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The role of commodity prices, market prices and business expectations in predicting changes in the CPI: An application of Neftci's methodology to inflation

Kearney, Timothy Francis, Ph.D.

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U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

THE ROLE OF COMMODITY PRICES, MARKET PRICES AND BUSINESS EXPECTATIONS IN PREDICTING CHANGES IN THE CPI: AN APPLICATION OF NEFTCI'S METHODOLOGY TO INFLATION.

by

TIMOTHY F. KEARNEY

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Date

Chair of Examining Committee

9/22/92
Date

Michael Grossman
Executive Officer

Salih N. Neftci

Michael Grossman

Theodore J. Joyce

Supervisory Committee

THE CITY UNIVERSITY OF NEW YORK

ABSTRACT

THE ROLE OF COMMODITY PRICES, MARKET PRICES AND BUSINESS EXPECTATIONS IN PREDICTING CHANGES IN THE CPI; AN APPLICATION ON NEFTCI'S METHODOLOGY TO INFLATION

by

Timothy F. Kearney

Adviser: Salih N. Neftci

In response to the poor forecasting record of standard inflation models in the 1980s, Federal Reserve Governors Wayne Angell and Manuel Johnson advocated the use of a market-based commodity price rule (CPR) when assessing price trends. The CPR proposal suggests that expectations are informationally efficient, and so anticipate inflation developments. This study, in contrast to most empirical work to date, tests the use of expectations variables such as changes in commodity prices, the shape of the yield curve and business expectations in predicting inflation based on their information content alone. Having demonstrated the use of such variables in predicting changes in the CPI, the study then compares the forecasting ability of the expectations variables with a leading inflation index that also includes structural variables. In six of the nine periods tested, the root mean square error and Theil's U from a

dynamic forecasting model are lower when using the expectation variables only. Next, Neftci's methodology for forecasting turning points in the real economy is applied to inflation. The Neftci methodology is grounded in the assumption that a change in regime (in this case a move from inflation to disinflation or the reverse) is signalled by sharp, simultaneous downturns in a number of economic variables. An index is constructed with the expectations variables being used as a leading indicator of inflation. When the index reaches 90, then a change in regime is deemed "imminent". The application of Neftci's methodology shows considerable promise. Of the eight inflation episodes examined here, five were signalled by the Neftci index.

Acknowledgements

This work has developed from my growing belief that the actions of men and women can tell economists a great deal about the working of the economy. As John F. Muth said long ago, economic models do not assume enough rationality. This study is an attempt to rectify that shortcoming to some small degree. In many ways, I must thank millions of traders and businesspeople for allowing me to indirectly learn about their beliefs and expectations from their behavior.

I would like to thank Professor Salih Neftci for his help and support not only during the writing of this dissertation, but also throughout my years as a student at the Graduate Center. He has been a mentor and an important influence upon my development as an economist. In addition, I would also like to thank Professor Michael Grossman for his support during my studies.

Most importantly, I would like to thank my family for the sacrifices they have made over the years of my studies. Without the kind understanding of my wife, Dorothy Kearney, I could not have found the time or energy to finish my Doctorate. This work is lovingly dedicated to her and to our sons, Thomas Sean and Daniel Patrick.

Finally, I would like to thank George Ziskind who prepared this manuscript for publication. He was able to make the production process bearable, and I thank him for that.

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I. INTRODUCTION

As Anderson (1989, p.1) has pointed out, "Fatal flaws in all the standard inflation models became apparent in the 1980s." The use of monetary variables in predicting inflation became very difficult due to sharp swings in velocity, leading to hard times for the monetarist model in the 1980s. This came about as financial deregulation led to disintermediation and the need for new monetary definitions. The attendant inability to model monetary demand led to extremely poor inflation forecasting performances, especially on the part of M1, M1-A, and M3. While somewhat better, the forecasting record of M2 and the monetary base likewise suffered in the 1980's.

The Phillips curve model has had an extremely poor forecasting performance for an even longer time. The model was at a loss to explain stagflation in the 1970's, and consistently overpredicted inflation in the 1980's. Nonetheless, despite the model's poor performance over the past 20 years, there are a number of important forecasters and policy-makers who are believed to be Phillips curve enthusiasts.

This breakdown of the forecasting ability of standard models creates problems for analysts and policymakers, who are basing their decisions on their expectations of future inflation. This breakdown prompted Federal Reserve Board Governor Wayne Angell (1987) to issue a call for policy makers to look at commodity prices when assessing price trends. Angell maintained that a numerical average of nine commodity price indices (including the IMF, Journal of Commerce, and CRB cash and futures indices) was able to predict turning points in the inflation rate. Angell's colleague on the Fed Board, Governor Manuel Johnson, expanded the list of variables to be considered in 1988 to the shape of the yield curve, levels of and rates of change in spot and futures commodity prices, and the exchange rate. These proposals have become the core of the commodity-price rule (CPR) approach to monetary policy. Alternatively, they are known as the Angell/Johnson proposal.

The idea behind the proposal is simple, and it relies on the assumption that securities markets are informationally efficient. Traders, speculators, hedgers, and investors are all investing their funds based on the information available to them in the world's currency, financial and commodity markets. These decisions are based on the governmental policies in place, as well as other potential sources of benefit or pitfall. The commodity price rule emphasizes the auction markets because they are the most efficient and visible markets. This is not to say that these are the only markets that embody these expectations about trends and future policy developments. All markets utilize information and are forward looking. If companies think prices are going higher, they invest in inputs and inventory. People buy property when prices are rising. But given that the securities markets are so efficient, liquid and visible, they offer excellent indicators for use in the task of assessing monetary trends.

The commodity price rule holds that when Fed policy is disinflationary there should be a flat or inverted yield curve, falling gold/commodity prices, and a rising exchange rate. In short, an improvement in the value of money versus hard assets would be observed. When policy is inflationary, then financial assets should lose value and hard commodity prices should rise. In short, Angel and Johnson merely propose that the Fed utilize the information available in various auction markets in order to understand the implication its monetary policy.

II. THE COMMODITY PRICE RULE: WHAT IS IT?

Most empirical research done to date on the commodity price rule approach to monetary policy has used commodity prices to improve the forecasting ability of some sort of structural inflation model, under the assumption that commodity price changes ultimately move down the price chain and lead to changes in finished goods indexes. As such, they look at commodity price inflation as being a lower level of inflation.

While this is clearly part of the reason that a commodity price rule would work, it is only part of the reason that this approach has merit. The Angell/Johnson proposal is much more of an information-based approach than solely a price-chain approach to inflation. The starting point here is straight from Muth (1961, p. 316): "...expectations, since they are informed predictions of future events, are essentially the predictions of the relevant economic theory." More formally, "...expectations of firms...tend to be distributed for the same information set, about the prediction of the theory (or the "objective" probability distributions of outcomes)."

Seen in this light, the commodity price rule is not a structural model of inflation. It assumes that markets are efficient, that agents have rational expectations, and that these agents in the financial and commodity markets are investing funds in various assets on expected states of the world. As such, these markets are forward looking. With these agents formulating their expectations of the future based on the relevant economic theory, prices in these markets should be seen as the outcome of investors judging the likelihood of certain states of nature attaining.

The expectations based in prices in these markets are more encompassing than any one theory of inflation. While there is still controversy over the relative merits of a monetarist model of inflation versus a Phillips Curve model of inflation, the Angell/Johnson proposal says that the agents in the financial markets know and base their investment decisions on the relevant model as well as any contingencies which these structural economic models cannot strictly include. In and of itself, then, the commodity price rule does not explain the inflation mechanism. Rather, it is an information-using forecaster which encompasses the information contained in structural models, and then some.

While no one has yet to test a pure version of the CPR, most empirical studies to date tend to show that measures of lagged commodity prices help in explaining future inflation. The following study tests the value of including changes in the shape of the yield curve, the rate of change of commodity prices and the level and rate of change of gold, the yield curve, as well as businesspeople's expectations of price changes.

III. THE BOUGHTON, BRANSON AND MUTTARDY STUDY

Boughton, Branson and Muttardy (1990) and Boughton and Branson (1991) have developed an interesting methodology to test if commodity prices are in fact leading indicators of inflation. They test for the entire G-7 and for composite currency-based commodity prices; here, I will limit my description of the model and reporting of their results for dollar-denominated commodity prices in the US only.

a) Integration Tests

Boughton, Branson and Muttardy (BBM) tested for the integration level of the variables under test. They determine that the evidence generally points to consumer price inflation being an I(2) process while commodity prices are an I(1) process. This implies that the variables cannot be cointegrated. As Boughton and Branson (1991, p. 321) pointed out, under these circumstances "it is possible to turn to tests of shorter-run relationships, ignoring the long-run constraints that might otherwise have been imposed by the data."

b) Granger Causality Tests

BBM next look at Granger causality tests of commodity prices and inflation. They test the hypothesis that the first difference of the 12-month inflation rate of the variables is the appropriate filter to use for testing the data. That is, using seasonally adjusted data, they tested:

$$(1)\ dX(t) = a + d[X(t-1)] + d[Z(t)] + u(t)$$

where the variable X is CPI inflation (commodity prices), Z is commodity prices (CPI inflation), u(t) is the random, normal error and d is the first-difference operator. Since they feel that their data could suggest that CPI is of a higher order of stationarity than commodity prices, they feel that there is the possibility that the commodity data may have been over differenced. Thus, they also test to see if the 12-month change in commodity prices Granger-causes the first difference of CPI inflation. Finally, they test three time periods; 1966-87; 1972-87; 1974-87.

