

THE RELATIONSHIP BETWEEN MONEY AND PRICES REVISITED,

By

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INTRODUCTION

In a recent article in the Journal of Political Economy [5], Edgar Feige and Douglas Pearce tested the causal relationship between the rate of inflation and several measures of monetary and fiscal action. To their surprise [5, p. 519], Feige and Pearce found no evidence suggesting a causal link between the growth in the money supply and the rate of inflation.

In this paper I will show three weaknesses in their analysis. In the first place, the method they used cannot detect some types of dependence. Second, they did not hold constant other factors that could affect the rate of inflation. And finally, the hypothesis they tested does not correspond to any economic theory that implies a link between money and prices.

I will briefly discuss the technique Feige and Pearce used and some of the results they obtained. Then in the next three sections of the paper, I will discuss in detail the three weaknesses in their method. Finally, I will present a more complete model of the relationship between money and prices.

Feige and Pearce's Method

The technique they used is based on the time-series method of Box and Jenkins [2]. It was developed by

Haugh [8] to reduce the apparent correlation between two independent time-series that results solely because each time-series is autocorrelated. (See [3], [8] and [9] for detailed discussions of this problem.) Put simply, the method eliminates all the autocorrelation from a time-series by determining how current values of the series are related to past values. This systematic part of the time-series is then removed by forming a prediction for each observation that is based only on the past history. The remaining error (i.e., the difference between the actual and the predicted values) is purely random -- it is uncorrelated with the error in any other period.

What Feige and Pearce did was generate a set of these random errors for the rate of inflation and several monetary aggregates and a fiscal measure. Then they correlated the errors in the rate of inflation with the errors in the rate of growth in each of the other variables.

Table I shows two of the models that Feige and Pearce estimated: one for the quarterly rate of change in the wholesale price index and the other for the quarterly rate of change in currency plus demand deposits (M1). Although Feige and Pearce estimated models for other variables, I have shown these two because I will discuss the relationship between these variables later in the paper.

TABLE I

ESTIMATED TIME-SERIES MODELS FROM FEIGE AND PEARCE
(With 95% confidence interval)

Wholesale price index: Quarterly data from 1953 III to
1971 II

$$(1-B^4) (1-\underset{+.231}{.300B}) p_t = .039 + (1-\underset{+.028}{.693B^4}) a_t$$

Q=28.77 (37 d.f.)

Currency plus demand deposits: Quarterly data from 1953 II
to 1971 II

$$(1-B^4) (1-B) (\underset{+.224}{1-.705B} + \underset{+.270}{.291B^2}) ml_t = (1-\underset{+.197}{.835B}) (\underset{+.278}{1-.535B^4}) a_t$$

Q=22.42 (36 d.f.)

where p_t is the quarter-to-quarter percentage change
in the wholesale price index,

ml_t is the quarter-to-quarter percentage change
in M1 (currency plus demand deposits),

a_t is a random error,

B is a backshift operator -- defined as $B^i x = x_{t-i}$,

and Q is a measure of randomness -- distributed
as a Chi-squared.

Source: Feige and Pearce [5], pp. 505 and 512.

A few words might shed some light on what these two equations mean. First, both variables are seasonally differenced. That is, the observation is the rate of growth in a given quarter minus the rate of growth in the same quarter one year earlier. This differencing is represented by the expression $(1-B^4)$ where B is a backshift operator -- defined as $B^i x_t = x_{t-i}$. Additionally, the money series is differenced from one quarter to the next; this is shown as $(1-B)$.

The next term in each equation represents the autoregressive structure of the transformed (differenced) variables: the price variable is taken to be a first order autoregressive process; the money variable is a second order autoregressive process.

The right hand side of each equation gives the moving average error specification. The price variable has a constant and a first order seasonal moving average error structure. Money has a first order regular moving average and a first order seasonal moving average error structure.

These equations can be interpreted as the best predictors of the growth in prices and money given only the past history of each variable. The error term, a_t , is the part of each observation that cannot be accounted for by the past history. These are the values that Feige and Pearce used to test the relationship between money and

prices. Each set should be purely random: as a test for randomness, the value of Q for each equation can be compared to the Chi-squared distribution. In both cases, the value of Q is less than the critical value at the 95% level -- indicating randomness. Since the errors in these two series were not correlated at lags up to twelve quarters, Feige and Pearce could not reject the hypothesis that the rate of inflation is causally independent of the rate of growth in the money supply. I will now show the weaknesses of their approach.

