly used price indices, in which the prices of short-lived goods receive a relatively heavy weight, will rise introducing a systematic upward bias into the estimation of changes in the general level of prices. The reverse holds when the real interest rate falls.

If an increase in the real interest rate produces an increase in the general level of money prices through a once-and-for-all rise in velocity, the resulting increase in commonly used price indices will contain two components: 1) an increase due to the *rise* in the general level of prices and 2) an increase due to the bias introduced by capturing only part of the price changes that have occurred. However, wealth-maximizing market participants will ignore both of these components in forming their expectation regarding the *future* rate of inflation in the general level of prices. They will ignore the first component because it represents a once-and-for-all change which leaves the future rate of inflation unaffected. They will ignore the second component because its effect is to overstate the true change in the general price level. On the other hand, *estimates* of price expectations that employ the common methodology (the ability to reproduce actual changes in the CPI) will include both.

This argument can be presented more formally. Assume there are two kinds of goods — short-lived, Q^S, and long-lived, Q^L — and money. Suppose, in the base period, the real rate of interest is r_0. Then,

$$(4) \quad M_0 \cdot V_0 = P_0^S \cdot Q_0^S + P_0^L \cdot Q_0^L$$

where M_0 is the money supply, V_0 is velocity, and P_0^S and P_0^L are the prices of short- and long-lived goods, respectively.

If the interest rate increases to r_1, velocity will rise as relative prices change.[16] Let

[13] Alchian and Klein, "On a Correct Measure of Inflation," p. 173.

[14] Durable goods have a weight of 18.75 percent in the CPI. Nondurable goods and services have weights of 47.19 and 34.03 percent, respectively. See Bureau of Labor Statistics, *Handbook of Methods*, Bulletin 1910, 1976. The GNP deflator includes the prices of currently produced capital goods but it excludes the prices of existing capital assets.

[15] Economic theory suggests that velocity will rise with an increase in r. This is discussed below.

[16] Quantities will eventually adjust as well but that is ignored here. In any case, the quantity adjustment which takes place makes no difference for the measurement of the change in a fixed weight index.

$$(5)\quad F_1 = \frac{P_1^S \cdot Q_0^S + P_1^L \cdot Q_0^L}{P_0^S \cdot Q_0^S + P_0^L \cdot Q_0^L}$$

represent the level of a Fisherian price index in the current period. If the change in the interest rate was the only change that affected the index between the base and current period, the change in the Fisherian price index is

$$(6)\quad \Delta F = F_1 - 1.$$

Let

$$(7)\quad C_1 = \frac{P_1^S \cdot Q_0^S}{P_0^S \cdot Q_0^S}$$

represent the level of a commonly used price index in the current period. It differs from the Fisherian index in that it excludes prices of long-lived goods. The change in this price index, due to the change in r occurring between the base period and the current period, is

$$(8)\quad \Delta C = C_1 - 1.$$

It is a simple matter to show that an increase in the real rate of interest will have a greater effect on the commonly used price index than on the Fisherian price index. We know that

$$(9)\quad P_1^S/P_1^L > P_0^S/P_0^L$$

because a rise in the real rate of interest increases the price of short-lived goods relative to long-lived goods. Now consider the Fisherian index which can be written as

$$F_1 = \frac{P_1^S}{P_0^S} \times \left[\frac{Q_0^S + (P_1^L/P_1^S)Q_0^L}{Q_0^S + (P_0^L/P_0^S)Q_0^L}\right].$$

That is,

$$F_1 = C_1 \times \left[\frac{Q_0^S + (P_1^L/P_1^S)Q_0^L}{Q_0^S + (P_0^L/P_0^S)Q_0^L}\right].$$

The term in the brackets is less than one since, from (9),

$$P_1^L/P_1^S < P_0^L/P_0^S$$

and thus

$$Q_0^S + (P_1^L/P_1^S)Q_0^L < Q_0^S + (P_0^L/P_0^S)Q_0^L.$$

It follows that $F_1 < C_1$ and $\Delta F < \Delta C$.