Their results are generally the same for both specifications of the filter and for the first each period: Commodity prices precede movements in consumer prices at least the 5% confidence level.

c) In-Sample Tests

BBM then regressed the first difference of the 12-month CPI inflation rate on a 12-month, fourth order polynomial distributed lag of the dependent variable, as well as fourth order polynomial lags of commodity prices and M2 money growth:

(2) $CPI(t) = \sum_{i=1}^{12} a(i)\ CPI(t-i) + \sum_{i=1}^{12} b(i)\ COMMODITY(t-i) + \sum_{i=1}^{12} c(i)\ M2(t-1) + u(t)$

where:

CPI(t) = first difference CPI inflation in period (t)

CPI(t-i) = lagged CPI variable

COMMODITY(t-i) = the lagged values of the first difference of commodity price inflation

M2(t-i) the lagged values of the first difference of M2 growth, and

u(t) = a normal, randomly distributed error term.

BBM determine from their work that M2 is not helpful in explaining the CPI variable, although commodity prices are significant and do. The test statistic is the F-statistic on the marginal contribution of each explanatory variable. In the case of the commodity price variable, with the exception of the 1974-87 period, the variable is significant at least at the 5% level. M2 is not significant for any period.

d) Post-Sample Predictive Ability

As the authors point out, a much stricter test of the usefulness of commodity prices as a leading inflation indicator is whether the equations improve the forecast ex ante. BBM break up their sample period so as to be able to test six consecutive two-year periods; i.e. the 1968-75 period is used to generate the estimating equation, which is then used to generate a dynamic forecast for the 1976-77 period. They next extend the sample period to cover up to 1958-1977 for generating the estimating equation, which is used to produce a dynamic forecast for 1978-79. The last test period is 1958-1985 for the estimating equation and 1986-87 for the forecast. BBM estimated equations of the type #2 above, that is, the first differences of the 12-month growth rate of M2 and commodity prices is regressed on the first difference of the 12-month growth rate of the CPI.

$$(3)\quad CPI(t) = \sum_{i=1}^{12} a(i)\, CPI(t-i) + \sum_{i=1}^{12} b(i)\, COMMODITY(t-i) + \sum_{i=1}^{12} c(i)\, M2(t-1) + u(t)$$

where:

CPI(t) = first difference CPI inflation in period (t)

CPI(t-i) = lagged CPI variable

COMMODITY (t-i) = the lagged values of the first difference of commodity price inflation

M2(t-i) = the lagged values of the first difference of M2 growth and

u(t) = a normal, randomly distributed error term.

The mean absolute prediction errors and root mean square error (RMSE) for this equation are compared with an autoregressive version of the data, which are derived from equations generated by using only a 12-month 4th order polynomial distributed lag on the first difference of the 12-month change of the CPI (lagged one period), or:

(4) $CPI(t) = \sum_{i=1}^{12} a(i)\ CPI(t-i) + u(t)$

where:

CPI(t) = first difference CPI inflation in period (t)

CPI(t-i) = first difference CPI inflation in period (t-i)

u(t) = a random, normally distributed error term.

BBM find that the commodity price variable reduces the RMSE in four of the six periods when compared with the autoregressive version. M2 only reduces RMSE in only two of the six periods. When M2 and the commodity price variables are both used in the right-hand side of the equation, they together reduce the RMSE in three of the six periods. Clearly, the M2 variable is not especially useful in predicting inflation.

IV EXTENSIONS AND FIRST RESULTS

a) Introduction

The BBM paper clearly demonstrates that commodity prices do help in improving the forecasting of inflation, and are able to outperform forecasts using monetary variables. In this section of this paper, I extend their test of inflation-expectations measures to include other financial variables. In addition, I use survey-based measures of the inflation expectations of business people as suggested by Moore (1986). In addition, while BBM use contemporaneous values of the commodity price index and money growth, the inclusion of the expectations data requiring lagging all variables by one period. This is because the business expectations data are published with one month's lag. Finally, I test the usefulness of the commodity price rule variables as leading indicators by comparing their performance in predicting inflation with the leading inflation index developed by the Center for International Business Cycle Research (CIBCR) at Columbia University.

As with BBM, I use the CPI as the dependent variable (See Chart 1). However, I expanded the list of explanatory variables and tested the usefulness of the financial market measures which Johnson suggested, such as the price of gold, the shape of the yield curve from fed funds to the 10 year bond, as well as the Journal of Commerce commodity price index (JoC). This latter index was developed by Professor Geoffrey Moore, the director of the CIBCR, for the Journal of Commerce as an explicit indicator of future inflation trends, and is included in the CIBCR leading inflation index.

As opposed to Johnson, I did not use the exchange rate as a leading inflation variable since the exchange rate can give false signals on the direction of inflation. A depreciating currency is not necessarily evidence of increasing inflation. It could be merely recording faster disinflation (or deflation) abroad than at home. That is, the value of money may be improving quickly in the US compared to commodities and gold, but it may be improving even more quickly in Germany which would lead to a sharp slide in the exchange value of the dollar. Under such a circumstance, a false signals may arise from the foreign exchange markets on inflation.

Besides these securities markets variables, Moore (1986) has suggested that business people also have a good sense of the direction of inflation. In his study, Moore suggested using measures of businesspeople's price expectations to help forecast inflation, specifically the Dunn & Bradstreet (D&B) diffusion index of rising prices. This index is included in the CIBCR leading inflation index. For the purposes of this study, I included the D&B diffusion index, which includes business managers who expect prices to be higher in the coming quarter, as well as one half who expect no change. Charts 2 through 8 show the relationship between the variables included in this study and inflation turning points.

b) Integration Tests

At this point, monthly data from January 1970 to September 1991 were used. This is because the IMF data series first notes a movement of gold prices away from the Bretton Woods $35/oz parity in March 1968; thus, to get a lag structure of 18 months or longer necessitated using 1970 as the base.

I tested for the order of integration of each variable by testing for unit roots on successive differences of the variables, starting with the logged-level of the data. The test statistic used was the Dicky-Fuller test, using 18 lags of the data. The results supported BBM's finding that while the inancial variable data were integrated of the first order, the CPI data was integrated of order 2. Following BBM, the integration tests used 18 lags and took the following form:

(5) $x(t) = a\, x(t-1) + \sum_{i=1}^{18} (x(t-1) - x(t-j)) + e(t);\ i{=}/{=}j$

where:

x(t) = the variable being tested in period t

a = the constant term

x(t-1) = the variable in period t-1

x(t-i) - x(t-j) = the one period change in the variables going from period t-1 to period t-18, and

e(t) = a normally distributed error term.

TABLE 1

INTEGRATION TESTS: Unit Root (Constant, 18 lags)

Variable	**Dickey-Fuller t-Statistic**
First Difference, CPI Log Level	-2.127
Second Difference, CPI Log Level	-4.112#

= significant at 1% level or higher.

This implies that CPI is integrated of order 2, or I(2).

Variable	**Dickey-Fuller t-Statistic**
Gold Price, Log Level	-1.455
First Difference, Gold Price, Log Level	-4.074 #

= significant at 1% level or higher.

This implies that the gold price is integrated of order 1, or I(1).

Variable	**Dickey-Fuller t-Statistic**
JoC Commodity Price Index, Log Level	-2.226
First Difference, JoC Index, Log Level	-4.761 #

= significant at 1% level or higher.

This implies that the JoC index price is integrated of order 1, or I(1).

Variable	Dickey-Fuller t-Statistic
D&B Diffusion Index	-1.931
First Difference, D&B Index	-4.237 #

= significant at 1% level or higher.

This implies that the D&B index price is integrated of order 1, or I(1).

Variable	Dickey-Fuller t-Statistic
Yield curve	-4.0753 #

= significant at 1% level or higher.

This implies that the yield curve is integrated of order 0, or I(0).

As also shown in Durand and Blondal (1988), as well as BBM, the integration tests show that CPI integrated of order I(2), hile the expectations variables are of order I(1) or I(0). This means that the change in the yield curve variable is stationary and the first difference in the other expectations variables are stationary after taking one difference. Consumer prices, however, are only stationary after taking second differences. Since the CPI series is of a different order of integration from the expectations variables, the data sets cannot be cointegrated as a result. This implies that there is no equilibrium relationship between the levels of the various data sets. As a result, "it is possible to turn to tests of shorter-run relationships, ignoring the long-run constraints that might otherwise have been imposed by the data"

(BB, p. 321). Thus, I will limit myself in this study to the short-run dynamics of the expectations variables/inflation relationship.

c) Granger Causality Tests

The real crux of the matter at this point is the short-term dynamics among the variables. Do these variables Granger-cause the inflation measure? As in section b), Part III, Granger-causality tests were undertaken for each of the variables in the data set of the following form:

(6) dX(t) = a + d(ln X(t-1) + d(ln Z(t))

I used a lag structure of 24-months for each variable. I first tested the first difference in the 12-month change in the CPI against the 12-month change in gold prices, the trade-weighted dollar, and the JoC index. The D&B variable is already in a rate-of-change form, that is, it surveys how business managers expect prices to change in the coming quarter. As such, the index was only differenced once. As for the yield curve variable, I used the 1-month change in the shape of the yield curve.

