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Evidence on the Existence of Common Stock Inflation Hedges

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Abstract

Evidence on the existence of investments that are good hedges against unexpected inflation is sparse. In this study we demonstrate a procedure for forming common stock portfolios whose returns covary positively with unanticipated inflation, and show that such portfolios can be used to hedge against purchasing power risk.

"Evidence on the Existence of Common Stock Inflation Hedges"

I. Introduction

Although asset payoffs are in nominal terms, rational investors should seek investments which are efficient in real terms. Despite this seemingly obvious interest in real wealth maximization, initial versions of the capital asset pricing model (CAPM) by Sharpe [1964] and others were expressed in nominal terms and utility maximization involved holding combinations of the risk-free asset and the market portfolio only. However, several recent extensions of capital asset pricing theory have dealt with maximization of the expected utility of real wealth. Within this context, the rationale for holding an additional asset called a hedge portfolio is provided. For example, Long's [1974] multi-period CAPM shows that rational investors should hold long (short) positions in hedge portfolios to hedge against (or speculate on) unanticipated shifts in the price level and other factors affecting lifetime consumption. More recently, Manaster [1979] and Sercu [1981] have shown, in a single-period setting, procedures for transforming nominally-efficient portfolios into real-efficient portfolios through the addition of an inflation hedge portfolio.

Once one leaves the realm of theory, the need for empirical identification of inflation hedge portfolios arises. To date, there has been little empirical evidence of the ability to identify such portfolios on an ex ante basis. Without such evidence, it is difficult to verify those capital asset pricing theories which are developed in an inflationary environment.

Our purpose in what follows is to present evidence of the existence of common stock inflation hedge portfolios and to explain a procedure for building such portfolios. The balance of the paper is organized as follows. Part II reviews previous empirical evidence concerning the existence of inflation hedging potential. Part III is devoted to our hedging strategy. Here we first consider some characteristics of a successful hedging strategy and then examine the hedging potential of both the market portfolio and individual common stocks. We then develop our strategy and present the results of hedging against the risk associated with one particular nominally-efficient portfolio: a portfolio consisting only of default-free fixed-income securities. While we deal with only one portfolio from the efficient set, the portfolio is of special interest since its only source of risk is purchasing power risk. Our results indicate that a common stock hedge portfolio could have reduced the variance of real returns on Treasury bills by over 26 percent over the 1974-1979 period. In Part IV, the hedging strategy is modified slightly to allow comparison with a test performed by Schipper and Thompson [1981] in a multi-period setting. Conclusions follow in Part V.

II. Previous Attempts to Identify Inflation Hedges

Related empirical research can be divided into two categories: (1) attempts to develop hedging strategies for reducing the risk of real returns on fixed-nominal-income securities, and (2) attempts to establish the descriptive validity of the Long multi-period CAPM.

Bodie [1976, 1980] has sought portfolios whose returns covary positively with unexpected inflation. He [1976] demonstrated that a long position in the aggregate stock market could not be used to hedge against purchasing power risk, since the market index varies negatively with unexpected inflation. Bodie then turned to the commodities futures market [1980] and found that futures contracts could be used to offset purchasing power risk. Using annual data from the 1953-1978 period, a well-diversified portfolio of commodities futures contracts could have been used to offset 17.4 percent of the variance of return on Treasury Bills, while increasing mean real return from 0.4 percent to 0.67 percent.[1] Bodie proposes that his strategy could be a valuable alternative to the now much-maligned variable-annuity contracts. But in general, the strategy has somewhat limited appeal.

Biger (1975) did not explicitly identify a common stock hedge portfolio, but he did compare real-efficient portfolios with nominally-efficient portfolios. Over the 1950-1954 period, Biger reports variances of real return on real-efficient portfolios which are 0.3 percent to 26.1 percent less than variances of real return on a nominally-efficient portfolios with the same mean real returns.[2] However, an important limitation of the results is that the portfolios were constructed using information available only on an ex-post basis. Thus, while his results indicate that common stocks do offer hedging potential, there is no evidence that one would be able to forecast inflation hedges and construct successful hedge portfolios on an ex ante basis.

Examples of tests of multi-period CAPM's include those by Gouldey [1980] and Schipper and Thompson [1981]. While Gouldey's test did not require the actual identification of the assets to be included in an inflation hedge portfolio, his results suggest "...that investors can economically form portfolios of stocks and default-free securities to hedge against consumer price level inflation and that, in average, there is strong evidence for the existence of inflation risk."[3] (p. 258)

Schipper and Thompson [1981] did attempt to construct inflation hedge portfolios. Although such portfolios could easily be identified on an ex-post basis, as in Biger's study, the researchers had difficulty in identifying inflation hedge portfolios on an ex ante basis. A hedge portfolio was constructed by combining long and short positions in 521 common stocks. When the portfolio was constructed using information from odd quarters, the portfolio failed to offer significant hedging potential during even quarters.