RELATIONSHIPS LOST: THE REMOVAL OF RELEVANT INFORMATION

The method Feige and Pearce used disregards three types of information about the relationship between variables. First, the long run trend is removed. Second, seasonal variation is removed. And finally, information contained in the past history is removed. Let me turn now to a discussion of how the removal of this information can reduce the observed relationship between two variables.

Consider first the long run trends. The first step in the Box-Jenkins method is the removal of any trend in the data. This is usually accomplished by differencing the series. Thus, if both prices and money were growing on the average of 5% a year, the first step in this method is to discard this information. The rationale behind this

is that one cannot say whether the common growth rate is evidence of money growth "causing" growth in prices or vice versa; furthermore, there is the possibility that a third factor is causing both to grow at this rate while money and prices are independent. For these reasons, one must be careful when interpreting the common trend; but, elimination of the trend will make any longer run relationship between the variables hard to observe.

Similarly, removal of seasonal variation eliminates variation that is common to both variables. Once again, since one cannot attribute the shared seasonal pattern to one variable or the other, the solution is: throw it out.

It turns out, however, that the results of this method are affected somewhat by the method selected to remove the seasonal pattern. David Pierce reports such difficulties in a recent article [11]. He used two different methods for removing seasonality: subtracting seasonal means and taking seasonal differences. Either method can be used and the results should not depend on which is chosen. He reports, however, "Also bothersome was a lack of cross correlation, at lag zero, of the two sets of residuals from the demand deposit series filtered in each way, suggesting that the deterministic detrending/deseasonalization procedure possibly took too much out of the series." [11, p. 19] Loosely translated, this means that

the demand deposits variable was made to be independent of itself in the current period by applying two appropriate methods of adjustment.

The final type of information removed from the data is information contained in the past history of each series. Now under the assumption of independence of the two series, nothing is lost: the history will not contain any information about the other variable. But, the first step in Feige and Pearce's method removes all the information contained in the past history of the rate of inflation -- even information that comes about because of changes in the money supply. If, for example, the rate of inflation adjusts to changes in the growth rate of the money supply, the adjustment is attributed to past history of inflation. The second step in their process can only try to pick up the period when a change in money first starts to influence prices. If the initial influence is consistent, the second step will show significant correlation and independence can be rejected. But, if the timing of the initial effect is irregular, it is possible that no significant correlation would be found between the two sets of residuals generated in the first stage.

An example should clarify this point. Suppose the government announces in November its intention to print 200 million brand new \$50 bills and mail them out next

April. Nothing has happened to the money supply: Feige and Pearce will not uncover a "surprise" in the money growth rate until April. The rest of us need not wait that long. If the announcement of this policy causes individuals to expect prices to rise in the future, some may attempt to buy now before prices become higher. This attempt to adjust purchases could cause prices to rise now. In this case, the unpredictable rise in prices starts five months before the "unpredictable" rise in the money supply. The government is not always so eager to announce such a policy -- usually there is no announcement. But, if increases in the money supply affect prices, and it pays to predict prices, then it will pay to predict increases in the money supply. Under these circumstances, unpredictable increases in prices would occur when the market changed its prediction of money growth not necessarily when actual changes in money growth occur.

The length of time may vary between when a change in money growth happens and when the market was able to predict the change. If so, the timing of the initial response of prices will vary as well. This possible variation in the short run response makes it important to capture the longer run effects as well to see the true relationship between money and prices. The longer run response is, however, virtually eliminated in their method.

Another problem with their method is that the distribution of the cross-correlation coefficients was calculated under the assumption of independence of the two series. It is possible that the procedure will remove some actual correlation in the first step. In his paper describing the method, Haugh warns, "It also needs to be emphasized perhaps that the asymptotic distribution discussed here assumes the independence of the two series. Hence, the simple distribution discussed is not appropriate when real cross-correlation of some magnitude exists." [8, p. 384]

As a final indication of the loss of information in this method, let me note that the method requires that the series be stationary. This means that there can be no major changes in the series. This requirement eliminates every episode of substantial inflation. To illustrate this, I have graphed the growth rate in prices from 1946 to 1976: this is shown in Figure 1. The vertical lines on the graph delineate the period Feige and Pearce used. As can be seen in the graph, this is a period of fairly stable prices: every major period of inflation has been ignored. Though these periods are the most likely to result from excess monetary expansion, they cannot be evaluated with Feige and Pearce's method. This severely limits the usefulness of their procedure in detecting the effects of money growth on inflation.