The following set of data was tested, then: 1) the first difference in the 12-month change the CPI (CPI variable) and the first difference in the 12-month change of the Journal of Commerce index; 2) The CPI variable and the 1-month change of the yield curve (Fed Funds less 10 year bonds); 3) the CPI variable and the first difference in the Dun & Bradstreet diffusion index. In each case, I could not reject the null of the leading indicators Granger causing the CPI variable, but that the converse was not the case.

Over the 1970-91 period, the hypothesis that inflation is Granger caused by the expectations variables cannot be rejected except for one exception -- gold. Whether the tests are done with lags of 6, 12, 18 or 24 months, they provide at best ambiguous results. This was a surprising result, since many analysts including Johnson and Angell believe that gold prices are a reliable measure of inflation expectations.

TABLE 2.

Granger Causality Tests

1970-91; 24-Lags

Null Hypothesis	**F-statistic**	**Probability**
CPI not Granger caused by gold	1.442	.0907
Gold not Granger caused by CPI	1.727	.0227*
CPI not Granger caused by the yield curve	2.0483	.0039#
The yield curve not Granger caused by CPI	.62390	.9145
CPI not Granger caused by D&B	1.6624	.00314*
D&B is not Granger caused by CPI	1.3343	.1442
CPI not Granger caused by JoC Commodity prices	2.3557	.00314 *
JoC not Granger caused by CPI	.7822	.7571

= Significant at 1% or higher

* = Significant at 5% or higher.

Presented in this way, the F-statistic implies that there is a 9.07% chance that the one-month change of the CPI rate is not Granger-caused by the one-month change in the gold price inflation rate; likewise, there is a 2.27% chance of the reverse. Thus, the evidence is at best ambiguous as to which causes the other, and may point towards CPI inflation presaging movements in gold prices. However, the hypothesis that movements in the other expectations variables cause movements in inflation cannot be rejected at least the 5% level in the other cases. In no case is that true of movements in inflation preceding movements in the expectations variables. BBM also suggested that Granger-causality tests should be run for the period after the large run-up in commodity prices in the wake of the breakdown of the Bretton Woods agreement. This could be especially relevant for gold, in that some time may have been necessary for an equilibrium price to be found after gold prices were freed. This was not the case. Once again, the results pointed to accepting the hypothesis that movements in the expectations variables (except gold) Granger cause inflation at least the 5% level in the case of the JoC and the yield curve variables. The results for the Dun & Bradstreet variable in this case was ambiguous. Again, in no instance can we accept the hypothesis that movements in the inflation rate did not cause the expectations variables at the 5% level.

TABLE 3.

Granger Causality Tests

1974-91; 24-Lags

Null Hypothesis	F-statistic	Probability
CPI not Granger caused by gold	1.2419	.2201
Gold not Granger caused by CPI	.1552	.0596
CPI not Granger caused by the yield curve	1.7319	.0245*
The yield curve not Granger caused by CPI	.9476	.56816
CPI not Granger caused by D&B	1.4328	.0987
D&B is not Granger caused by CPI	1.3421	.1445
CPI not Granger caused by JoC Commodity prices	2.0736	.0041*
JoC not Granger caused by CPI	.9250	.5682

= Significant at 1% or higher

* = Significant at 5% or higher.

The poor performance of gold in both instances argued in favor of dropping gold prices from the explanatory variable list in order to push the sample period back to the 1950s in order to obtain the longest time-series possible. Commodity prices, the yield curve, CPI inflation, and the D&B variable are all available back from the

1950s. A consistent series for each can be constructed from 1956 forward. Thus, I reran the causality tests with a 24-month lag structure from 1958 forward, which is the first period for which all the lagged data are available. In this case, the data strongly point to the causality of movements in the expectations variables as opposed to the reverse.

TABLE 4.

Granger Causality Tests

1958-91; 24-Lags

Null Hypothesis	F-statistic	Probability
CPI not Granger caused by the yield curve	2.4602	.0002#
The yield curve not Granger caused by CPI	.9039	.5969
CPI not Granger caused by D&B	2.217	.001#
D&B not Granger caused by CPI	1.087	.351
CPI not Granger caused by JoC Commodity prices	2.631	.0001#
JoC not Granger caused by CPI	.946	.5376

= Significant at 1% or higher

* = Significant at 5% or higher.

I also tested to see if the one-month change in the CIBCR leading inflation index Granger-causes inflation. The CIBCR leading index is comprised of (1) growth in the Journal of Commerce price index; (2) growth rate of imported fuels prices; (3) diffusion index of Dunn & Bradstreet expected change in selling prices; (4) D&B expected change in buying prices; and (5) D&B expected vendor performance, (6) percent employed; (7) growth in debt. Since these data are already largely growth rate variables, I will test the one-month change in the CIBCR index against the one-month change in the 12-month change of the CPI.

Broadly speaking, the first five indicators of the CIBCR index can be seen as expectations measures which would fit under the forward-looking, Angell/Johnson proposals. However, the other two economic indicators would likely be known to forward-looking markets and would be discounted into market prices. As such, they should be of little help in explaining inflation. In part d of this section I will compare the leading indicators properties of the CIBCR index versus the purely expectations variables being tested here.

Table 5.

Granger Causality Tests

1958-91; 24-Lags

Null Hypothesis	**F-statistic**	**Probability**
CPI not Granger caused by CIBCR leading index	2.744	.0001#
CIBCR leading index not Granger caused by CPI	1.21	.22

= Significant at 1% or higher

d) In-Sample Tests

Following BBM, I next tested an equation using the three expectations variables described as described above. However, where BBM used a fourth-order polynomial distributed lag for the estimating equation, I used Schiller smoothness priors, or Schiller lags, using 12-lagged explanatory variables. Schiller smoothness priors operates under the assumption that the researcher's prior belief about the shape of a polynomial distributed lag are not very strong. Schiller lags make the restrictions on the equations stochastic.

Experimentation with various values for the "k-factor" used in the Schiller Lag structure showed that the highest R-bar-2, and the lowest root mean square error and lowest value of Theil's U in dynamic forecasts over the entire period obtained when Schiller's rule of thumb value is used as opposed to other values. Schiller's rule of thumb value is the sum of the betas times sixty-four, divided by the number of lags taken to the fourth power. The time period used was 1958-91, giving 408 observations.

Thus, I regressed the CPI variable against the following: 1) the one-month change of the 12-month change in JoC commodity prices lagged one period; 2) the one month change in the D&B diffusion index lagged one period; 3) the 12-month change of the yield curve in basis points lagged one period and 4) the one- period lagged value of the dependent CPI inflation variable. For each explanatory variable, the sum of the lag coefficients of the explanatory variables were significant at the 90% level or higher. The regression results are (with the numerical values equal to the sum of the lag coefficients and their t-values beneath):

(7) CPI(t) = .305 CPI(t-1)+.03358 JoC(t-1)+ .0539 D&B(t-i) +.0019YC(t-i)
3.0133 1.7097 2.111 4.0618

where:

CPI(t) = first difference CPI inflation in period (t)

CPI(t-1) = the one-period lagged CPI variable

JoC(t-1) = the one-period lagged values of the first difference of the 12-month change in commodity prices

D&B(t-1) = the one-period lagged value of the first difference D&B diffusion index of rising prices

YC(t-1) = the one-period lagged value of first difference in the change in the slope of the yield curve from fed funds to the 10-year Treasury note.

For this equation, the R(bar)2 = .377; the standard error of the regression was .001206. The Durbin-h statistic, which is used to test for autocorrealation when lagged values of the dependent variable are included as explanatory variables, was 1.477. As such, we cannot reject the null hypothesis of no serial correlation.

At this point, I compared this equation comprised of the set of leading indicators against an equation using the following explanatory variables 1) the one-period lagged value of the one-month change in the CIBCR leading inflation index; and 2) the one-period lag of the CPI variable. Again, the Schiller prior technique with 12-lagged values was used. In this formulation, the t-statistic on the sum of the lags was significant for both explanatory variables. However, the R(bar)2 was lower and the standard error was higher for this equation as compared to the equation using the previous set of leading indicators.

$$\text{(8) } CPI(t) = \underset{4.505}{.4458\, CPI(t\text{-}1)} + \underset{4.727}{.14466\, CIBCR(t\text{-}1)}$$

where:

CPI(t) = first difference of CPI inflation in period (t)

CPI(t-1) = the one-period lagged CPI variable

CIBCR(t-1) = the one-period lagged values of the one-month change of the CIBCR leading inflation index.

For this equation, the R(bar)2 = .284, as compared with .377 when using the prior set of leading indicators; the standard error of the regression is .001293 versus .001206. The Durbin-h statistic was -.1383.

e) Out-of-Sample Tests

The importance in developing a leading inflation indicator comes more from its ability to predict the future rather than explain the past. Thus, the out-of-sample tests are actually the most important measure of a set of indicators' ability to serve as a leading inflation indicator. In their paper, BBM proposed comparing the root mean square error (RMSE) of the equation which included the leading indicators with the RMSE from an equation which only included a 4th order, 12-lag pdl of the lagged dependent variable.