A problem with the approach used by Schipper and Thompson is that rather severe requirements are placed on the data. Using their notation, the hedge portfolio is the vector X where

$$\underline{X} = \Omega^{-1}\underline{\gamma}$$

where

Ω = the variance-covariance matrix of security returns and

$\underline{\gamma}$ = the vector of covariance of returns with unexpected inflation.

To minimize sampling error, the authors used 21 years of quarterly data over the period, 1954III - 1975II.

A necessary condition for any successful inflation hedging strategy is some stability in assets' covariances of returns with unexpected inflation over time. But there is little reason to expect such stability over the lengthy horizon used by Schipper and Thompson. In contrast, the hedging strategy that we illustrate in Part III requires stability over a shorter and more reasonable time period. Other modifications of the Schipper-Thompson strategy are also used to mitigate the impact of sampling error.

III. Hedging Against Purchasing Power Risk in a Fixed Nominal Income Stream

A. Characteristics of a Successful Hedging Strategy

The characteristics of a hedge portfolio which can be used to transform a nominally-efficient portfolio into a real-efficient portfolio have been derived analytically by Manaster [1979] and Sercu [1981]. In both papers, the hedge is a zero-investment, zero-expected real-return portfolio whose return covaries positively with (unexpected) inflation. Both Manaster and Sercu derive precise definitions of a hedge portfolio which could be employed in an empirical setting. However, use of those definitions would introduce the same estimation problems which may have rendered the Schipper and Thompson strategy unsuccessful.

In contrast, our approach is based on two less precise but intuitively appealing characteristics, referred to below as effectiveness and efficiency, which must be possessed by any inflation hedge portfolio. We then construct a strategy likely to possess these characteristics, and which, in the absence of margin requirements, would be a zero-investment, zero-expected-return strategy. (We will actually assume that our strategy requires a net positive investment due to margin requirements; however, implementation of the strategy need not, in general, have any impact upon margins.[4])

Consider a return which is fixed, in nominal terms, in the amount of 1 + R. Then the real return can be defined as:

$$(1) \qquad \frac{1+R}{1+\tilde{i}}$$

where $\tilde{i}$ denotes the inflation rate. Although the nominal return is fixed, there exists some uncertainty surrounding the real return, since the inflation rate cannot be predicted with certainty. A measure of the risk associated with the real return is:

(2) $$\text{Var}\ (\frac{1+\tilde{R}}{1+\tilde{i}})$$

We adopt terminology used by Boonekamp [1978] and others when we refer to this risk as purchasing power risk.

Assume that some proportion w of our wealth is invested in a portfolio which offers a real return $\tilde{h}$ characterized as follows:

(3) $$\tilde{h} = 1 + \bar{h} + b\tilde{u} + \tilde{e}$$

where $\tilde{u}$ = unexpected inflation

$\tilde{e}$ = error term

$b = \text{cov}\ (\tilde{h},\tilde{u})/\text{var}(\tilde{u})$

$\bar{h}$ = mean real return on hedge portfolio

At this point, there exist no restrictions on the value of $\bar{h}$. However, the strategy to be developed later will be constructed so that $\bar{h}$ equals zero. We say that the portfolio can be used to hedge against purchasing power risk if:

(4) $$\text{Var}[(1-w)[\frac{1+\tilde{R}}{1+\tilde{i}}] + w(1+\tilde{h}) < \text{Var}[\frac{1+\tilde{R}}{1+\tilde{i}}]$$

Within this context, Bodie [1976] has developed a measure of the risk-reducing potential of a hedge portfolio. The percentage reduction in total risk, which can be achieved by investing w percent of wealth in the hedge is:

(5) $$S = \cfrac{1}{1 + \cfrac{\text{Var}(\tilde{e})}{\text{Var}(\tilde{u})[(1+R+b)^2]}}$$

where

$$(6) \qquad w = \frac{(1+R)(1+R+b)}{(1+R+b)^2 + \frac{Var(\tilde{e})}{Var(\tilde{u})}}$$

By combining the hedge portfolio with the investment in a fixed nominal income stream, risk is reduced to:

$$(7) \qquad (1-S)[Var(\frac{1+R}{1+i})]$$

Note that since u and R are already given, the value of the hedge depends only on b and Var(e). In this paper, we say that b provides a measure of the <u>efficiency</u> of the hedge and Var(e) provides a measure of the <u>effectiveness</u> of the hedge. As explained below with the aid of Figure 1, a good hedge must be both efficient and effective.