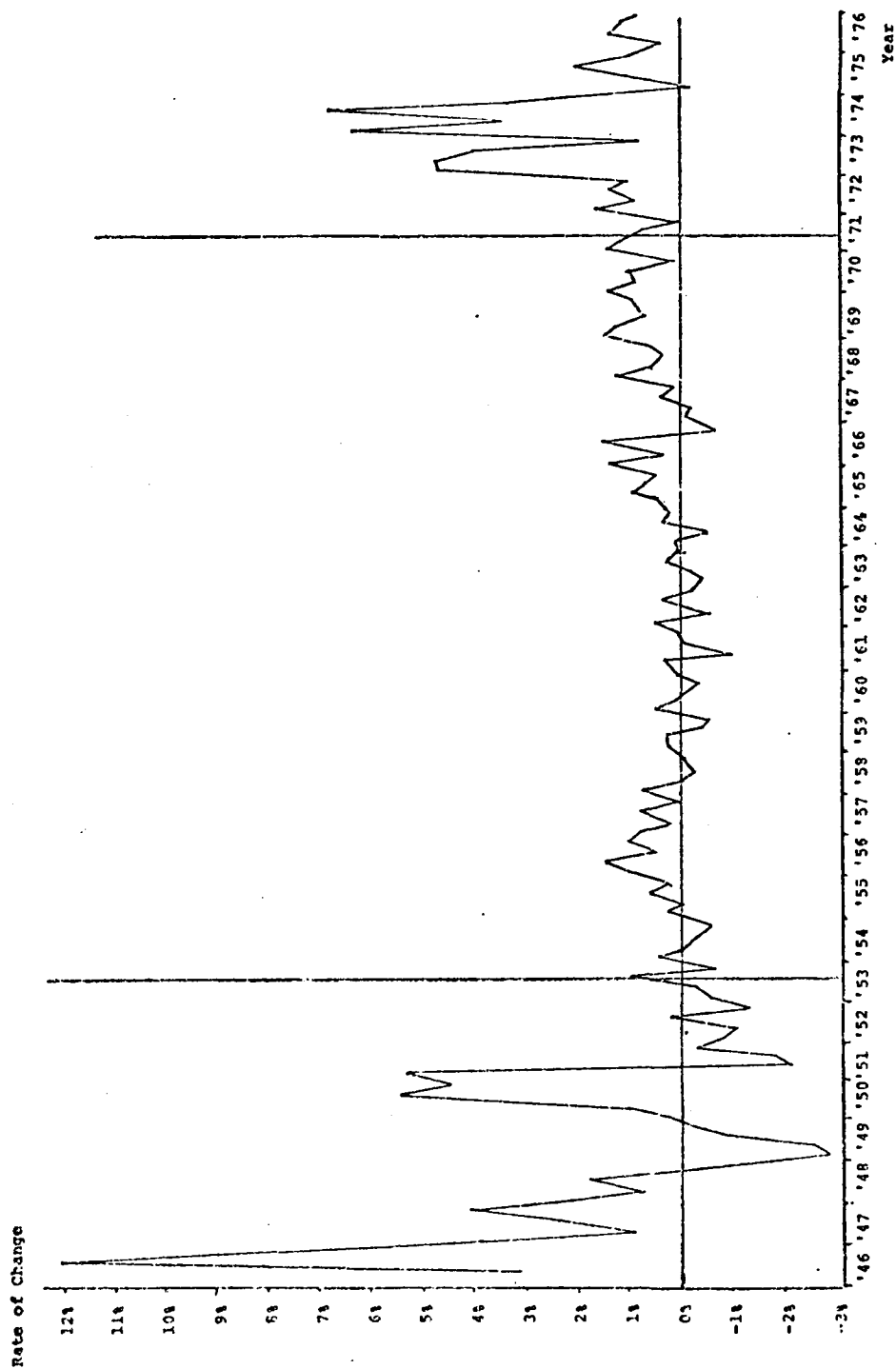


FIGURE 1: QUARTER-TO-QUARTER RATE OF CHANGE IN THE WHOLESALE PRICE INDEX -- 1946 I to 1976 IV.