In general, when the real interest rate is increasing, use of price indices that are based primarily on short-lived goods will introduce a systematic upward bias into estimation of changes in the general level of prices (in the Fisherian sense). The reverse is true during periods of decline in the real interest rate.[17]

[17]Interestingly, Alchian and Klein commented on this source of inherent measurement error in the CPI and GNP deflator, but did not pursue its implications for estimating the real rate of interest. They remark: "It should be noted that although our discussion emphasizes that movements in asset and service prices differ largely because of differing rates of adjustment to cyclical monetary disturbances there may also be a significant secular bias due to changing equilibrium real asset yields. (The apparent increase in real rates of interest over the years is ignored in our discussion.)" Alchian and Klein, "On a Correct Measure of Inflation," p. 180.

Point 2: Biased Estimates of the Real Interest Rate

If r remains unchanged, changes in commonly used price indices accurately reflect changes in a Fisherian index of prices. Consequently, the methodology summarized in equations 1-3 will yield accurate estimates of r for such periods. However, during periods in which r is changing, bias in the common price indices introduces, through equations 2 and 3, bias into any estimate of the real interest rate that employs these indices.

To demonstrate this second point, ignore other factors that affect common price indices (e.g., a change in the monetary growth rate) and express C as a function of the real rate of interest. That is,

$$(10)\quad C = \phi(r),\ \phi' > 0.$$

The error generated in estimating the real interest rate by the method employed in the studies referenced earlier is given by

$$(11)\quad \hat{r} - r = P_e - f(\phi(r)).$$

The error in estimated changes in the real rate is obtained by differentiating equation 11 with respect to r. In doing so, note that the price expectations (P_e) of market participants are based upon the anticipated future rate of change in the general level of prices in the sense of Fisher's theory and not upon once-and-for-all changes produced by changes in r. Hence, price expectations will be unaffected by changes in r while the *estimate* of price expectations will vary positively with such changes. That is,

$$(12)\quad \frac{d\hat{r}}{dr} = 1 - \frac{\partial f}{\partial \phi}\frac{\partial \phi}{\partial r}.$$

The term $\frac{\partial f}{\partial \phi} \cdot \frac{\partial \phi}{\partial r}$ is always positive. Estimates of changes in the ex ante real rate of interest will *always understate* any actual change that occurs.

Even worse, the procedure employed in previous work can err in assessing *the direction of change* in the real rate. If the effect of a change in the interest rate on the commonly used price index described in

Table 1

Selected Estimates of the Real Rate of Interest[1]

Year	Elliot short-term	Carlson T-bill rate	St. Louis Fed yield on high grade corp. bonds	Ex post short-term yield
1970	0.57%	2.38%	2.86%	2.58%
1971	1.59	1.05	2.18	2.02
1972	2.13	1.28	2.72	2.52
1973	1.07	2.35	2.84	2.10
1974	-0.41	0.40	1.78	0.28
1975	—	0.07	0.05	-2.25

[1]The interest rate we report is the annual average of the various subperiods. In the case of Elliot, we report his neo-Keynesian monetary estimate which he accepts as most accurate. The Federal Reserve Bank of St. Louis discontinued publishing estimates prior to the end of 1975. The estimate we attribute to them for 1975 is one that we calculate using their method of estimation.

equation 12 is sufficiently large, $\frac{d\hat{r}}{dr}$ will be negative. Hence, even though the change in the real rate is positive, the estimated change could be negative. This may explain the declining estimated real rates reported for the mid-1970s.

EVIDENCE ON CHANGES IN THE REAL RATE

Table 1 presents some previously reported estimates of the ex ante real rate of interest from 1970 to 1975. Additionally, it presents the difference between current short-term market rates and contemporaneous rates of change in the CPI. The latter would represent the "true" ex post yield if changes in the CPI measured changes in the general level of prices without error.