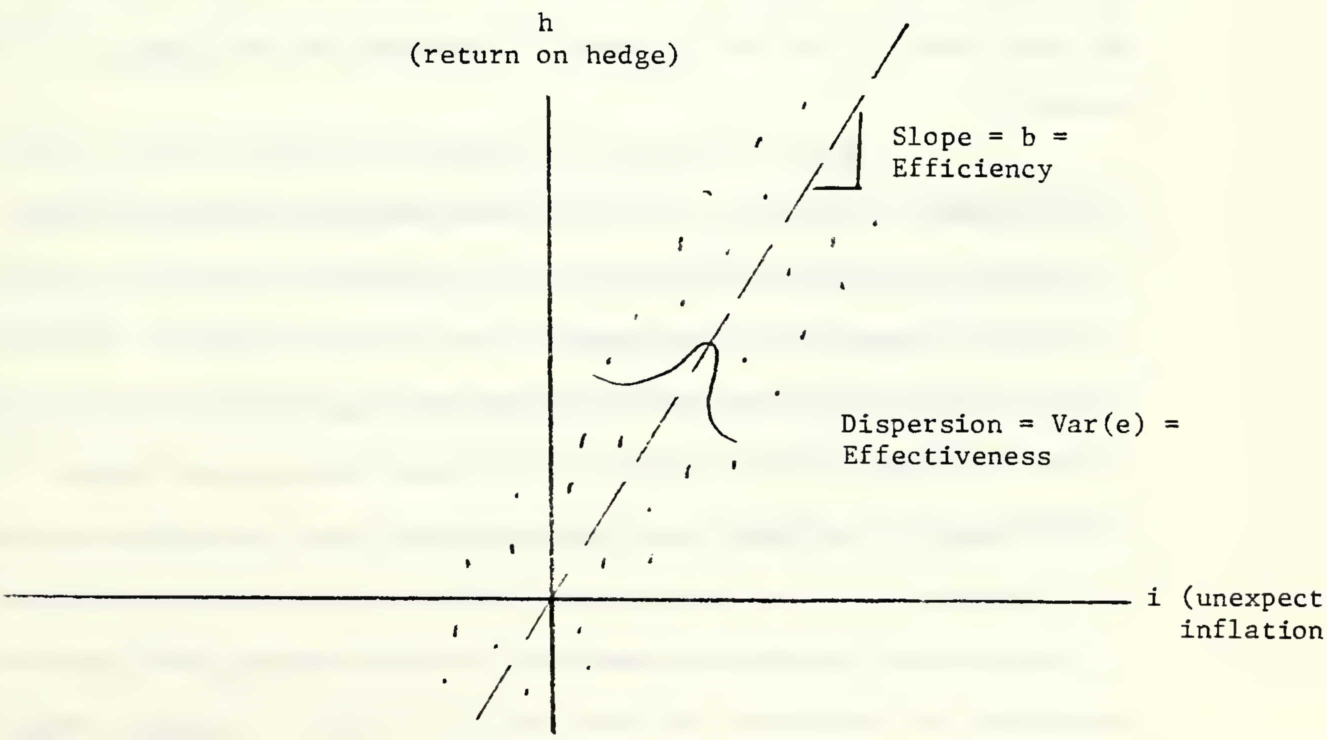

Figure - 1
Illustration of Hedge Effectiveness and Efficiency

Efficiency. As can be seen in equation (5), the percentage reduction in total risk (S) is higher, the greater is b. Furthermore, if b is very high, then it will generally be possible to offset a substantial degree of purchasing power risk with only a small investment in the hedge. Thus, we say that the hedge is more efficient, the higher is b.

Many of the assets traditionally considered good inflation hedges are actually quite inefficient. Consider housing as an example. Quarterly data provided by Fama and Schwert [1977] indicate that when unexpected inflation is 1 percent, the nominal value of housing tends to rise only 0.45 percent (that is, $b = .45$). In contrast, we will demonstrate a strategy using common stocks (during the 1974-1979 period) which offers an expected return of 4.2 percent in a period with 1 percent inflation ($b = 4.2$). In this case, ignoring non-inflation risk, a $5,000 investment in the common stock hedging strategy could offset the same amount of purchasing power risk as a $55,000 investment in housing.[5]

Effectiveness. So long as $b > -(1+R)$, the hedge portfolio can be used to offset at least some purchasing power risk. (Note that S and w in equations (5) and (6) are both positive only when $b > -(1+R)$.) However, a high value of b does not guarantee that the hedge portfolio will offset a substantial amount of total risk. The reason is that, even while offsetting some purchasing power risk, an asset could introduce new risks, such that total risk does not decline significantly. Since the variable $\tilde{e}$ in equation (3) captures variation in the hedge return, which is not correlated with unexpected inflation, we call $Var(\tilde{e})$ a measure of "non-inflation risk". Note that in equation (5), S is shown to be a declining function of Var($\tilde{e}$). We say that a hedge is very effective if it offsets some purchasing power risk, while not adding too much non-inflation risk, so that total risk can be substantially reduced.

Some assets traditionally considered good inflation hedges are ineffective, at least when viewed individually. A good example is gold. Over the July 1974 through December 1979 period, the price of gold rose, on the average, 1 percent for each 1 percent of unanticipated inflation.[6] Thus, gold could have been used to hedge against purchasing power risk. However, over 99 percent of the variation in the price of gold was non-inflation risk. An investor who used a $10,000 investment in gold to offset part of the purchasing power risk of a $100,000 investment in three-month Treasury bills would actually have increased total risk by nearly 500 percent. And a variance-minimizing combination of gold and Treasury bills could have reduced total risk of the Treasury bills by less than a fraction of a percent.