OMITTED VARIABLES: THE PROBLEM OF NOT HOLDING CONSTANT
OTHER FACTORS THAT AFFECT PRICES

Feige and Pearce test whether a single variable, say the growth in M1 (currency plus demand deposits) is able to improve the prediction of inflation based solely on the past history of inflation. They do not, however, hold constant any other factors that may affect prices in order to isolate the effect of money growth alone on prices.

A simple example will clarify this point. Suppose price increases are influenced by both money supply increases and by output increases (measured at constant prices). Suppose further that the true relationship is that a 1% increase in real output decreases prices by 1%, and that a 1% increase in the money supply increases prices by 1%. If money and output tend to move together, then it is likely that no relationship would be revealed when only the money supply is accounted for: if each change in the money supply were matched by an equal change in output, there would be no change in prices predicted by this simple model.

From this discussion, it follows that if the link between money and prices is altered or weakened by movements in other variables, then failing to take these movements into account will reduce or even eliminate the observed relationship between money and prices. In

the next section, I will present a model stating that changes in the money supply affect either prices or real output. An implication of this model is that if an increase in the money supply increases real output, then no increase in prices need be expected. Further, I will present some evidence indicating that unexpected changes in the growth rate of money are followed by changes in real output rather than prices, and that expected changes in the growth rate of money affect prices. (This is consistent with the results found by Barro [1]). Given these results it is not surprising that Feige and Pearce found no significant correlation between unexpected changes in the money supply and unexpected changes in prices -- if the model is valid, no such correlation would be predicted. Let us turn now to this model.

THE RELATIONSHIP BETWEEN MONEY AND PRICES

Before empirically testing hypotheses about the effect on prices of changes in the money supply, it is necessary to formulate a theoretical link between money and prices and to show that the hypotheses being tested are consistent with the theory. If a hypothesis does not follow logically from the theoretical model, then rejecting the hypothesis does not suggest rejecting the model.

To show that Feige and Pearce have cast little doubt on the influence of money on prices, I will now present, briefly, a theoretical model of this influence and show that the relationship Feige and Pearce tested is not implied by this model. (For a more completely specified model of the impact of money on the economy, see Milton Friedman [6].)

The theory that money affects prices stems from the idea that the flow of goods and services can be viewed in two equivalent ways: as the value of the goods and services sold or as the amount of the medium of exchange used to purchase the goods and services. Equating these two measures yields what is called the quantity equation:

$$(1) \quad MV = PQ$$

where M is the average stock of money,

V is velocity -- the average number of times a unit of money is used to purchase goods and services,

P is a weighted average of the prices of all goods and services,

and Q is the quantity of all goods and services sold.

The quantity MV is the value of money used to buy goods and services during the observation period; the quantity PQ is the value of the goods and services sold during that period. By definition, these two measures must be equal: the quantity equation is an identity not a behavioral relationship.

Expression(1) can be transformed to show the relationship between the growth rates of the individual components. By taking logs of both sides of equation (1) and differentiating with respect to time, the following relationship holds:

$$(2) \quad m + v = p + q$$

or equivalently,

$$(2') \quad m = p + q - v$$

where m is the growth rate of the stock of money,

v is the growth rate of the velocity of money,

p is the growth rate of the aggregate price level,

and q is the growth rate of real output.

This does not yet imply a link between growth in the money supply and growth in prices. It states only that an increase in the money supply must be met with an increase in prices, an increase in output, or a decrease in the use of money -- velocity. Clearly, more is needed than this simple expression to posit a link between money and prices: some proposition about the effect of money supply on velocity and output is needed. This proposition is that growth of velocity and growth of real output are, in the long run, unaffected by growth of the money supply. Justification for this proposition can be found in Friedman [7, p. 132] and Michael Darby [4, p. 104]. They

assert that growth in velocity and output depends on such things as growth in population, improving technology, real rates of return, etc. rather than the number of dollar bills in circulation.

