

INFLATION AND STOCK RETURNS: EVIDENCE
FROM THE SPANISH STOCK MARKET

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1.- INTRODUCTION

Even if on intuitive grounds it may seem reasonable to think of stocks as a hedge against inflation, the empirical evidence has shown that, in fact, inflation has a negative effect on the stock market. There have been many contributions on this apparent paradox, both at a theoretical and empirical level. Several lines of research have been developed, identifying the different effects whose conjunction results in the negative effect of inflation on stock returns. It is possible to distinguish two different strands in the literature. The first focusing on a microeconomic level and the second on the macroeconomic one.

At a microeconomic level, a first line of research was devoted to the nominal contracting effect, justifying the impact of inflation on stocks by the increase of nominal corporate profits, due to historic cost accounting, and the increment on the effective tax burden of the firm caused by inflation. Relevant references are Feldstein (1980), Feldstein and Summers (1979), Summers (1981), French, Ruback and Schwartz (1983), and Pearce and Roley (1988). A different theoretical justification of the relationship between inflation and stock returns that is based on the stock market equilibrium is the one developed (among others) by Day (1984) and Stultz (1986). In Day's paper the negative correlation between inflation and stock returns results from shocks in the productivity level which inversely affect the rate of inflation both expected and unexpected and the real returns on stocks. On the other hand, Stultz (1986) suggests that unanticipated increases in expected inflation decrease real returns on stocks because of the effect it has on the holding of real balances and on the level of investment in the production process.

Finally, Modigliani and Cohn (1979) suggests that investors irrationality would justify the negative inflation effect.

The macroeconomic approach to this phenomenon establishes that behind the apparent link between inflation and stock returns, there is a chain of relationships which are both economically and statistically justified and whose explicit recognition implies that the statistical effect of inflation on stock returns is not significative anymore. This is the "proxy effect", since inflation is here a substitute for another variable.

Two main theories have been proposed following these lines. On the one hand the approach developed by Fama (1981) shows that inflation is a "proxy" for the future rate of growth, either of national product or else of industrial production. On the other hand, Geske and Roll (1983) challenged that explanation by arguing that the important link goes from changes in real interest rates to real stock returns, so that there is a "reverse causality". Both theories are consistent with Day's (1984) results which establishes the theoretical rational for a negative correlation.

Although this literature has contributed to our understanding of the effect of inflation on stock returns, the effect of its two components, expected and unexpected inflation, is less clear, because their measure rises some difficulties.

Our aim here is to study the effect of inflation on stock market returns in Spain. This is of interest by itself not only because it has not been previously studied, but also because international evidence is particularly helpful in the analysis of this problem^{1/}. We also particularly want to emphasize the fact that distinguishing the expected and unexpected components of inflation could be done more accurately in industrial countries in which, like in Spain, inflation has varied within a wide range, with a top annual rate of 24,5% in 1977 and rates close to 5% in the last years, while this has not produced a structural disequilibria. This high variability of the inflation rate will help in obtaining additional evidence so as to sustain one of the different proposed explanations of the inflation effect. Namely, we want to use the Spanish evidence to test 1) which is the best method to compute expected and

unexpected inflation: an autoregressive analysis of the inflation series or the use of short term interest rates to obtain the expected value of the real interest rates which, in turn, allows us to determine the expected inflation rate as a difference between short term interest rates and expected real interest rates; 2) how the effect on stock returns is affected by the choice of one particular way of computing the expected and unexpected components of inflation and 3) whether this two components are equally important in the analysis of stock returns.

Our results show, first of all, that the expected and unexpected components of inflation are better measured using autoregressive methods on the inflation series rather than computing them indirectly by making use of the series of ex post real interest rates.

The superiority of the autoregressive analysis of the inflation series is reflected in the results we obtain on the effect of expected and unexpected inflation on real stock returns: when using interest rates to compute the two inflation components, there is no effect of either variable on real stock returns; still, if we compute them out of the inflation series we obtain evidence of the negative effect of inflation on stock returns.

Over the period of analysis (1976-1988) both expected and unexpected inflation have a significant effect. Still, if we divide the period so as to allow for structural changes in the economy, we observe that, in fact, only expected inflation had an effect on stock returns over a first period 1976-1979, while exactly the opposite holds true in the posterior subperiod, 1980-1988. More precisely, expected inflation had an influence on stock returns over a two year period, during which inflation was close to 20%. Except for that period, unexpected inflation seems to be the relevant variable as far as the analysis of the stock market is concerned.