B. Common Stocks As Hedges Against Purchasing Power Risk

Empirical results presented below require estimates of unexpected inflation. The approach adopted is to assume that unexpected inflation is equal to the difference between the expected and the realized real return on Treasury bills.[7] The approach differs from that of Fama [1975] in that the expected real return is not assumed equal to a constant. Rather, we use a moving average model which allows for a fluctuating expected real return.[8] The resulting implied forecasts of expected inflation appear to be unbiased and efficient over the 1960-1979 period.

It should be noted that estimates of unexpected inflation are subject to measurement error. Because of this measurement error, coefficients from regressions using our estimates as independent variables will be biased toward zero. This bias tends to weaken the power of our empirical tests.

Common Stocks On Average: A Poor Inflation Hedge

We now examine the possibility of using the market portfolio as an inflation hedge. Several previous researchers, including Jaffe and Mandelker [1976], Bodie [1976], and Fama and Schwert [1977] have shown that common stock indexes covary negatively with unanticipated inflation. Regressing quarterly real returns of a NYSE index on our estimates of unexpected inflation and updating earlier results through 1979, Table I shows that previous results are confirmed. For the combined period, for every 1 percent increase in unexpected inflation, the common stock return tended to fall by over 6 percent.

TABLE I

Common Stock Index Real Returns** versus Unexpected Inflation

1960 - 1979 (80 observations)

Quarterly Index Return = .014 - 6.68* (UNEXPECTED INFLATION) $R^2 = 0.14$
(-3.58) Var(e) = 0.0064

1960 - 1969 (40 observations)

Quarterly Index Return = .016 - 5.89** (UNEXPECTED INFLATION) $R^2 = 0.10$
(-2.07) Var(e) = 0.0045

1970 - 1979 (40 observations)

Quarterly Index Return = .011 - 6.92* (UNEXPECTED INFLATION) $R^2 = 0.15$
(-2.64) Var(e) = 0.0086

*Based on T statistics (in parentheses), significant at the 5% level or less

**Based on the NYSE Value Weighted Index obtained from the CRSP Tape.

Although it is clear that a long position in the stock market portfolio cannot serve as a hedge against unexpected inflation, Bodie [1976] posited that perhaps a short position could serve as a good hedge. But using our quarterly data from the 1960-1979 period and equation (5) to compute S, a short position in the market could have reduced the total risk associated with a fixed quarterly nominal income stream by less than 18 percent.[9] This reduction in total risk would be achieved at the significant cost of holding a short position in the market portfolio.

Individual Common Stocks As Inflation Hedges

Although the market portfolio as a whole serves as a poor inflation hedge, it is possible that certain individual stocks or combinations of individual stocks could serve as valuable hedges. To examine this possibility, we chose a sample of 571 common stocks for which quarterly returns were available on the CRSP tape from 1960 through 1979.

Table II presents a list of the 20 most efficient and 20 least efficient stocks in our sample over the 1960-1979 period. Note that even the most efficient hedges do not have b-coefficients which are significantly positive. In fact, over 73 percent of the sample stocks had real returns which were significantly below zero.

It is interesting to examine the types of stocks which appear on the lists of good and poor hedges. The good hedges are dominated by mining and oil companies. The worst hedges are dominated by airlines and consumer-oriented firms such as retailers and soft drink producers.

These patterns are more easily perceived in the industry analysis of Table III. The industries least affected by unanticipated inflation are mining and oil and gas. The industries most adversely affected by unexpected inflation include retailing, textiles, airlines, beverages, apparel, and motion pictures. Each of these industries markets products which have been referred to as "non-essential consumption goods." It appears that during periods of unexpectedly high prices, consumers cope with tight budgets by avoiding expenditures on items such as soft drinks, movies, clothing, and air travel. Note that other industries dealing with "essential" consumption goods (e.g., groceries and food manufacturers) are not nearly so affected by unexpected inflation.

[Tables II and III about here]

Since no individual stock has a significantly positive correlation with unexpected inflation, it is obvious that no single stock could be an efficient hedge. Furthermore, since 75 percent to 100 percent of the risk associated with individual stocks is non-inflation risk, individual stocks would tend to be very ineffective hedges.[10] The strategy presented now combines certain individual stocks to form a portfolio which is both an efficient and effective hedge.