This holds only in the long run, however. During the adjustment to changing rates of money growth, the growth in velocity or output can change. The growth will eventually return to the rate determined by the real factors mentioned earlier. If this assertion is true, eventually the rate of growth of prices will match the rate of growth of the money supply. It is important to emphasize that this need not be the case if growth in velocity or output occurs for some time. Only when the growth rates for velocity and output return to their long run values is the rate of inflation expected to match the rate of growth of the money supply.

Furthermore, [nothing in the preceeding analysis suggests that only the rate of growth of the money supply affects prices. Other factors (for example reduced output during a period of severe weather, higher rates of capacity utilization than economically optimal, and cartel agreements among producers) can temporarily change the growth in prices or even result in a permanently higher level of prices.] Although these factors are not expected to have a continuing effect on the rate of inflation (see

Darby [4, p. 126] and Karnowsky [10, p. 18] for example), they can result in short run deviations of inflation from the rate predicted by monetary growth alone. These factors can be quite important in predicting short run changes in the price level, as will be shown in the final section.

Having outlined a theoretical link between money and prices, I will turn now to a discussion of whether the hypothesis tested by Feige and Pearce is an expected outcome in this framework. A few numbers may help in this discussion: let us assume that the money supply is growing at 6% a year, velocity is constant, real output is growing at 2% a year, and prices are growing at 4% a year. These growth rates are consistent with the quantity equation in the growth rate form. Now suppose that at the end of a quarter, published figures show that the money supply is 2% higher than at the end of the previous quarter. Is the information that money growth was higher than expected enough to predict that the growth in prices will be higher from some quarter to the next? The answer is no -- prices need never deviate from their previous growth path if, for instance, money growth were lower in the following quarter and individuals merely adjusted temporarily their holdings of money. Even if the growth in money stayed at the higher rate, it would be difficult to predict when the

effect on prices would begin. Only after the growth rates of output and velocity returned to their long-run values of 2% and 0% would the quantity equation require that prices grow faster than before. The delay between a change in the rate of money growth and a change in the rate of inflation will depend on whether output or velocity changes and, if so, for how long.

The quantity equation simply does not require a link between random variations in the growth rate of money and random variations in inflation; yet, this is the relationship that Feige and Pearce are looking for. As a simple test of how random variations in money growth affect other variables, I have separated money growth rate into two components: that which can be predicted from the past history and that which cannot. To do this, I used a method that is similar to that used by Feige and Pearce. Then, I regressed the growth rates of output, velocity, and prices on these two components of money growth (lagged one quarter) and the dependent variable lagged one and two quarters. Before I give a more detailed description of the test and the estimated equations, let me summarize the findings. I found that the unexpected part of money growth has a positive effect on the growth in output, a negative effect on the growth in velocity, and virtually no effect on the rate of inflation. Furthermore, I found that the

expected part of money growth affects prices and not output or velocity. (Again, see Barro [1] for further evidence on this relationship.)

To separate money growth rate into the predicted and unpredicted components, I ran the following regression on quarterly data from 1948 III to 1975 III:

$$m = .004 + 1.33m(-1) - 0.44m(-2) + e_m + 0.29e_m(-1)$$

$$(3.122) (16.18) \quad (-5.38)$$

$$R^2 = .88$$

where m is the change in the log of $M1$ from one year earlier, and

e_m is a random error.

This equation represents a simple model where the prediction of the growth rate of money is formed on the basis of the previous two values and the error in the prediction in the last period.* The fitted values of this equation were taken as the predictable part of money growth and the residual was taken to be the unpredictable part. These components will be labeled m_e and m_u .

To see if these components were able to improve the predictions of the growth in the other variables, I ran the following equations from 1950 III to 1975 III:

*Though the Box-Jenkins method Feige and Pearce used should give better predictions, I have used the simpler regression method. This is because the Box-Jenkins method has no clear-cut rules for selecting the best model. For this reason, results are obtained by trial-and-error: to avoid this arbitrariness, I used ordinary regression.