In what follows, I will compare the RMSE of the equation which includes the expectations variables with the RMSE of the equation which uses the CIBCR leading index, as well as the Theil's U. However, I will differ in the choice of period over which the dynamic forecasts are done from BBM. BBM simply break up their sample period so as to be able to test six consecutive two-year periods, starting in 1978. Here, I will compare the periods post-Bretton Woods during which the CPI reached a turning-point, as defined by Roth (1990): 1975, 1976, 1980, 1983, 1984 and 1986, as well as 1990 and 1991. These are periods when the direction of CPI inflation was decisively changed (See Chart 1). The study did not test the 1960s, a period of very low variability in the inflation rate (BB, 1989). In addition, I did not test the 1972 turning point due to the imposition of wage/price controls in that year, as well as the break-up of the Bretton Woods system. Additionally, I tested out-of-sample the January 1981-December 1991 period.

As BBM note, it is a tall order to estimate the "best" equation for each time period during which one would like to make out of sample tests, thanks to limits on the experimenters time. As a result, I followed BBM in utilizing the form of the equation for the entire period when undertaking the tests. That is, the "k" value and optimal lags derived above for the entire 1958-91 period were used. Then, for each sub-period, the equation was estimated from 1958 to the year before the turning point. For example, in the case of the turning point year 1975, the equation was estimated over 1958-74. Then, an out of sample forecast was done over the twelve months of 1975. This was done for both the CIBCR and the expectations leading indicators indexes. The expectations leading indicator model produced lower root mean square errors and lower values for Theil's U in six of the nine years under study, as well as during 1981-91 period.

TABLE 6.

Root Mean Square Errors from 12-month Dynamic Forecast

1975

CIB .001725*
EXP .001838

1976

CIB .001705
EXP .0011488*

1980

CIB .001573*
EXP .001959

1983

CIB .00144
EXP .001127*

1984

CIB .001251
EXP .00108*

1986

CIB .001918
EXP .001894*

1988

CIB .000937
EXP .000787*

TABLE 6. (contd.)

1990	
CIB	.001657
EXP	.001532*
1991	
CIB	.00095
EXP	.00069*
1981-91	
CIB	.001521
EXP	.0014095*

* = lower RMSE;
CIB = equation which uses CIBCR leading index.
EXP = equation which uses expectations variables as leading index.

TABLE 7.

Theil's U Statistic from 12-month Dynamic Forecast

1975

CIB .5584*
EXP .5579

1976

CIB .9178
EXP .6179*

1980

CIB .7609*
EXP .9478

1983
CIB .6224
EXP .5801*

1984

CIB .1.6679
EXP 1.3694*

1986

CIB 1.0735*
EXP 1.1352

1988

CIB 1.1669
EXP .9801*

1990

CIB .9301
Exp .9124*

TABLE 7. (contd.)

1991	
CIB	.9834
Exp	.7207*
1981-91	
CIB	1.1169
Exp	.1.019*

* = lower Theil's U

These results imply that expectations variables alone help improve the inflation forecast. This is because expectations variables incorporate any deterministic model of inflation and therefore anticipate the results which arise from the deterministic model. This is not to argue that a deterministic model is unimportant; indeed, to the extent that the underlying model can be better understood, expectations can be better formed by market participants. What it does argue is that expectations variables alone are sufficient to act as leading indicators of inflation. I believe that the expectations leading index may able in this context to improve forecasts as compared with the CIBCR index for the following reasons:

1) The expectations index uses only explanatory variables which are actually forward looking. Both business people and financial market participants know the value of the growth of debt, the vendor performance data, and the percent employed portions of the CIBCR index. As such, they should already be factored into the prices facing the D&B or financial markets. The tests described here suggest that

these variables have no information which cannot be known and priced into the financial variables.

2) The CIBCR index uses two measures of business expectations. It is possible that only one is necessary. If so, the CIBCR could be overfit.

3) The imported fuels component may be redundant, since all other prices (commodity as well as financial) are sensitive to changes in fuels prices. Movements here may be anticipated, or at least included in, the changes registered in the shape of the yield curve or in other commodity prices. Indeed, West Texas Intermediate crude oil prices are already included in the JoC index.

V. AN APPLICATION OF THE NEFTCI PROBABILITY INDEX TO INFLATION

a) Explanation of the Neftci Probability Index

Professor Salih N. Neftci of the City University of New York has developed a methodology to forecast cyclical turning points for the real side of the economy. Dr. Neftci's methodology utilized sequential analysis to come up with the probability of a cyclical turning point occurring. The methodology draws upon the assumption that the beginning of a recession in the economy is signalled by a sharp, simultaneous downturn in a number of economic variables. Neftci's methodology is dynamic, in that the prior period's probabilities are used in deriving the current period's index. The onset of a peak in the business cycle is considered to have occurred when the probability index reaches 90; that is, there is a 10% change of error. (Zarnowitz, 1992; Niemira 1991). Neftci (1982) tests this idea relying on the Commerce Departments index of leading economic indicators (LEI) to signal recession, while Palash and Radecki (1985) test both the LEI and financial variables, including M1 growth.

In short, "... Neftci's approach reduces to a formula that takes monthly observations on a selected variables and estimates the probability of an imminent recession for the latest month". (Palash and Radecki, p. 37). To smooth the data, a three-month moving average of the change in, say, the LEI, is obtained. Since it is assumed that an the behavior of economy in recession differs fundamentally from an economy in expansion, the first step is to break the data into periods of growth expansion and growth recession. From these two groups the historical data are used to derive probability that a given observation of the one month change in the LEI is coming from a recession or a recovery.

The next step is to develop an a priori probability distribution that the age of a recovery contains information about the imminent onset of a recession. In a sense, this step attempts to define a "life expectancy" of the recovery or recession. In his paper, Neftci gives conditional probabilities of this likelihood, although McCulloch (1975) notes that once an expansion has exceeded its historical minimum, then the likelihood of a turning point is independent of its age.

Next, the probability distributions for recession/recovery, and the a priori probability distribution of the "life expectancy" are combined to derive the Neftci probability index:

$$(9)\ Prob(t) = (Prob(t-1) + (1 - Prob(t-1)) * (Prior(t)) * (Prob1)/ ((Prob(t-1) + (1 - Prob(t-1) * (Prior(t) * (Prob1) + (1 - Prob(t-1)) * (1 - Prior(t)) * (Prob2))$$

Where:

Prob(t) is the Neftci probability index in period t

Prior(t) is the life expectancy of the recession (recovery) based on its length to period t

Prob1 is the probability that the change in the LEI was drawn from a recession

Prob2 is the probability that it was drawn from a recovery and

Prob(t-1), the recursive element, is the index derived during the past period.

The index is set to zero at the beginning of each recovery (recession) cycle.

b) Application of the Neftci Probability Index to the Inflation Cycle

While much research has been done using the Neftci probability index to forecast the business cycle, until now it has not been used to forecast the inflation cycle. Garner (1988) did mention that applications of the Neftci methodology to inflation could be interesting, but he did not undertake such as study. What follows, then, is the first application of the Neftci methodology to inflation.

Having shown in the first part of this paper the value of expectations variables in predicting inflation, I utilized the expectations model, that is, the lagged first difference of the 12-month change in the Journal of Commerce commodity price index, the lagged first difference of the Dunn & Bradstreet diffusion index of rising prices, the lagged first difference in the change of the slope of the yield curve from fed funds to the 10-year Treasury note, and the lagged value of the first difference in the 12-month change in the CPI, as a leading indicator series for inflation. The expectations model was estimated over the 1958 - 91 period to derive the coefficients in the manner described in section 4 above. Then, a dynamic forecast of the one-month change in the inflation rate was made over the 1973 - 91 period. (This covers changes in the inflation rate after both the breakup of the Bretton Woods system of fixed exchange rates as well as after the brief period of wage/price controls which President Nixon ordered in 1972.) The dynamic forecasting technique is utilized because lagged values of the dependent variable are included as an independent variable. The dynamic technique uses forecasts of the dependent variable as the value of the lagged dependent variable in deriving forecasts.

For the purposes of this study, a turning point was defined as a period when the one-month change in the 12-month change in inflation reversed sign for at least five months and that the cumulative change in inflation during this time was greater than one percentage point. In essence, these were periods when the direction of CPI inflation was decisively changed. Using this definition, we see that there were the following inflation cycles from 1975 to the present:

Peak/Trough	Trough/Peak
1/75 - 12/76	1/77 - 3/80
4/80 - 7/83	8/83 - 3/84
4/84 - 12/86	1/87 - 4/89
5/89 - 9/89	10/89 - 11/90
12/90 - 10/91	

Using this schemata, the Neftci methodology was applied in the following way:

1) Determining the probability distributions. Over this period, there were 115 months during which the 12-month inflation rate was falling, and 87 months during which it was increasing. A three-month moving average was taken to smooth the data, which was then broken into the two groups, which are analogous to growth expansions and contractions. Niemira (1990) points out that a theoretical distribution such as the normal can be used to derive the historical probability distributions.

To determine if the normal distribution is appropriate, we tested the distribution of the historical data. The Jarque-Bera statistic can be used to test whether a series is normally distributed. The Jarque-Bera statistic has a chi-squared distribution with two degrees of freedom, and the null hypotheses is that the data are normally distributed. With Jarque-Bera statistics of -.4888 for the peak/trough set and (1.1348) for the trough/peak set, I could not reject the null hypothesis of normality. The data were normalized, with the probability distributions then taken from the normal distribution.