All of these estimates show dramatic declines in 1974 and 1975, years in which substantial increases were recorded in the CPI. Elliot's reaction to his results is perhaps typical. He asserts:

> . . . some relationship appears to exist between the temporal pattern of the real rate and the current rate of inflation. . . . The negative and statistically significant nature of this relationship suggest that expected real rates are systematically lowered when the most current realized rate of inflation is increasing.[18]

However, before concluding that changes in the CPI affect the real rate of interest, it seems appropriate to determine whether other evidence is consistent with this hypothesis. Changes in the ex ante real rate of interest imply specific behavior in the prices of long-lived assets relative to the prices of short-lived assets. Falling real rates of interest in 1974 and 1975 should have been accompanied by a rise in the present prices of long-lived assets (which produce future consumption services) relative to the prices of short-lived goods. Evidence indicates, however, that the relative price of long-lived assets *fell* during 1974 and 1975. This evidence is inconsistent with the contention that the ex ante real rate of interest declined precipitously during this period.

SOME EVIDENCE FROM INDIVIDUAL MARKETS

The movement of relative prices in various markets is examined below. As noted earlier, a change in the ex ante real rate of interest shows up as a change in the relative price of less durable (present) goods in terms of more durable (capital) goods. An increase in the ex ante real rate of interest reflects an increase in the demand for present goods relative to capital goods. Consequently, the price of present goods in terms of capital goods will rise. This adjustment in relative prices mirrors the change in the ex ante real interest rate.

[18]Elliot, "Measuring the Expected Real Rate of Interest: An Exploration of Macroeconomic Alternatives," p. 442. For similar statements see Carlson, "Short-Term Interest Rates as Predictors of Inflation: Comment," p. 472; Feldstein and Eckstein, "The Fundamental Determinants of the Interest Rate," p. 366; Yohe and Karnosky, "Interest Rates and Price Level Changes, 1952-1969," p. 24 and p. 26.

By its nature, this type of evidence requires examination of price movements in individual markets. This procedure of examining relative price movements is always open to the charge that any observed relative price change in an *individual market* may be due to circumstances unrelated to a change in the ex ante real interest rate. As was noted previously, however, a change in the ex ante real interest rate pervades all markets. If an examination of a number of markets reveals that the price of the less durable good has consistently moved in the same direction relative to the price of the more durable good, the contention that the observed change in relative price is due to the impact of special circumstances in each of these markets loses much of its force.

Since the ex ante real interest rate can not be directly observed, any evidence about its magnitude or direction of change will always be circumstantial. The evidence presented below is no exception. However, as Thoreau has noted, "(s)ome circumstantial evidence is very strong, as when you find a trout in the milk."

The evidence presented below is reasonably consistent across the various markets for the 1968-1975 period. Moreover, changes in the price ratios examined correspond perfectly across markets for the 1972-1975 period. However, the direction of change in the ex ante real interest rate implied by these price ratio changes occurring during the later period contradicts that reported in previous studies. This contradiction is perhaps not surprising. We have shown that past increases in the real rate will introduce a downward bias into *estimates* of the *present* change in the ex ante real interest rate. Examination of changes in the price ratios occurring in all four markets indicates an increase in the ex ante real interest rate in the two years immediately preceding 1974. Three of the four markets indicate an increase in the real rate in the three years immediately preceding 1974. The above contradiction is the "trout" whose presence is verified by this evidence.

1. *The Commodity Markets:* Changes in the real rate of interest will be reflected in changes in spot relative to futures prices. The spot price of a good is today's price for delivery today while the futures price is today's price for delivery in the future. A decrease in the real rate must be reflected in a decrease in the value of present (spot) goods *relative* to future goods. Spot prices will fall *relative* to futures prices when the ex ante real rate of interest falls.