C. A Strategy To Hedge Against Purchasing Power Risk

The essence of the strategy is to assume a long position in stocks which are predicted to be the "best" hedges and an offsetting short position in the stocks which are predicted to be the "worst" hedges. The portfolio should include enough stocks to diversify away much non-inflation risk. At the same time, such a combination should yield a portfolio with a high b-coefficient. To understand this, consider stocks A and B with b-coefficients equal to 1 and -5, respectively. Although neither stock, on an individual basis, is very efficient, a combination of a long position in A and a short position in B offers a b-coefficient of 6 and is thus more efficient than either A or B.[11] The offsetting of long and short positions can thus yield an efficient hedge portfolio. Note also that, if the systematic risk of the long and short positions are comparable, the scheme represents a zero-expected-return strategy.

Implementation of the strategy requires the definition of "best" and "worst" hedges. If individual stocks were ranked according to their b-coefficients, the resulting long and short positions would tend not to have comparable systematic risk.[12] To avoid this problem we instead rank the stocks based upon <u>correlations</u> of return with unexpected inflation.

The success of the strategy depends on how well one can predict the best and worst hedges. We present results here for two cases. First, we assume that the investor is clairvoyant and is capable of predicting perfectly the 50 stocks with the highest correlations of returns with unanticipated inflation and the 50 stocks with the lowest correlations. In the second case, we use historical market data to predict the correlation coefficients.

To avoid distortion in inflation rates caused by wage and price controls, the strategy was tested only for periods after June, 1974.[13]

Case 1: "Perfect" Foresight

Returns of each of the 574 stocks in our sample were regressed against unanticipated inflation, using quarterly data from July 1974 through Decmeber 1979. A long position was assumed in the 50 stocks with the highest correlations of real returns with unexpected inflation; a short position was assumed in the 50 stocks with the lowest correlations. No portfolio revision was allowed over the five and one-half year period.

Regressing the real return on the hedge portfolio against unexpected inflation, the result is

$$\text{Real return on hedge portfolio} = .01 + \underset{(4.62)}{11.02^*}\ (\text{unexpected inflation})$$

*Significant at .0005 level (one-tailed test)

$R^2 = .52$
Var(e) = .0050

Note that 11.02 = b, the measure of hedge efficiency, is high. Further, since the R^2 for the equation is a reasonably high .52, other sources of risk are reasonably low. In terms of the earlier graph, the hedge should also be relatively effective. Using equations (5) and (6) to compute S and W, we find that this is true. S = 55 percent and W = 4.6 percent. In other words, by investing in the hedge 4.6 percent of the amount invested in Treasury bills, 55 percent of purchasing power risk could have been eliminated. Since all of the risk associated with Treasury bills is purchasing power risk, the strategy would then reduce total risk by 55 percent.

Although the strategy was designed to yield a zero expected real return, the actual mean real return on the hedge portfolio was 1.7

percent per quarter, which is in excess of the mean real return on Treasury bills over this period (-0.37 percent per quarter). Thus, during the period examined, the strategy could have reduced total risk while increasing mean return.

Without Perfect Foresight

Using only past returns data, the correlations of unexpected inflation with returns of stocks for the prior six-year period were used to select the 50 best and 50 worst (predicted) hedges. For example, the 50 best predicted hedges for 1979 would be the 50 stocks whose correlations were highest over the 1973 through 1978 period. A long position is assumed in the 50 best predicted hedges and a short position is assumed in the 50 worst predicted hedges.[14]

The return on the combined hedge portfolio was then calculated over the July 1974-December 1979 period. When the quarterly real return on the portfolio was regressed against unanticipated inflation, the following estimates were obtained.

$$\text{Real return on hedge portfolio} = .01 + 4.23^{*}\ (\text{unexpected inflation})$$
$$(2.17) \qquad R^2 = .19 \qquad \text{Var}(e) = .0033$$

*significant at the .025 level (one-tailed test)

Computing S and W, we have S = 26 percent and W = 5 percent.

A $50,000 investment in each of the long and short positions, when combined with a $950,000 investment in Treasury bills, would offer a variance of real return which is 26 percent lower than the variance of real return associated with a $100,000 investment in only Treasury bills.

Again, while the expected real return on the hedge portfolio was approximately zero, the actual mean real return was about 1 percent per quarter. Therefore, the hedging strategy, while reducing risk, would have increased the mean real return on Treasury bills from a 0.37 percent loss to a 0.26 percent loss.

IV. Hedging Potential and the Long CAPM

The hedging strategy discussed above can easily be tested in the context of the Long CAPM and compared with the results of Schipper and Thompson [1981] by working with covariances instead of correlations.[15]

Referring back to equation (1), V is the vector of covariances of stocks returns with unexpected inflation. Our strategy is to rank securities using sample estimates of the elements of V (say V_j) derived from quarterly data over the prior six-year period. Portfolio weights are not assigned to all securities in our sample, as required by equation (1). Rather, we again assume a long position in the 50 stocks with the highest values of V_j and a short position in the 50 stocks with the lowest values of V_j. In this way, we greatly reduce the possibility that sampling error would cause a "bad hedge" to be included in the long position, and vice versa. The resulting combined portfolio is held for one year; then new estimates of V are derived and the portfolio is revised.