2) The a priori distribution of the life cycle of inflation. In his paper, Neftci (1982) utilized conditional probabilities of the onset of recession. Niemira (1990, p. 93), in his application of the Neftci methodology to a number of foreign countries, suggests that "... a simple strategy would be to have probabilities build to the average duration and to hold constant". I utilized this strategy. I followed Niemira suggestion and had the likelihood build month-by-month to the average duration of the cycle, at which point I held the likelihood constant at that average.

3) The development of the index. I applied the Neftci formula in the following way:

(10) Prob(t) = (Prob(t-1) + (1 - Prob(t-1)) * (Prior(t)) * (CPI1)/
((Prob(t-1) + (1 - Prob(t-1) * (Prior(t) * (CPI1) +
(1 - Prob(t-1)) * (1 - Prior(t)) * (CPI2))

where:

Prob(t) = the Neftci probability index in period t

Prior(t) is the life expectancy of the inflation contraction (expansion) based on its length to period t

CPI1 = the probability that the change in the leading inflation index was drawn from a contraction

CPI2 = the probability that it was drawn from a recovery and

Prob(t-1) = the index derived during the past period.

The Neftci index was set to zero at the end of each contraction (expansion) cycle. Additionally, following Koenig and Emery (1991), if the index exceeded .95 in a given month, it was set to .95 to prevent the index from becoming stuck at unity. Chart 9 shows the development of the Neftci index during each of the cycles identified above.

c) Results and Interpretation

The Neftci probability indexes provided some lead time in term of forecasting a change of inflation direction, though a signal was not given in three periods. As with the real side, evidence of an imminent change is assumed when the index reaches .90. In what follows, this will be called the first Neftci signal.

TABLE 8

Peak/Trough Period	**First Neftci Signal**	**Months Lead**
1/75 - 12/76	None	None
4/80 - 7/83	3/83	5
3/84 - 12/86	11/85	14
5/89 - 9/89	None	None
12/90 - 10/91	No Signal	--
Average		**4.75**

Trough/Peak Period	**First Neftci Signal**	**Months Lead**
7/71 - 3/80	6/78	21
8/83 - 3/84	None	None
1/87 - 4/89	11/88	6
10/89 - 11/90	10/90	2
Average		**7.25**

In calculating the month lead/lag, I made allowances for the fact that the expectations variables would be known one month in advance of the revised CPI data, and so a peak in, say, 7/83 for inflation would not be known until 9/83. With the inclusion of the Dunn & Bradstreet expectations, we would have all of the 7/83 data in 8/83. Thus, the Neftci signal in 3/83 is actually known five months ahead of the actually date that we would know the final results of the 7/83 CPI trough.

During the period when inflation moved from a peak to a trough, the average signal was given 4.75 months in advance. The index did not capture the brief inflation downturn in early 1989, which lasted only five months, the minimum under this methodology. Excluding this period, but including the longer 1/75 - 12/76 period which also gave no signal, the average lead time was 6 2/3 months. The lead was only two months for the 11/90 peak, perhaps as a result of that year's inflation being set off by a sharp rise in oil prices during the fall, rather than a gradual build-up of inflationary pressures. By 10/91, the end of the data set used in this excercise, there was still no signal of an impending trough in inflation. Data from later months has born this out, as CPI inflation has continued to fall. Taken together, the short lead in 1990 and the lack of a signal in the 1/75 - 12/76 period are obviously a weakness in the methodology, which nonetheless remains promising.

The Neftci index' performance during the trough/peak periods was also promising. The average lead during the four periods was 7.25 months. While there was no signal given during the brief 8/83 - 3/84 reversal period, it was an upturn of only seven months.

That no signal was given during the 8/83 - 3/84 and 5/89 - 9/89 periods suggests that the methodology may not be able to handle short reversals in inflation direction. While troubling, it could suggests that these short reversals are less changes in the direction of inflation and more simply pauses. If Neftci is right about the real side, i.e., that expansions/recessions are characterized by abrupt changes in a number of variables at once, then this phenomenon could be also at work with inflation variables. The failure of the method to pick up short-term variations may imply that no reversal has been detected in the behavior of the inflation variables.

VI. POTENTIAL DIFFICULTIES AND DIRECTIONS OF FUTURE RESEARCH

Part of the problem research on the commodity price rule has is that it is open to the Lucas Critique that policy regime changes necessarily imply that financial asset price behavior will be different once the policy regime changes. This is perhaps especially true of the time period examined above, which stretches over a 34 year time horizon and is dependent on arbitrage relationships. The bond and money markets certainly operated under different arbitrage relationships when the Fed endeavored to keep rates low as during the 1950s and 1960s, operated differently when inflation was climbing in the 1970s, and certainly was different during the disinflation 1980s. This may be the key as to why the price of gold, a key investment commodity which pays no interest and is heavily dependent on, and presumably is sensitive to, inflation rates is not a good leading inflation indicator.

Gold's poor forecasting record raises another important question for the commodity price rule approach: Is gold's poor record in forecasting inflation reflective of other factors at work in the gold market or is it suggesting problems with the Angell/Johnson propositions themselves. It is interesting to note the three expectations variables included as leading indicators above are all traditionally tied in with the real side of the economy. Output follows prices, so industrial commodity prices (the JoC) should also react to economic growth. A flattening or inverting yield curve is often viewed as a precursor to recession. And business managers' perceptions and expectations arise from their work in the real economy, not from arbitrage relations. The Angell/Johnson proposal rests implicitly on the idea that monetary policies don't affect real variables, but the indicator which has few real side uses (gold) -- and therefore should be a pure inflation play-- is not useful.

This study lends support to the idea that commodity prices and other anticipatory variables are useful in predicting inflation, but is not necessarily a LEI as it stands. Given that the JoC covers 18 commodity prices, and the yield curve covers two interest rate variables, the set of variables which I have chosen does contain quite a bit of information, however.

Finally, as the idea of a commodity price rule has taken hold and analysts and market participants have begun to rely increasingly on the approach, the Fed has begun to utilize the approach as an input to policy-making. Indeed, the proposals themselves came from two Fed Board governors. This reliance, while good for the Fed and market participants, makes the job of modelling harder since the Fed can quickly counteract its own policy moves if markets indicate that they are inflationary. That is, if the Fed (say) lowers the federal funds rate and that this policy change led to a rise in commodity prices and a steepening of the yield curve, or if expectations reports like the D&B, then the Fed could reverse its policy. Thus, the chain of events as described above would occur, but inflation would not occur since the

FOMC would have drawn the correct conclusions from market signals and reversed itself. In other words, rising commodity prices may not be met with higher inflation after all.

As for the Neftci methodology, these first results are very promising. Except for the short periods discussed above, the method does give some lead time in forecasting turning points. More research into inflation itself would give insight on the further application of the method. For example, Neftci's work (1986) on asymmetries in real variables could be applied to the study of inflation. For example, negative CPI inflation is rarely observed, and long periods of sustained, downward price pressure are never observed, at least not in the US. In addition, applications of this methodology to traded goods indexes, such as the producer price index, could be done.

VII. BRIEF REVIEW OF LITERATURE

Most empirical studies of the commodity price rule, which in the main have used commodity prices to improve the fit of other types of structural inflation models, have not looked at the strictly informational content which markets contain. In this section, I will review some of the more widely cited studies and include brief comments on them.

1) One of the first empirical studies of the commodity price rule (CPR) was done by Whitt (1988). Whitt tested the value of adding commodity price inflation to an money-growth model which explained GNP deflator, CPI and PPI inflation. He used the following equation:

$$(11)\quad P(t) = a + \sum_{i=1}^{16} m(i=1)\ M(t-i) + \sum_{i=1}^{16} c(i-1)\ RCIP(t-1-i) + u(t)$$

where:

P(t) = quarterly percent change in the inflation rate being tested;

M(t) = percent change in the money supply used in period t;

RICP(t) = first difference of the log of the CRB raw industrial commodity price index in period t;

u(t) = an error term exhibiting 1st order autorcorrelation.

Whitt uses a 16 period lag length for money, as well as the current value plus 15 lags for commodity prices when estimating the CPI. The coefficients were estimated using third- or fourth-degree Almon polynomials with tail constraints, and the Cochrane-Orcutt technique was used to adjust for serial correlation of the residuals.

Whitt (1989, p. 34) notes that shorter lags suffice for the PPI, since "... many of the items in the PPI are inputs which are used later in producing the final goods covered by the CPI." This sentence underscores the general approach which investigators have taken to the CPR, that changes in commodity prices are viewed as being part of an inflation transmission mechanism. This is undoubtedly true, but I believe Angell and Johnson were actually calling for the use of the information inherent in commodity prices.

Seen this way, money growth may not be needed in the equation at all. The agents determining commodity prices have already looked at money supply behavior, have deduced the most likely outcome, and have built that into (presumably) inflation sensitive prices. Thus, money supplies should not be needed. And in fact, for the 1975-87 period, commodity prices do explain inflation, with the money supply growth parameter insignificant.

The lack of significance for the monetary measures could be viewed an indirect affirmation of the view that commodity prices already have processed monetary information. One test of the CPR would be exactly this; include money growth into a commodity price equation and test if the parameter is significant. As the results here show, it is not.