Between 1960 and 1972 the average annual ratio of the Dow Jones index of spot prices to the Dow Jones index of futures prices was 1.019, with a standard deviation of .018 (see table 2). Between 1973 and 1975 this ratio averaged 1.057. In 1974, when previous studies report a precipitous decline in the real rate (see table 1), the ratio reached its *highest* level (1.076) in the entire 16-year period. Relative price behavior in the commodities markets is inconsistent with a falling ex ante real rate of interest in 1974 and 1975.

Table 2
Spot and Futures Prices
1924-1926 = 100

Year	Index of spot prices	Index of futures prices	Ratio of spot prices to futures prices
1960	141.80	141.22	1.004
1961	149.85	148.44	1.009
1962	149.85	143.90	1.041
1963	159.83	154.49	1.034
1964	142.99	136.82	1.045
1965	142.47	139.31	1.022
1966	139.44	136.71	1.019
1967	142.88	141.79	1.007
1968	144.45	143.26	1.008
1969	144.90	139.10	1.041
1970	145.07	144.81	1.001
1971	144.35	146.30	.986
1972	189.49	184.58	1.026
1973	340.51	320.50	1.062
1974	384.53	357.26	1.076
1975	296.33	287.88	1.029

SOURCE: The Dow Jones Commodities Handbook, Dow Jones Company, New York 1977, pp. 178-179.

2. *Durable and Nondurable Goods:* Durable goods, by definition, embody a longer-lived stream of future services than do nondurable goods. Therefore, falling real rates of interest imply a decrease in the price of nondurable goods relative to the price of durable goods.

From 1960 to 1972 the average ratio of the U.S. Bureau of Labor Statistics' index of nondurable goods prices to its index of durable goods prices was .976 (table 3), with a standard deviation of .040. Between 1973 and 1975 it averaged 1.122. In 1974 it was 1.156. Again, this relative price behavior is inconsistent with

Table 3
Nondurable and Durable Goods Prices

Year	Index of nondurable goods prices	Index of durable goods prices	Ratio of nondurable goods prices to durable goods prices
1960	89.4	96.7	.924
1961	90.2	96.6	.933
1962	90.9	97.6	.924
1963	92.0	97.9	.939
1964	93.0	98.8	.941
1965	94.6	98.4	.961
1966	98.1	98.5	.995
1967	100.0	100.0	1.000
1968	103.9	103.1	1.007
1969	108.9	107.0	1.017
1970	114.0	111.8	1.019
1971	117.7	116.5	1.010
1972	121.7	118.9	1.023
1973	132.8	121.9	1.089
1974	151.0	130.6	1.156
1975	163.2	145.5	1.121
1976	169.2	154.3	1.097
1977	178.9	163.2	1.096
1978	192.0	173.9	1.105

SOURCE: Department of Labor, Bureau of Labor Statistics, Consumer Price Index, Special Indexes.

Table 4
Ratios of Earnings/Stock Prices and Price of Nondurable Goods/Stock Prices

Year	Standard and Poor's Stock Price Index[1]	Earnings/Price ratio X 100	Ratio of nondurable goods prices to stock prices
1960	55.8	5.90	1.61
1961	66.2	4.62	1.36
1962	62.4	5.82	1.45
1963	69.9	5.50	1.31
1964	81.4	5.32	1.14
1965	88.2	5.59	1.07
1966	85.3	6.63	1.15
1967	92.0	5.73	1.08
1968	98.7	5.67	1.05
1969	97.8	6.08	1.11
1970	83.2	6.46	1.37
1971	98.3	5.41	1.19
1972	109.2	5.50	1.11
1973	107.4	7.12	1.23
1974	82.8	11.60	1.82
1975	86.2	9.12	1.89
1976	102.0	8.90	1.66
1977	98.2	10.80	1.82
1978	96.0	12.05	2.00

[1]Standard and Poor's Statistical Service, Security Price Index Record, Standard and Poor's Corporation, New York, N.Y.

the dramatic decline in the real rate suggested by the estimates in table 1.