The preeminence of the unexpected inflation variable is corroborated using a portfolio approach. We know that the effect of inflation, both expected and unexpected, on stock returns should be higher for higher beta stocks, and this should be true whatever the origin of the

effect of inflation on stock returns, if there exists a risk free asset whose real return is less sensitive to inflation than the one of the market. In order to test this, we construct 10 portfolios ranking from low to high beta, and regress the returns of each portfolio on expected and unexpected inflation. The result is that high beta portfolios are clearly more sensitive to unexpected inflation than low beta ones, while this is not so for the expected inflation.

Finally, we conclude our analysis by looking at the effect of the monthly announcement of the inflation rate on the daily market return. Again, the previous negative evidence is confirmed for unexpected inflation.

The structure of the paper is the following: in the next section, we will examine the different ways which can be used to compute expected and unexpected inflation and how they perform in the Spanish economy. Then, after describing the data in section 3, we analyze the effect of expected and unexpected inflation on aggregate real stock returns. This is presented in section 4. In section 5 we examine the effect of inflation on the returns of portfolios that differ by their beta and in section 6 we examine announcement effects. Finally, section 7 provides some concluding remarks.

2.- EXPECTED AND UNEXPECTED INFLATION

Two alternative methods to construct series of the expected and the unexpected components of inflation have been used in the literature. The first one is straightforward: the autoregressive analysis of the inflation series yields an expected and an unexpected rate of inflation. The implicit assumption underlying this approach is that investors have rational expectations. This approach has been developed by Nelson (1976), Schwert (1981), Pindyck (1984) and Kaul (1987) who uses it for the analysis of expected inflation in the cases of

Canada and Germany.

The second method pioneered by Fama (1975), is based on the difference between short term nominal interest rates and real interest rates, that reflects the market expectations on inflation. The underlying assumption here is that investors will only accept interest rates that fully compensate them for the expected depreciation in the real value of the asset. This measure of expected inflation has been used in the subsequent works of Fama (Fama and Schwert (1977), Fama (1981), Fama and Gibbons (1984)) as well as in Solnik (1983), James, Koreisha and Partch (1985), Bernard (1986) and Kaul (1987) for the U.S. and U.K.

In order to understand the relationship between these two alternative methods of measuring expected and unexpected inflation, the starting point is the Fisher relationship between nominal and real interest rates. Taken as an ex post equality, the Fisher condition simply determines the realized value of the real interest rate, that is given by

$$r_t = NR_{t-1} - \pi_t \quad (1)$$

where r_t is the real interest rate, NR_{t-1} is the nominal interest rate for the period that goes from $t - 1$ to t , and π_t is the corresponding inflation rate. (The choice of the subindexes is made so as to reflect the dates at which the observation of the variable is possible).

Ex ante, the Fisher equation is a relationship between nominal rates and **both** expectations on real interest rate and on the inflation rate:

$$NR_{t-1} = E[r_t|\phi_{t-1}] + E[\pi_t|\phi_{t-1}] \quad (2)$$

where expectations are taken conditionally on all the information available at period $t - 1$, that is supposed to be summarized in the value of ϕ_{t-1} .

The ex ante Fisher equation allows us to determine expected inflation out of an assumption on the way in which expectations on real interest rates are formed and reciprocally, so that we obtain expected real interest rates out of the hypothesis on expected inflation movements.

Adding (1) to (2) we obtain:

$$- [E[r_t|\phi_{t-1}] - r_t] = E[\pi_t|\phi_{t-1}] - \pi_t \quad (3)$$

so that the deviation of real interest rates from its expected value equals unexpected inflation. This implies that assuming rational expectations on inflation yields rational expectations on real interest rates. In addition, it entails that minimizing the errors in forecasting the value of one variable is equivalent to minimizing the errors in the forecasting of the other one.

We have considered both approaches. On the one hand, we have performed an autoregressive analysis of the inflation series for the Spanish economy and obtained expected inflation from march 1976 to september 1988. On the other hand, we have applied Fama and Gibbons approach to the one month interbanking rate, obtaining a series of expected inflation from july 1980 to september 1988.

The analysis of the inflation series shows that inflation can be modeled as

$$\Delta\Delta_{12}\pi_t = (1 - .97B)(1 - .30B^3)(1 - .82B^{12})a_t$$

where Δ indicates first differences, Δ_{12} differences of order 12, B is the backwards shift operator, so that $B^k x_t = x_{t-k}$, and a_t is white noise.