2) In an early paper, von zur Mueller (1989) uses simple OLS to compare the predictive power of four regressions in explaining the 12-month change in either the CPI or GNP deflator as the dependent variable. The regressions build on themselves by adding explanatory variables: 1) only lagged dependent variable; 2) (1) + 12-month changes in commodity prices; 3) (2) + the CIBCR leading inflation index; 4) (3) + the ratio of GNP to trend. The regressions are:

$$(12)\quad p(t) = a + \sum_{i=1}^{24} b(1i)\ p(t-i) + \sum_{i=1}^{24} b(2i)\ x(t-1) + u(t)$$

where:

p(t) = the 12-month change of either the CPI or the GNP deflator;

p(t-i) = the lagged values of the 12-month growth of the relevant inflation measure;

x(t-i) is a vector which is expanded to include a) the 12-month change of the FRB experimental commodity price index; b) the CIBCR leading inflation index; c) the ratio of real to potential GNP.

u(t) = a normally distributed error term

In the paper, von zur Mueller (p. 36) notes that M1 and M2 growth rates were also tested, but "within the twelve month horizon, money growth tended to degrade forecast performance", another indirect test which suggests that commodity prices already have taken all available information about future states of the world from monetary growth.

This is perhaps the most pure test of the CPR which I have found. On problem with this model, however, is that the ratio of real to potential GNP would already be known to market agents, and should be superfluous to the analysis. In fact, von zur Muehlen (p. 35) notes that "...little additional predictive power is added by specifying an additional Phillips-curve variable --the gap between actual and potential real GNP." As with the monetary variables above, I hold forth that the reason that this Phillips-curve variable is not significant is that the information which is already included in it has been captured in the commodities themselves.

3) Webb (1988) uses a VAR model format to test if commodities do improve model performance. He tests three models against each other. Each model uses a different formulation of the data, but the variable set is essentially the same: CPI inflation is a function of: 1) its own lagged values; 2) the Journal of Commerce Commodity price index; 3) the 90-day T-bill rate; 4) capacity utilization rate; 5) the dollar exchange rate; 6) and the monetary base. He finds that commodity prices help to improve CPI forecasts by only a small amount.

4) Fullerton, Hirth and Smith (1991) do not attempt "to test any specific theory or impose any a priori modeling restrictions on the equations that are estimated".

They use multiple transfer ARIMA analysis to test the lead-lag structure of their model. They test the general form of the model as:

(13) $C(t) = A^{(-1)} * (B) * [w(b)\, p(t) + g(B)\, S(t) + r(B)\, R(t)] + Q(b) + u(t)$

where:

$C(t)$ = the stationary CPI series

$P(t)$ = the stationary working series for various commodity prices, including gold, oil, soybeans, copper, etc.

B = the back-shift operator

$S(t)$ = the stationary working series for the slope of the yield curve;

$R(t)$ = the stationary working series for exchange rates;

$Q(B)$ and $A^{(-1)}*(B)$ = the general order auto-regressive and the moving average polynomials and

$u(t)$ = the error term associated with the process.

They test some 15 equations, utilizing numerous combinations of the various regressors, with various specifications of the leads/lags. Their general results are firstly, that numerous commodity prices have consistent CPI relationships; this falls into the category of commodities as part of the CPI chain. Secondly, that commodities help at the margin improve other models of inflation.

5) Garner (1988) looks at the proposition that commodity prices do indeed have an important role as a monetary target. Using cointegration tests, he finds that there is no stable link between the levels of commodity prices and consumer prices, confirming Branson and Boughton's results. Thus, he rejects the potential usefulness of commodity prices as central bank target.

He then tests if the addition of commodity price measures can improve an inflation forecast. He finds that commodities "Granger cause" inflation, since they improve inflation predictions in the model:

$$(14)\quad P(t) = a + \sum_{i=1}^{12} b(i)P(t-i) + \sum_{i=1}^{12} c(i)\ CP(t-i) + \sum_{i=1}^{12} d(i)\ Z(t-i) + u(t)$$

where:

P(t) = the rate of change of the CPI;

CP(t-i) = on commodity measure, either the CRB index, the JOC index, the PPI crude materials index, or gold prices;

Z(t-i) = a vector of two variables, one financial and one real. The financial vector is either M1 or monetary base growth, or the 3-month T-bill rate. The real variable is either industrial production, the trade weighted dollar, oil prices, or the wage index.

The general conclusion which Garner (p. 14) draws from the Granger tests is that commodity prices "are useful in predicting the general inflation rate, even when other relevant inflation variables are included in the information set".

This data set gives rise to thirty-two combinations. Certain combinations can be viewed as partial tests of the CPR. They would include either the CRB, JOC, or gold as the price variable, but not the PPI-materials price measure, since it is not a market-determined price. As for the real variable, oil prices and the exchange rate are both part of the Johnson proposal.

The general conclusions which can be drawn from Garner's results is that commodity prices indeed "Granger cause" inflation under the tests here. The Granger tests show gold significant at the 5% level for both the exchange rate/T-bill combination and the oil/T-bill combination. The CRB index is significant at the 1% level with the oil/T-bill combination, although only at the 10% level for the exchange rate/T-bill combination. The JOC is significant at the 1% level for the oil/T-bill combination, and the 5% level for the exchange rate/T-bill combination.

Chart 1

CPI INFLATION and TURNING POINTS

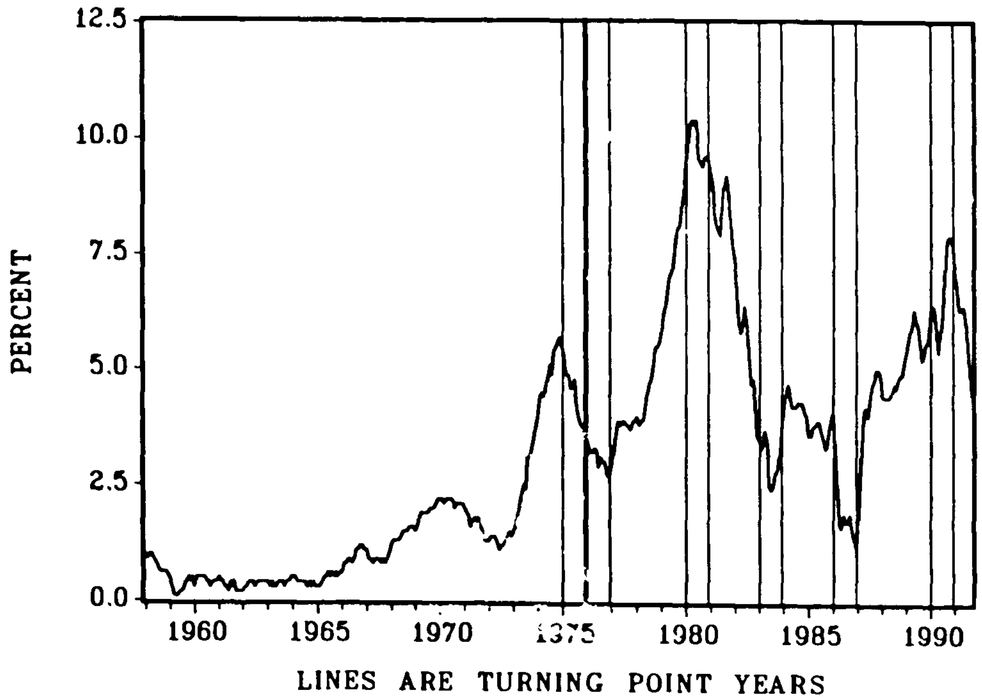
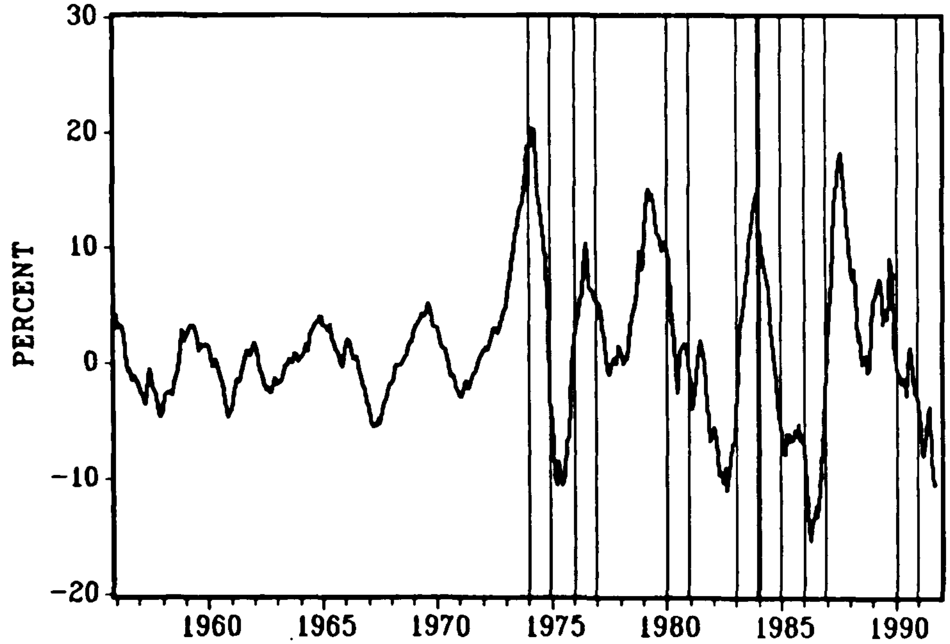