$$q = 0.0098 + 0.612m_u(-1) - 0.049m_e(-1) + 1.54q(-1) - 0.72q(-2) \\ (3.91) \quad (2.64) \quad (-1.01) \quad (23.83) \quad (-10.48)$$

$$+ e_q - 0.39e_q(-1)$$

$$R^2 = .93$$

$$v = -0.007 - 0.34m_u(-1) + 0.03m_e(-1) + 1.57v(-1) - 0.78v(-2) \\ (-4.21) \quad (-1.57) \quad (0.77) \quad (27.61) \quad (-13.67)$$

$$+ e_v - 0.56e_v(-1)$$

$$R^2 = .93$$

$$p = -0.002 + 0.24m_u(-1) + 0.13m_e(-1) + 1.65p(-1) - 0.77p(-2) \\ (-0.74) \quad (1.04) \quad (2.36) \quad (25.63) \quad (-11.93)$$

$$+ e_p - 0.37e_p(-1)$$

$$R^2 = .96$$

where q is measured as the change in the log of GNP(1958 \$) from the same quarter one year earlier,

v is measured as the change in the log of velocity from the same quarter one year earlier,

p is the change in the log of the wholesale price index from the same quarter one year earlier,

and, e_q , e_v , and e_p are random errors.

These equations are not meant to be complete specifications of the determinants of the dependent variables; nor should my breakdown of money growth yield the best measures of expected and unexpected changes since it ignores other information that could help predict money growth.

(See Barro [1] or Tranner and Trapani [13] for examples of better predictors of money growth.) The results shown in

the three equations above certainly suggest that the unexpected changes in money growth have a more consistent effect on output and velocity than on prices. It would also suggest that the relationship between money and prices cannot be fully investigated without taking other factors into account. I will present an equation for predicting prices that takes other influences into account.

THE RELATIONSHIP REVISITED

The relationship given below is not intended to be a complete model of the determinants of the price level: it contains no current values of the independent variables. Rather, it is intended as a way of predicting short run (from one quarter to the next) changes in the wholesale price index using only information that is available at the time the prediction is made. The purpose is to test whether the prediction formed using all the available information is better than the prediction formed using only the past history of prices.

This, too, was the purpose of Feige and Pearce's paper. My approach, however, differs from theirs in two important ways: 1) It lets more than a single variable influence the prediction of price changes, and 2) It forms a prediction of price based on all the variables

at the same time rather than by first forming a prediction based on past prices and then examining whether the extra variables explain much of the remaining error.

Description of the Model

The dependent variable -- the variable to be predicted -- is the growth rate of the wholesale price index. This is measured as the change in the log of the wholesale price index from one quarter to the next. Lagged values of the dependent variable were also included in the regression equation. This was meant to pick up any systematic adjustment that is not accounted for by the other independent variables.

Also held constant in the equation were the growth rate of real output, q , (measured as the change in the log of GNP (1958 dollars) from the previous quarter); the rate of capacity utilization in manufacturing, u , (in logs); and, the growth rate of unit labor costs, c , (measured as the change in the log of unit labor costs from the previous quarter). Each variable was included at lags of 1, 2, 3, 4 and 5 quarters in order to capture any adjustment over time to changes in these variables.

Finally, I included the growth rate of the money supply. I had intended to include a series of lagged values of the growth rate. This was not feasible, however, because of extreme multi-collinearity. To avoid this

problem, I measured money growth rate, $\bar{m}$, as the average of the growth rates in the past two years. Besides not having the problem of multi-collinearity, this measure is perhaps more consistent with the earlier evidence that expected money growth affects prices and unexpected growth affects output. The average of the rates is taken to be an approximation of the expected part of money growth.*

The equation was estimated from 1953 II to 1975 III and the following results were obtained:

$$\begin{aligned}
 p = & 0.009 - 0.094q(-1) - 0.557q(-2) - 0.512q(-3) + 0.188q(-4) \\
 & (1.02) \quad (-0.37) \quad (-2.17) \quad (-1.92) \quad (0.71) \\
 & + 0.15q(-5) + 0.198c(-1) - 0.441c(-2) - 0.504c(-3) \\
 & (1.14) \quad (1.07) \quad (-2.57) \quad (-2.84) \\
 & - 0.072c(-4) + 0.219c(-5) + 0.188u(-1) - 0.062u(-2) \\
 & (-0.40) \quad (1.27) \quad (2.03) \quad (-0.52) \\
 & + 0.103u(-3) - 0.231u(-4) + 0.024u(-5) + 0.006p(-1) \\
 & (0.84) \quad (-1.83) \quad (0.25) \quad (0.05) \\
 & + 0.25p(-2) + 0.047p(-3) + 0.309p(-4) + 0.210p(-5) \\
 & (2.27) \quad (0.37) \quad (2.68) \quad (1.53) \\
 & + 0.900\bar{m}(-1) \\
 & (2.35)
 \end{aligned}$$

$$\bar{R}^2 = .579$$

where all variables are measured as stated in the text, and t-statistics are given in parenthesis.