Although some of the papers, like Fama and Schwert (1977), Geske and Roll (1983), Solnik (1983), and James, Koreisha and Partch (1985), make use of the extreme assumption of constant real interest rates, the analysis of the series of real interest rates has been extended so as to take into account the stochastic process that underlies the real interest rate movements. This is a more powerful approach which has been developed by Fama and Gibbons (1984) and Fama (1981). Following this line, we obtain the following process for

$$(1 - .23B^{12})\Delta r_t = a_t$$

We are able to compare the two methods by estimating the standard error of the variable a_t . The results are reported in Table 1.

The diagonal of the table contains the standard error of the unexpected components of each variables as it results from the autoregressive analysis. We are then able to compute the standard deviation of the errors for the other variable which, according to equation (3), is equal to the standard error of the variable except for rounding errors.

The outcome of this comparison is that, at least in the Spanish economy, the autoregressive analysis of the series yields a better approximation to both the stochastic process of inflation and real interest rates. This is in contrast to the result obtained by Schwert (1981) on the U.S. market, which showed a slightly smaller standard deviation for unexpected inflation using the Treasury Bill model. The difference could be attributed to imperfections in the interbanking market.

3.- THE DATA

The inflation data represent the percentage changes in the Consumer Price Index. This index is readily available from the Bank of Spain and the Instituto Nacional de Estadística. Data on industrial production are employed as indicative of real economic activity. The monthly index of industrial production is also available from the Bank of Spain. The data finally used correspond to the percentage changes in the index.

The monthly and daily returns on the market portfolio were obtained as the percentage changes in the index provided by the Banco Bilbao Vizcaya (BBV). This is an index adjusted by changes in the capital structure and by dividends. It contains approximately 70 stocks from the four stock exchanges in the country. It is a value-weighted index rebalanced every year, and data on prices for shares trading on more than one stock exchange are taken from the exchange on which the share had highest trading volume.

Finally, monthly data on individual securities are from the Instituto de Economía Pública. The 25 year period covered by this data starts in December 1962 and ends in December 1987. This means that a total of 300 monthly returns are available. The final sample is composed of 165 stocks.

4.- AGGREGATE EFFECT OF EXPECTED AND UNEXPECTED INFLATION

In this section, we examine the effect of expected and unexpected inflation on real stock returns. We also test the hypothesis that bringing in the future rate of growth of production may cancel the significative effect of inflation as suggested by Fama (1981) and Kaul (1987).

For the sake of completeness, we also examine the same regressions using the measures of expected and unexpected inflation obtained out of the short-term interest rate series as well as the effect of introducing a rate of growth that has been deseasonalized.

Our main results are summarized in Table 2. The empirical evidence suggests that for the whole period both expected and unexpected inflation have a significant negative effect on real stock returns. This is in accordance with the results obtained by Fama (1981) and Kaul (1987) for monthly data.

In order to allow for structural changes, we examine the same relationship on two subperiods. In fact, the relationship obtained for the whole period results from an important effect of expected inflation during the years 1976-1980 combined with an important effect of unexpected inflation from 1980 till 1988. Other partitions of the period of analysis are possible, and they indicate that the effect of expected inflation is concentrated over a short period around the years 1977 and 1978, during which the inflation rate was the highest of the

period. Given that we are dealing with a very short period, it is difficult to establish a link between the two phenomena, as it is difficult to trace back the effect of expected inflation to any other characteristic of these two years.

On the other hand, unexpected inflation has an effect on real stock returns over a much longer period which extends until 1988 and, although it does not have a significant effect over the first subperiod^{2/}, its effect upon inflation does not depend precisely on the partition in two subperiods. This suggests that emphasis should be placed not on expected but on unexpected inflation.

Now, although the effect of expected inflation is the most anomalous one, the fact that unexpected inflation affects stock returns still has to be explained. So we first investigate the "proxy" hypothesis as it has been used to understand the effect of expected inflation by Fama (1981) and Kaul (1987).

Introducing the future rate of growth of industrial production does not alter the results. Although it decreases the value of the t-statistic, the effect of expected and unexpected inflation still remains. It should be pointed out that this variable has a positive significant coefficient, as predicted by the theory, only on the second subperiod, which confirms the idea that the analysis over the period 1980-88 yields more reliable results. To further establish the absence of this proxy effect, we have introduced the rate of growth of industrial production with other time leads, still this entails an even stronger rejection of the "proxy" hypothesis^{3/}.

Since industrial production series have a high seasonal component, we investigate the proxy effect using deseasonalized series for the future rate of growth of industrial production.

The results reported in Table 3 show that the coefficient of the rate of growth of industrial production is not significant anymore at the 5% level for the second subperiod. This suggest that the proxy effect could be related to the way in which seasonality is treated in the

literature on the proxy effect.