Chart 2

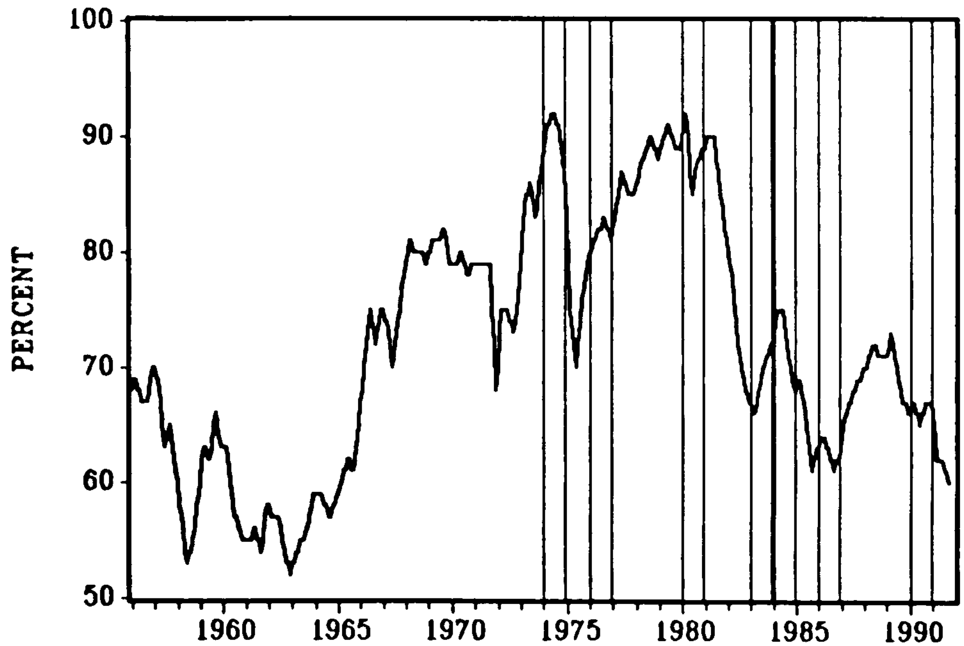
12-MONTH CHG of JoC INDEX & TURNING POINTS



VERTICAL LINES ARE TURNING POINTS

Chart 3

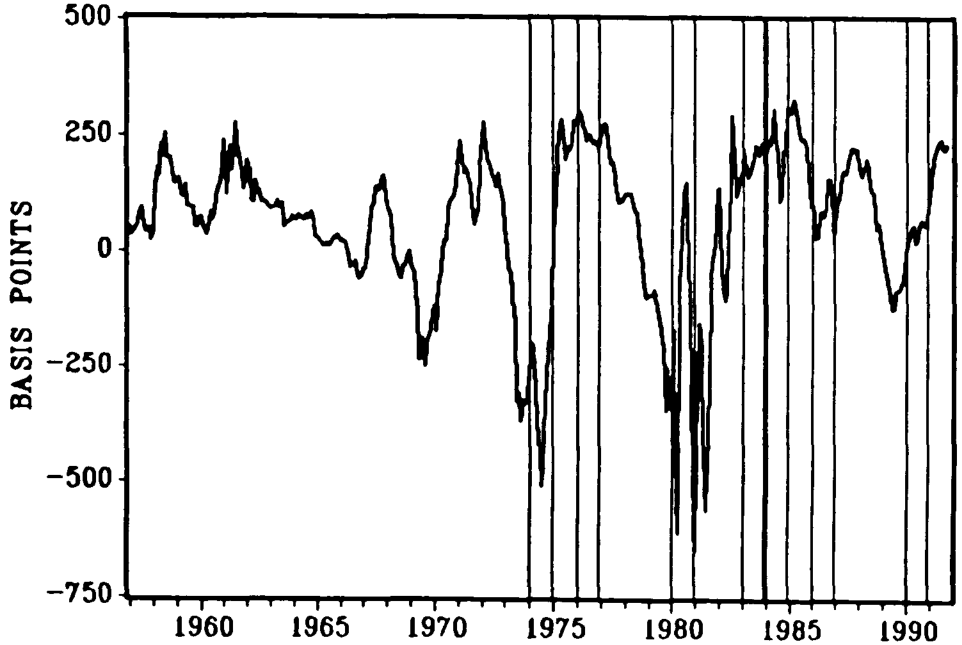
DUN & BRADSTREET PRICE EXPECTATIONS DIFFUSION INDEX