*As an alternative, I divided money growth into two parts: the average growth from one year earlier and the average growth from two years earlier to one year earlier. The results of this equation, shown in the Appendix, were similar except that only the money growth from two year earlier to one year earlier had an effect on prices.

There are several tests of whether including money growth and the other variables improves the prediction of price changes. First is the significance of the coefficient on the money growth rate; second is a test on the change in the unexplained error when the additional variables are included in the equation; and last is a test for remaining serial correlation in the residuals of the estimated equation. This test checks for residual autocorrelation at lags up to 20 quarters. Each of these tests will be discussed in detail below.

The simplest test of significance is the test that a single coefficient is different from zero. This is accomplished by comparing the t-ratio -- the ratio of the estimated coefficient to its estimated standard error -- to the critical value of the t-statistic. The calculated "t" for the money growth coefficient in the regression equation is 2.35. This exceeds the critical value at the 95% confidence level so the null hypothesis that the coefficient is zero can be rejected.

The hypothesis that all the additional coefficients (other than lagged price) are different from zero can be tested by observing the change in the unexplained errors when the additional variables are added to the regression equation.

To make this test, one can compute the statistic:

$$F(h/n-k-1) = \frac{(SSR_c - SSR_u)/h}{SSR_u/n-k-1}$$

where SSR_c is the sum of the squared residuals in the equation with the additional coefficients constrained to be zero,

SSR_u is the sum of the squared residuals in the full equation,

h is the number of constrained coefficients, and

$n-k-1$ is the number of degrees of freedom in the full regression.

This computed value can be compared with the critical value of the F statistic with $h/n-k-1$ degrees of freedom. The calculated value of this statistic is 2.618. This exceeds the critical value of the F statistic with 17/68 degrees of freedom at the 99% confidence level. Again, the hypothesis that all the additional coefficients are zero can be rejected.

The final test checks the residuals from the regression for remaining autocorrelation. This is necessary because, as Pierce [11, p. 14] says, the results "may be misleading if they ignore autocorrelation in the relevant series". In a comment on Pierce's paper, Christopher Sims [12, p. 23] points out, "for regression, the relevant series is the regression residuals".

To check for remaining serial correlation in the residuals, one can compute the statistic (see Feige and Pearce [5, p. 504]):

$$Q = (N-d) \sum_{k=1}^T r_k^2(e_t)$$

where N is the number of observations,

d is the number of differences required for stationarity -- zero in this case,

$r_k^2(e_t)$ is the squared cross-correlation coefficient at lag k, and

T is the number of lags -- 20 in this case.

The value of this statistic can be compared to the Chi-squared distribution with 20 degrees of freedom. The critical value of the Chi-squared distribution with 20 degrees of freedom is 31.41. The computed value of Q was 4.9. Since the computed value is less than the critical value, we can reject the hypothesis that the remaining error is not random.

Other Results

In addition to this equation, I ran two other experiments. One was to divide money growth into two parts: this was mentioned earlier. The other test was to run the equation above over the same period Feige and Pearce used in their work. After accounting for lags, the estimation period was 1954 IV to 1971 II. This equation, as well as the other experiment, is shown in the Appendix.

The major result of this experiment was that over the shorter period the coefficient on money growth was not statistically significant. As shown earlier, however, this shorter period was a time of fairly stable prices: not the persistent growth in prices that is likely to result from money growth. Thus, one might conclude that Feige and Pearce have chosen a period that is not appropriate for testing the relationship between money and prices. This is a limitation of the method they used, however: the periods of rapid inflation likely to result from excess money growth cannot be handled by the Box-Jenkins methods because these periods are not stationary. The results from the earlier regression (when the extra years were included) clearly indicate that when the observations with rapid growth in prices are considered, money growth does affect the growth of prices.