When using different estimates of expected and unexpected inflation, computed from the real interest rates, the results show that neither component of inflation is significant (See Table 4). The comparison with the previous result (that can only be done on the last subperiod because of the availability of data on interest rates) shows the sensitiveness of the unexpected inflation effect to the way we compute it. This seems to confirm the fact that the measure of expected and unexpected inflation is less reliable.

A third way to examine the effect of inflation is to regress real stock returns on expected inflation and on changes in this variable, which although correlated to the unexpected inflation contains a slightly different information. The results are akin to the ones we obtain when regressing real stock returns on expected and unexpected inflation (See Table 5). Still, when we regress real stock returns on expected, unexpected inflation and changes in expected inflation, it becomes quite clear that unexpected inflation dominates over changes in expected inflation, since this last variable is not significant anymore.

Consequently, use of expected and unexpected inflation computed from the autoregressive analysis of inflation yield better results than any other choice for these variables. Still, the effect of expected and unexpected inflation is not symmetrical. Even if both variables are significant, the expected inflation disappears if we suppress two years from the sample period. For this reason we believe that unexpected inflation is the relevant variable. The analysis of the next section comforts this view.

5.- UNEXPECTED INFLATION AND SYSTEMATIC RISK

A common feature of the models explaining the negative impact of inflation on stock returns

is the following: when there is a decrease in the rate of return of the market portfolio, those assets whose betas are particularly high will be more affected and, consequently, their returns will vary more negatively with unexpected inflation. In other words, we expect an inverse relationship between systematic risk and inflation betas. Moreover, our conjecture is that this relationship may clarify the relative importance of expected and unexpected inflation.

In order to test this hypothesis, the number of securities with complete data from 1976 to 1987 was observed. These securities were ranked according to their beta estimated during the whole period. Therefore, this ranking was maintained throughout the period, and ten equally weighted portfolios with approximately the same number of securities were obtained. Hence, portfolio one contains the firms with the smallest betas and portfolio ten includes high beta firms.

Table 6 reports the results of regressing the returns of the ten beta sorted portfolios on unexpected and expected inflation^{4/}. Two empirical regularities seem to be relevant in this table. First of all, the results confirm the unexpected inflation as the important variable affecting real stock returns. At the same time, except for the smallest beta firms, the level of expected inflation does not significantly affect real stock returns. However, it is interesting to note the rather high impact of expected inflation on low beta firms, which on the other hand, are firms with the smallest coefficients for the unexpected inflation.

Secondly, our results confirm the hypothesis that firms with the highest systematic risk would have rates of returns most negatively correlated with unexpected inflation. This is the case, irrespectively of including or not expected inflation in the regressions. Moreover, using an F-test with a full covariance matrix of residuals, we can reject the hypothesis that unexpected inflation betas are equal across the ten beta sorted portfolios. Table 7 contains the results.

We can therefore conclude that even after controlling for systematic risk, unexpected inflation

is negatively related to real stock returns, and that this is particularly the case the highest the systematic risk.

Returning to potential explanations of the empirical results, we know that the work of Fama (1981) indicates that the negative relationship between unexpected inflation and real stock returns is simply a proxy for the fundamental relation between anticipated real activity and stock returns. As we have seen in the previous section, the empirical results do not provide enough support for either the proxy hypothesis or for the Geske and Roll (1983) arguments. An alternative explanation should be considered.

Apart from the proxy effect suggested by these authors, the most convincing argument for this negative relation is, in fact, provided by Stulz (1986) in a paper that seems to offer an explanation for the negative relation between the level of expected inflation and stock returns. However, under rational expectations when investors observe the level of inflation, they should adjust their expectations about future inflation given the innovation in the current inflation rate. Therefore, the arguments in Stulz's paper are precisely relevant because they are the rational consequence of unexpected inflation or, alternatively, the implication of a change in expected inflation.

The increase in the opportunity cost of real balances is produced by "bad news" about the inflation rate. As a consequence, real interest rate has to fall to maintain the equilibrium in the money market. In the simplest case in which the mean-variance opportunity set is unchanged, the market portfolio moves down along the frontier at the same time that the real interest rate falls. Therefore, we have an attractive explanation of the negative relation between unexpected inflation and real stock returns.

It should be noted that there is a symmetry between the proxy argument of Fama (1981) and Stulz's reasoning. In this later paper, given a positive covariance between the real interest rate and the real return on the market portfolio, the influence of unexpected inflation on

stock returns should disappear once we allow for the negative effect of unexpected inflation on the real rate of interest. Unfortunately, when we tested this new "proxy hypothesis", by including the real interest rate on the regression, the coefficient of unexpected inflation became even more negative and significant than before.