VERTICAL LINES ARE CPI INFLATION TURNING POINTS

Chart 4

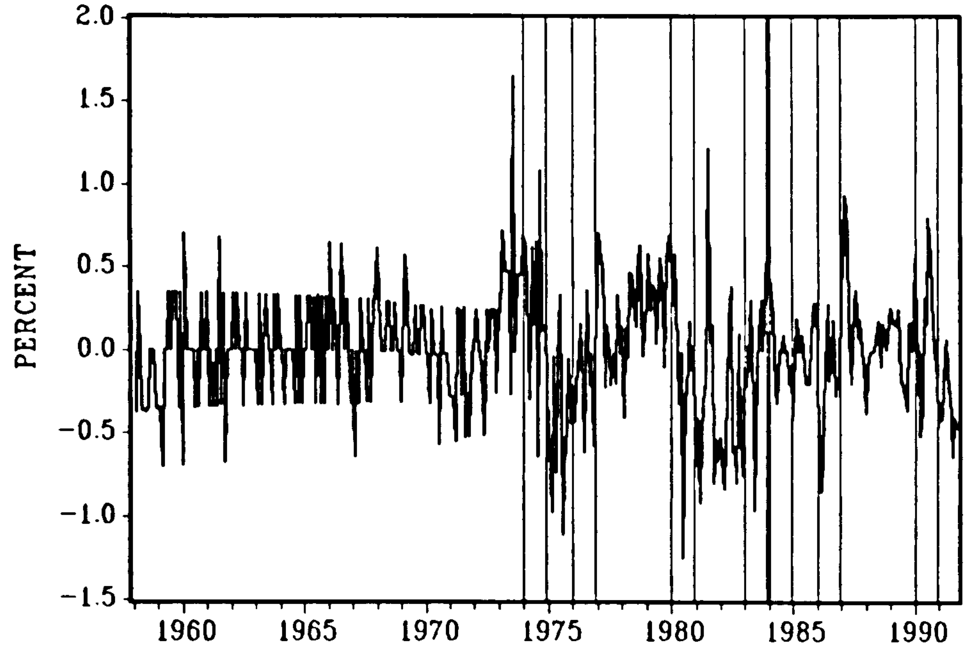
THE YIELD CURVE and CPI TURNING POINTS



VERTICAL LINES ARE TURNING POINTS

Chart 5

1-MO CHG IN 12-MONTH CHG of CPI & TURNING POINTS



VERTICAL LINES ARE TURNING POINTS

Chart 6
THE YIELD CURVE and CPI TURNING POINTS

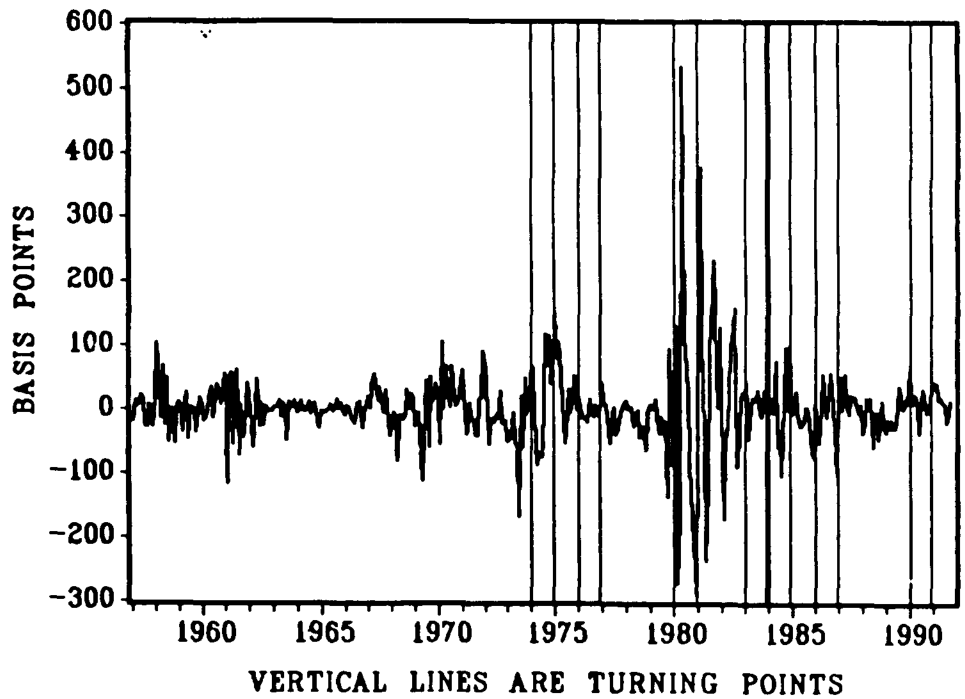
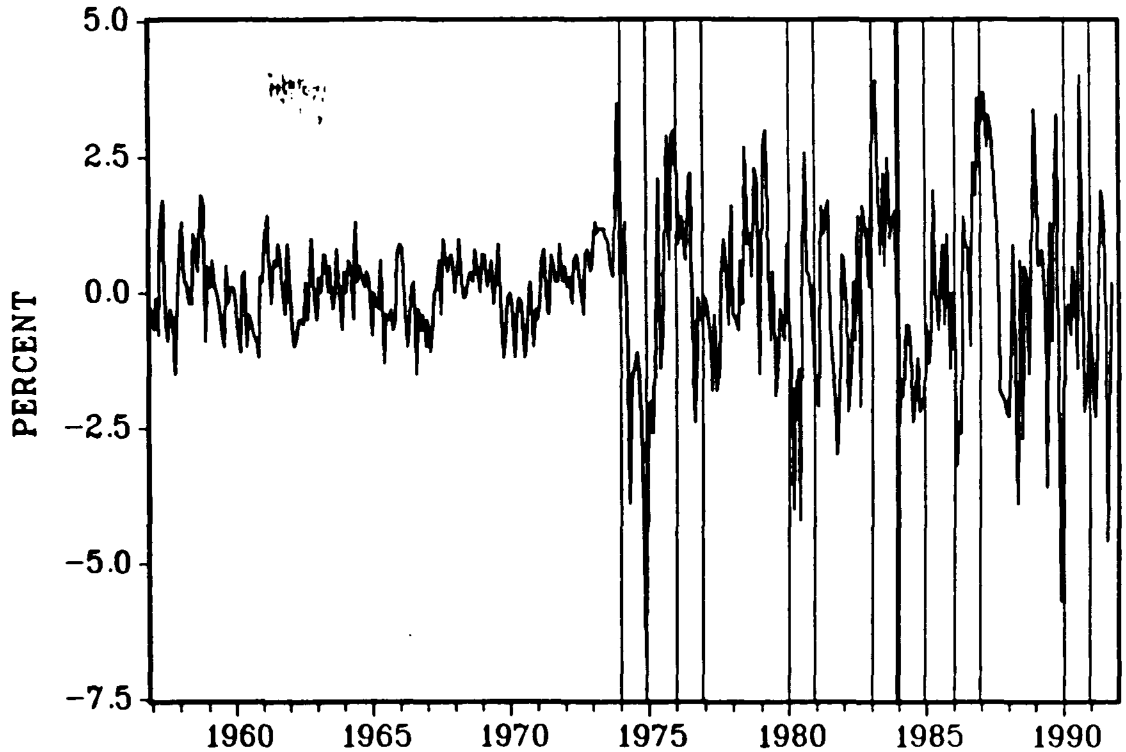


Chart 7

1-MO CHG IN 12-MONTH CHG of JoC INDEX & TURNING POINTS



VERTICAL LINES ARE TURNING POINTS

Chart 8

DUN & BRADSTREET PRICE EXPECTATIONS DIFFUSION INDEX

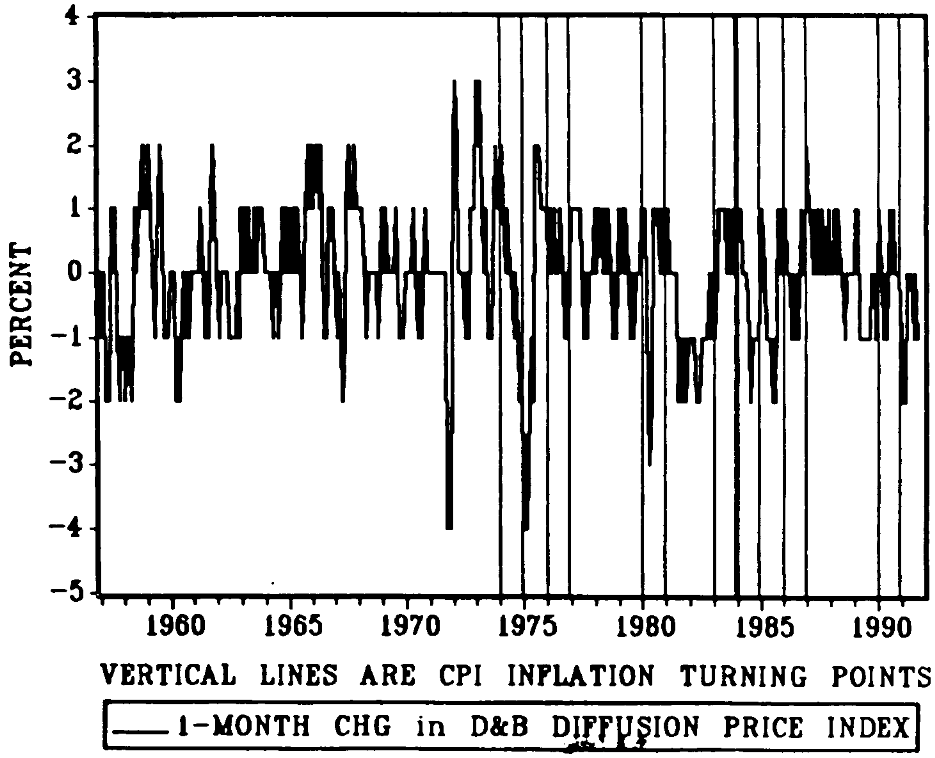
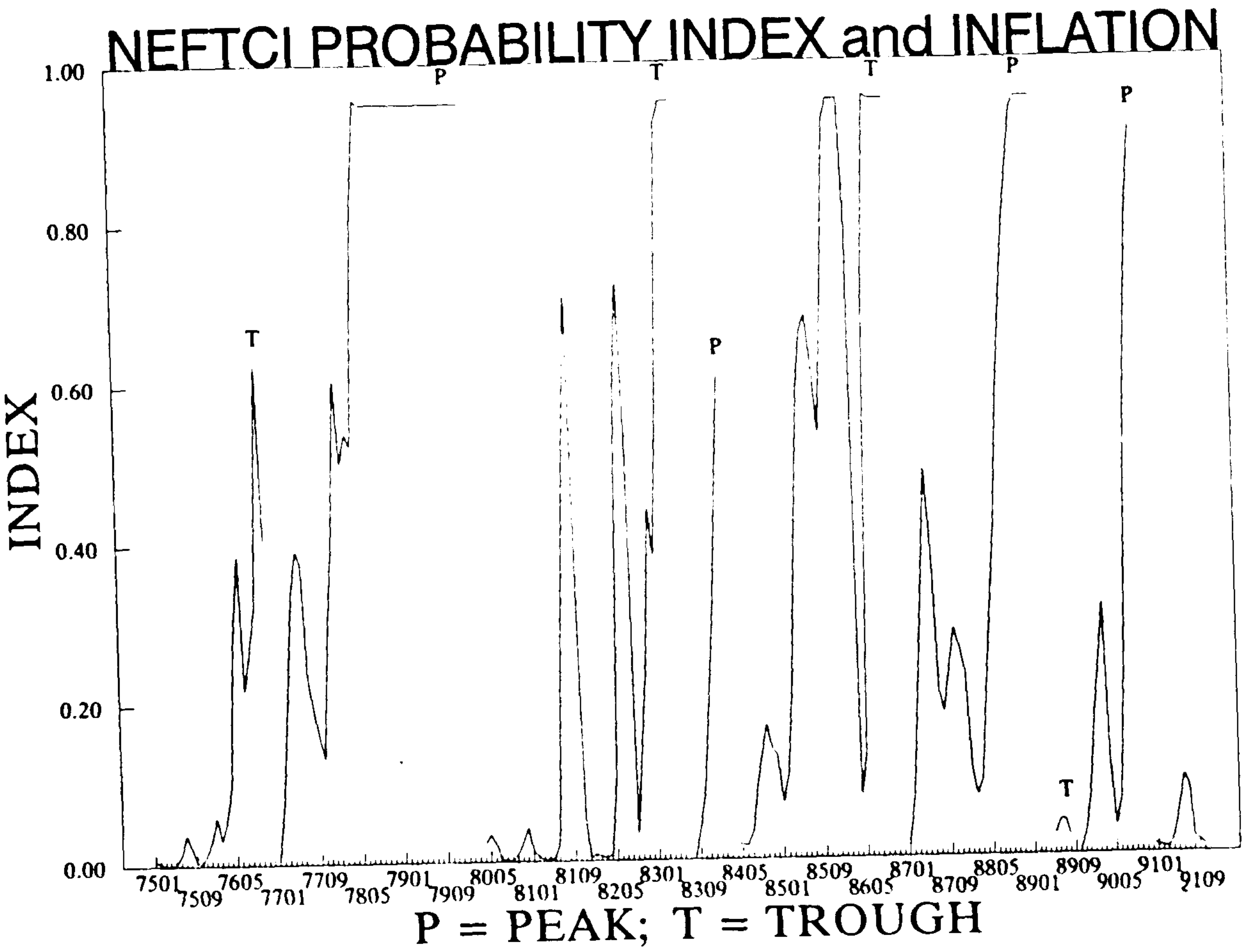


Chart 9


NEFTCI PROBABILITY INDEX and INFLATION
INDEX
1.00
0.80
0.60
0.40
0.20
0.00
T
P
T
T
P
P
T
P
T
7501
7509
7605
7701
7709
7805
7901
7909
8005
8101
8109
8205
8301
8309
8405
8501
8509
8605
8701
8709
8805
8901
8909
9005
9101
9109
P = PEAK; T = TROUGH

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