Hedging potential exists if there is a significant positive relationship between the return on the hedge portfolio and unexpected inflation. We address this issue by examining the coefficients of the following two regressions:

(8) $$r_{ht} = a_0 + \quad a_2 u_t + e_t$$

(9) $$r_{ht} = a_0 + a_1 r_{mt} + a_2 u_t + e_t$$

r_{ht} = real return on hedge portfolio in period t

r_{mt} = real return on market portfolio in period t

u_t = unanticipated inflation in period t

Table IV compares the results of our strategy with the Schipper and Thompson [1981] results. Whereas the Schipper and Thompson portfolio does not covary significantly with unanticipated inflation, in

TABLE IV

	Schipper & Thompson (7/54 - 6/75) (quarterly data)		Our Results (7/74-12/79) (quarterly data)	
regression	(8)	(9)	(8)	(9)
a_1	-	-1.59	-	- .377
$t(a_1)$	-	-5.43	-	-2.16
a_2	1.25	.28	8.88**	6.49*
$t(a_2)$	.65	.04	3.14**	2.30*
R^2	.005	.29	.33	.46

*significant at .025 level based on one-tailed test.
**significant at .005 level based on one-tailed test.

contrast, our procedure indicates significant hedging potential. The dramatic difference in results is possibly explained by the different procedures used to form the hedge portfolio, the use of different inflation expectations models, or by the different time periods examined. However, procedures employed here should place fewer demands on available data and are more reasonable in terms of stationarity requirements. Use of a time period characterized by higher magnitudes of unexpected inflation also increases the power of statistical tools used to identify "good" and "bad" hedges.

Conclusion

In a world of uncertain inflation, a rationale for acquiring hedge portfolios has been provided in both single and multi-period versions of capital asset pricing theory. In this study, we have provided empirical evidence of the existence of common stock portfolios that are effective and efficient hedges against unexpected inflation. As far as we know, our results provide the first evidence which suggests that one can construct, on an ex-ante basis, common stock portfolos which have significant hedging potential.

From a practical standpoint, the results may be useful for certain large investors or investment fund managers. For example, some pension funds make payments to retirees that are tied to an inflation index. In funds which include equity investments, a manager could divert funds from individual stocks which are among the worst hedges to stocks considered best hedges in order to help prevent or reduce large investment losses in the very periods when payments jump unexpectedly. The success of such a strategy will depend somewhat on the effects of transaction costs that we did not explicitly consider in the study, and the ability to forecast good and bad inflation hedges.

From a theoretical standpoint, the results have important implications for capital asset pricing in a multi-period setting. Hedging potential is a necessary but not sufficient prerequisite for the superiority of the multi-period CAPM over the conventional paradigm. Schipper and Thompson met with very little success in hedging against shifts in price level. In contrast, our results indicate that when hedging strategies depend only on data from recent (six-year) market history, common stocks can indeed offer significant inflation-hedging potential.

Several extensions of the study are warranted. In the present study, we examined only one point on the efficient frontier, the point where purchasing power risk was the only uncertainty. The methodology can be extended to develop more points on the efficient frontier and we are in the process of doing just that. Further useful extensions involve examining the effects of combining common stocks and other potential inflation hedge assets, such as commodities.

Although there appears to be sufficient stationarity to form effective inflation hedges through a statistical analysis of past data, little theory has been provided concerning those factors that determine which assets are good or bad inflation hedges. The development of this underlying theory would hopefully result in improved hedging ability.

TABLE 11

Twenty Most Efficient Hedges, 1960-1979*

Firm	Industry	1960's B coef-ficient	1970's B coef-ficient	1960-1979 B coef-ficient
Benguet Corp.	Gold Mining	3.6	6.9	5.9
MacAndrews & Forbes	Paper & Board prods.	2.6	4.2	3.8
Atlantic Richfield Co.	Oil & Gas	3.2	3.3	3.2
Standard Oil Co. (Ohio)	Oil & Gas	0.3	3.8	2.9
Homestake Mining	Gold Mining	-1.0	2.1	1.7
McIntyre Mines, Ltd.	Gold & Silver Mining	0.2	2.3	1.3
International Mineral & Chem	Fertilizers, Chemicals	-8.4	3.8	.7
Pacific Tin	Chemicals, Mining	-2.0	2.0	.5
Kennecott Corp.	Metals, Mining	-6.2	3.0	.3
Enserch Corp.	Gas distribution	-3.7	1.7	.3
ASA, Ltd.	Gold Mining	-0.1	0.5	.3
Campbell Red Lake Mining	Gold Mining	0.5	0.2	.3
Keystone Consolidate	Steel & Metal Fabrication	-6.4	2.5	.2
Campbell Soup Co.	Foods	4.6	-1.0	.2
Archer Daniels Midland	Foods	1.3	-0.5	.0
Holly Sugar Corp.	Foods	-11.3	4.2	-.1
Marathon Oil Co.	Oil & Gas	-0.8	0.0	-.4
Revere Copper & Brass	Copper, Brass, Aluminum	-7.0	2.1	-.5
Schlumberger, Ltd.	Oil & Gas	-1.4	0.1	-.6
Natomas Co.	Mining, Oil & Gas	12.0	-4.2	-.8