Furthermore, the estimates in table 1 do not appear to be appropriately related to relative prices over extended periods. If estimates generated by the standard method track the real rate, they should be positively correlated with the relative price ratios. This is not the case, however, between 1960 and 1975. The correlation between Elliot's estimates and the ratio of nondurable prices to durable prices is –.625. Between his estimates and the ratio of spot and futures prices, the correlation is –.484. The corresponding coefficients for Carlson's estimates are –.459 and –.073. Those for the St. Louis Fed are –.692 (significant at the 5 percent level) and –.121.

None of these estimates of the ex ante real rate of interest generated by the standard method moved in the direction implied by movements in these relative prices during the 1969-1975 period. The correlations suggest that the effect $\frac{\partial f}{\partial \phi} \cdot \frac{\partial \phi}{\partial r}$ described in equation 12 may be sufficiently large to make $\frac{d\hat{r}}{dr}$ negative.

3. ***The Stock Market:*** The stock market provides further evidence on this issue. Because stock prices represent the present value of expected future earnings, a decrease in the ex ante real rate of interest will be reflected by a rise in the price of shares relative to *current* earnings and a fall in the earnings to price ratio. During the period 1960-1972, earnings to price ratios averaged 5.709 (table 4) with a standard deviation of .511. In 1974 and 1975, earnings to price ratios reached levels of 11.60 and 9.12, respectively.

In addition, a decrease in the rate of interest will be reflected by a fall in the price of nondurable present consumption goods relative to stock prices. Between 1960 and 1972 the ratio of the Index of Nondurable Good Prices to the Standard and Poor's Stock Price Index averaged 1.234, with a standard deviation of .177. In 1974 and 1975 it rose to 1.82 and 1.89, respectively. Again, this relative price behavior is clearly inconsistent with the contention that the ex ante real rate of interest fell in 1974 and 1975.

CONCLUSIONS

The method currently used to estimate the ex ante real rate of interest can lead to serious error. The error arises because this method requires the investigator to measure the *expectations* of market participants regarding the *future* rate of inflation. Unfortunately, since these expectations are never directly observed, the accuracy of the measurement is questionable.

Price expectations have typically been approximated by observing *past* rates of change in either the CPI or the GNP deflator. This method of approximation assumes, first, that expectations about the future rate of inflation depend largely on the past rate of inflation and, second, that the past rate of inflation is accurately reflected by the past rate of change in these price indices. This article has put aside the first issue and argues that past rates of change in the CPI and the GNP deflator may not accurately reflect the past rate of inflation.

We have shown that real interest rate changes themselves affect these indices. This occurs not only because these price indices give substantial weight to the prices of current consumption goods, as opposed to the prices of assets productive of future consumption (capital goods), but also because they reflect the impact of once-and-for-all changes in prices produced by changes in the real interest rate. Therefore, it is impossible when using this estimation procedure to separate changes in the real interest rate from changes in the rate of inflation. As a result, the method produces biased estimates of changes in the ex ante real rate of interest.

Furthermore, the direction of this error is predictable. In particular, when the real rate of interest rises, as in 1974 and 1975, the current method of estimation will understate the change in the real rate. Evidence from the mid-1970s suggests that estimates of the real rate based on the CPI failed to detect the direction of change in the real rate.

Because estimates of the real rate employing measures of anticipated inflation based on common price indices are suspect unless real rates are unchanging, their value is severely limited for use in formulating economic policy. Estimates of the ex ante real rate of interest are important to policymakers if they aid in distinguishing shifts in relative demands from shifts in aggregate demand (i.e., are able to actually detect changes in the real interest rate). However, the widely employed method of estimation breaks down precisely during periods in which the ex ante real interest rate changes. Consequently, estimated changes in the ex ante real rate of interest should be checked against the behavior of the relative prices known to depend upon the real rate prior to employing these estimates for economic policy purposes.