CONCLUSIONS

In this paper, I have shown that the findings of no relationship between money and prices given in a paper by Feige and Pearce had three weaknesses. These are:

- 1) The method they used cannot detect certain relationships between variables,
- 2) They have not held constant other factors that can affect prices, and

- 3) The relationship they tested does not correspond to an economic theory that suggests that money affects prices.

Furthermore, I have shown that when the theoretical relationship between money and prices is correctly specified, a significant effect can be found. Specifically, I found that when the effect of output, capacity, utilization and unit labor cost were taken into account, the growth rate of money has a significant positive effect on the growth rate of prices.

APPENDIX

ADDITIONAL REGRESSION EQUATIONS

Range 1953 II to 1975 III

$$\begin{aligned}
 p = & 0.008 - 0.040q(-1) - 0.518q(-2) - 0.525q(-3) + 0.159q(-4) \\
 & (0.98) (-0.16) \quad (-2.03) \quad (-1.99) \quad (0.60) \\
 & + 0.085q(-5) + 0.230c(-1) - 0.442c(-2) \\
 & (0.62) \quad (1.28) \quad (-2.60) \\
 & - 0.570c(-3) - 0.153c(-4) + 0.158c(-5) \\
 & (-3.14) \quad (-0.81) \quad (0.89) \\
 & + 0.179u(-1) - 0.066u(-2) + 0.113u(-3) \\
 & (1.99) \quad (-0.56) \quad (0.92) \\
 & - 0.231u(-4) + 0.025u(-5) + 0.002p(-1) \\
 & (-1.85) \quad (0.27) \quad (0.02) \\
 & + 0.262p(-2) + 0.064p(-3) + 0.325p(-4) \\
 & (2.39) \quad (0.54) \quad (2.83) \\
 & + 0.206p(-5) + 0.131\bar{m}(-1) + 0.904\bar{m}(-5) \\
 & (1.52) \quad (0.46) \quad (2.54)
 \end{aligned}$$

$$\bar{R}^2 = .587$$

where p is the percentage change in the wholesale price index,

q is the percentage change in the GNP (1958\$),

c is the percentage change in the unit labor cost,

u is the log of the utilization rate in manufacturing, and

$\bar{m}$ is the average percentage change in money supply over the preceeding year.

Range 1954 IV to 1971 II:

$$\begin{aligned}
 p = & 0.009 - 0.370q(-1) + 0.037q(-2) + 0.109q(-3) \\
 & (1.97) \quad (-2.84) \quad (0.25) \quad (0.74) \\
 & -0.325q(-4) - 0.075q(-5) + 0.150u(-1) \\
 & (-2.19) \quad (-1.04) \quad (2.75) \\
 & -0.170u(-2) + 0.025u(-3) + 0.120u(-4) \\
 & (-2.19) \quad (0.30) \quad (1.48) \\
 & -0.102u(-5) + 0.095p(-1) + 0.206p(-2) \\
 & (-1.79) \quad (0.69) \quad (1.51) \\
 & -0.120p(-3) + 0.077p(-4) - 0.123p(-5) \\
 & (-0.87) \quad (0.60) \quad (-0.96) \\
 & +0.351 \bar{m}(-1) \\
 & (1.596)
 \end{aligned}$$

$$\bar{R}^2 = .327$$

where p, q, and u are as above and

$\bar{m}$ is the average growth in the money supply over the past two years.

(Note: Unit labor costs were removed from this equation because of high multi-collinearity.)

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THE RELATIONSHIP BETWEEN MONEY AND PRICES REVISITED

By

David E. Chase

(ABSTRACT)

This paper points out three weaknesses in the finding of no relationship between money and prices given in a recent paper by Edgar Feige and Douglas Pearce [Journal of Political Economy, 84 No. 3 (June 1976), 499-522.]

The weaknesses are:

- 1) The method they used cannot detect certain relationships between variables,
- 2) They have not held constant other factors that could affect prices, and
- 3) The relationship they tested does not correspond to an economic theory suggesting that money affects prices.

The theoretical link between money and prices is discussed and a relationship consistent with the theory is tested. It is found that when the effects of output, capacity utilization, and unit labor costs are taken into account, the growth rate of money has a significant positive impact on the growth rate of the wholesale price index.