Twenty Least Efficient Hedges, 1960-1979*

Firm	Industry	1960's B coef-ficient	1970's B coef-ficient	1960-1979 B coef-ficient
Tandy Corporation	Retail-electronics	-7.7	-31.0**	-29.4**
AVCO Corp.	Conglomerate	-26.7**	-18.2**	-23.7**
Lionel Corp.	Retail - toys	-16.9	-21.0**	-23.1**
Evans Corp.	Retail - lumber	-20.2**	-18.2**	-22.1**
Trans World Corp.	Airlines	-19.0**	-17.8**	-21.0**
Columbia Pictures	Motion Pictures	-1.2	-22.9**	-20.1**
Cadence Inds	Drug Stores	-10.0	-19.0**	-19.1**
Fedders Corp	Motor Vehicle Parts	3.5	-22.5**	-18.9**
National Airlines	Airlines	-10.7	-17.7**	-18.8**
Chris Craft Inds	Boats-building & repair	-41.6**	-6.6	-18.7**
MEI Corp	Soft drinks (bottling)	-7.6	-18.4**	-18.6**
MEI Corp	Soft drinks (bottling)	-7.6	-18.4**	-18.6**
Walt Disney Productions	Motion Pictures, Amusement	-5.6	-18.8**	-18.3**
Litton Inds	Conglomerate	-16.8**	-15.2**	-18.3**
Dr. Pepper Co.	Soft Drinks	-12.8**	-15.8**	-18.2**
Eastern Airlines	Airlines	-22.6**	-13.3**	-18.2**
American Bakeries	Bakery Products	-13.7**	-16.9**	-18.1**
Pan American	Airline	-18.7**	-14.0**	-17.9**
Royal Crown Co.	Soft Drinks	-14.7**	-15.2**	-17.8**
United States Inds.	Apparel	-12.1	-15.9**	-17.8**
Hilton Hotels Corp.	Hotels	-8.6	-17.0**	-17.7**

*"B-coefficients" are regression coefficients derived by regressing real quarterly returns against unanticipated inflation.
**Significantly less than zero at 0.5 level, using one-tailed test.

TABLE III

ASSOCIATION OF REAL RETURNS WITH UNEXPECTED INFLATION: INDUSTRY ANALYSIS*

Industry	No. of Firms	1960-1969		1970-1979		1960-1979	
		Beta	Correlation	Beta	Correlation	Beta	Correlation
Metals Mining	11	-2.370	- .098	- .310	- .014	- .927	- .041
Oil & Gas	24	-5.265	- .245	-1.850	- .112	-2.751	- .153
Mining: Non-metallic	5	-9.255	- .261	-2.203	- .084	-4.099	- .142
Utilities, Telephone	99	-5.000**	- .308	-4.013**	- .282	-4.313**	- .292
Paper	16	-2.291	- .109	-5.225**	- .265	-4.467**	- .223
Groceries	6	-4.781	- .207	-5.127	- .238	-5.073**	- .232
Foods manufacturing	26	-6.227**	- .282	-4.775**	- .273	-5.227**	- .278
Drugs, soaps, cosmetics	19	-5.941	- .228	-5.132**	- .298	-5.526**	- .276
Chemicals	21	-9.672**	- .381	-4.225	- .223	-5.606**	- .270
Steel	29	-8.923**	- .329	-4.533	- .236	-5.666**	- .263
Rubber, plastics, tires	10	-5.094	- .200	-5.922**	- .298	-5.733**	- .267
Non-ferrous metals	15	-9.497**	- .357	-4.632	- .248	-6.078**	- .287
Financial	28	-5.572	- .249	-6.488**	- .335	-6.283**	- .312
Transportation	15	-10.716**	- .393	-4.777	- .253	-6.285**	- .294
Motor vehicle manufacturing	5	-7.630	- .256	-6.053	- .236	-6.558**	- .245
Stone, Clay, Glass	17	-7.204**	- .287	-7.137**	- .320	-7.080**	- .308
Auto parts	8	-5.255	- .180	-8.106**	- .304	-7.480**	- .273
Machinery manufacturing	48	-10.341**	- .367	-6.695**	- .305	-7.679**	- .324
Beverages, drinks	9	-7.450**	- .306	-7.890**	- .442	-7.944**	- .399
Appliances & electrical equip.	32	-6.450	- .251	-8.417**	- .341	-8.006**	- .320
Ship, plane manufacture	24	-11.587**	- .375	-7.358**	- .279	-8.404**	- .305
Miscellaneous	45	-9.054**	- .354	-8.514**	- .379	-8.731**	- .374
Textiles	12	-8.880**	- .313	-9.246**	- .374	-9.250**	- .360
Apparel	6	-4.391	- .160	-11.048**	- .380	-9.567**	- .331
Retail	21	-6.046	- .271	-10.770**	- .424	-9.604**	- .390
Motion pictures, other	9	-7.284	- .205	-10.499**	- .349	-9.718**	- .308
Airlines	11	-13.801**	- .300	-12.494**	- .371	-13.028**	- .349
	571						

*Beta (regression coefficient) and correlation are derived by regressing real quarterly returns against unexpected inflation.

**Significantly below zero at 5 percent level (one-tailed test).

FOOTNOTES

[1]Bodie [1980], page 12.

[2]These amounts are calculated using data in Biger's Table 10.

[3]This conclusion must be interpreted with some caution. It is based upon an empirical test which assumes that the Long CAPM correctly describes the return-generating process.

[4]In calculating amounts invested in our hedging strategy of Section IIIC, we will assume that a 50 percent margin is required on both long and short positions. The amount invested in the hedge (referred to as w throughout section III) is equal to the amount of the margin.

It is important to note, however, that when a hedge portfolio is used in conjunction with a market portfolio of stocks, long and short positions in the hedge stocks are, in reality, additions to or reductions of long positions within the market portfolio. In this (more general) case, the addition of a hedge portfolio to an investment strategy need not require any additional net investment.

[5]Fama and Schwert regressed nominal returns on housing against unexpected inflation, to obtain a regression coefficient of .45. Then an estimate of the regression coefficient for real returns on housing is -.55. The ratio of (1+R+b) for our hedging strategy is then over 11 times as large as (1+R+b) for housing.

[6]The following equation was estimated by regressing nominal returns on gold against unexpected inflation, using quarterly data from the period 1974III-1979IV.

$$r = .057 + 1.05 \text{ (unexpected inflation}$$
$$R^2 = .003$$
$$T = .0245$$

[7]The realized return on Treasury bills was approximated by subtracting the increase in the Consumer Price Index from nominal Treasury bill returns.

[8]The model used was:

$$E(X_t) = -\theta_1 a_{t-1} - \theta_2 a_{t-2} - \theta_3 a_{t-4} + \delta$$

where

$$a_{t-i} = X_{t-i} + \theta_1 a_{t-i-1} + \theta_2 a_{t-i-2} + \theta_3 a_{t-i-3} - \delta$$

Procedures commonly used in estimation of Box-Jenkins forecasting models were used to re-estimate θ_1, θ_2, θ_3 and δ each quarter, using the most recent 28 observations.

The above model was chosen from among alternative candidates for several reasons. A moving average model incorporates a "learning effect" which can enable it to be robust with respect to instability in the behavior of the time series. Moving average terms at the second and fourth lags were included in part because some seasonality exists in the Consumer Price Index. This seasonality may arise because some items in the "typical market basket" are not sampled every month. For example, college tuition is sampled on an annual basis. Some items are sampled semiannually.

[9]This is in agreement with Bodie's estimate, although he used annual data from a different period (1953-1972).

[10]The portion of variance of real return which was not correlated with unexpected inflation in our sample of 571 firms over the 1960-1979 period ranged from 78.7 percent to 100 percent.

[11]Note that the regression coefficient of the combined stocks is equal to the sum of the coefficients of the individual stocks.

$$b_{\Sigma x} = \frac{Cov(\Sigma xj, y)}{Var(y)} = \frac{E[(\overset{n}{\Sigma} xj - E(\overset{n}{\Sigma} xj))(y-E(y))]}{Var(y)}$$

$$= \frac{E[(x_1-E(x_1))(y-E(y)]}{Var(y)} + \frac{E[(x_2-E(x_2))(y-E(y))]}{Var(y)}$$

$$+ \dots \frac{E[(x_n-E(x_n)(y-E(y)]}{Var(y)}$$

$$= \frac{Cov(x_1,y)}{Var(y)} + \frac{Cov(x_2,y)}{Var(y)} + \dots \frac{Cov(x_n,y)}{Var(y)}$$

$$= b_{x_1} + b_{x_2} + \dots b_{x_n}$$

[12]This is so because, as one would expect, the covariance of returns with unexpected inflation is highly correlated with systematic risk. However, the same appears not to be true of correlations of returns with unexpected inflation. For example, this systematic risk of the long position in the hedging strategy (without perfect foresight) was .98, while that of the short position was 1.06. The difference between the two estimates is statistically insignificant.

[13] See Fama [1975], pages 274-275.

[14] Note that the strategy allows portfolio revision; annual turnover averaged about 35 percent.

[15] Within the context of the Long CAPM, the hedge portfolio need not have zero systematic risk or a zero expected return. Thus, it is not necessary to rank stocks on correlations so as to achieve a hedge portfolio with zero systematic risk. In fact, Long's theory, together with available empirical evidence, would suggest that the hedge portfolio return should covary negatively with aggregate market returns. This is indeed the case in our hedging strategy.

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