On the other hand, the slope coefficient of regressing unexpected inflation on the real rate of interest coincides with Stutz's hypothesis. It is negative and significant. Once again, we must conclude that a complete explanation of the negative effect of unexpected inflation on real stock returns has not yet been found, at least when Spanish data is employed. This is, of course, a disturbing fact which justifies further theoretical work in this area.

6.- RESPONSE OF DAILY STOCK PRICES TO INNOVATIONS ON INFLATION RATES

This section extends the previous empirical evidence by studying the reaction of daily stock returns to the announcement of the Consumer Price Index inflation rate.

To the best of our knowledge, this is the first study of the response of daily stock prices to economic news in a rather thin equity market. Previous empirical evidence is only found for the U.S. market by Schwert (1981), Pearce and Roley (1985) and Jain (1988). Schwert shows that the market reacts negatively to the announcement of unexpected inflation; Pearce and Roley using survey data cannot find any significant relation, whilst Jain reports that when hourly data is employed, the CPI announcements are statistically and significantly related to stock returns.

This type of study may be of interest since it allows a rather precise estimate of the impact of surprises regarding the inflation rate upon the stock market. Moreover, it becomes an

effective way to study the informational efficiency of the market.

The period covered by this section goes from January 1984 to December 1988. This implies that we have data on 60 announcements. Given the empirical results of the previous section, we might expect a negative effect of unexpected inflation on stock returns. Note also that independently of the reason for having a negative impact in the day of the announcement, if the stock market is efficient, prices will react to information on the inflation rate when it first becomes available. Moreover, the hypothesis argues that the full negative response of stock prices to unexpected inflation should occur basically immediately.

To analyze the efficient market hypothesis, we observe the reaction of daily stock prices from -5 to +5 days after the announcement. It should be pointed out that the announcement date is the date in which daily newspapers include the actual inflation rate for the month^{5/}.

In order to estimate the impact of new information regarding the inflation rate on stock prices and to test the efficient market hypothesis, the following regression model was run for the 10 dates around the announcement date and for the date itself:

$$R_t = \beta_0 + \beta_1 UINF_t + \varepsilon_t \quad ; \quad t = -5, -4, \dots, 0, \dots, +4, +5 \quad (4)$$

where R_t is the return on the daily market index from $t-1$ to t and $UINF_t$ is the unexpected inflation for the corresponding month.

The empirical results, using the ARIMA methodology to construct the expected rate of inflation, are contained in Table 8. From 1984 to 1988, the estimation results tend to indicate that inflation surprises affect stock prices negatively and significantly. The major impact, however, seems to occur on the first and on the fifth day after the announcement. At the same time, three and two days before the announcement, the relationship between unexpected inflation and stock returns is also negative and significant. The coefficient on the announcement date is negative but significant only at the 10% level.

The results clearly indicate that common stock returns tend to be significantly and negatively affected during the days surrounding the innovation on inflation. On the other hand, the effect does not seem to occur primarily on the announcement date. On the contrary, the empirical results seem to imply that there is both leakage of information prior to the official announcement date (or else production of a good estimate of unexpected inflation by financial operators), and a rather slow response by the stock market to the news contained in the unexpected inflation.

It is interesting to examine the pattern of the negative response. Even if there is an effect two and three days before the announcement, on the day just before the formal arrival of news, it seems that the market becomes cautious waiting for the confirmation of the rumours that reached the market during the previous days. Finally, on the announcement date and on the next day, the negative impact is confirmed.

Table 9 contains the results using the Fama-Gibbons (1984) methodology for obtaining the serie of unexpected inflation. As in the results of section four of this paper, the conclusions are quite similar but they are not as strong as in the previous table. Once more, the way in which expected and unexpected inflation are estimated seems to be a crucial issue.

7.- CONCLUSIONS

This paper has investigated the effect of expected and unexpected inflation on real stock returns from 1976 to 1988 in Spain. It turns out that for the whole period both expected and unexpected inflation have a negative and significant impact on real stock returns. However, the results are sensitive to the way in which expected inflation is estimated. The negative relationship is significant only when an ARIMA methodology directly applied to the inflation

serie is employed. Moreover, it has been shown that this methodology is statistically superior to the alternative procedure used in obtaining a series of expected and unexpected inflation.

The paper also reports evidence on the relative importance of expected and unexpected inflation on stock returns. In particular, it seems possible to conclude that the relevant phenomenon is related to unexpected inflation rather than to expected inflation. Of course, this should be the case given that information already available about future economic activity is expected to be embedded in stock prices and to have no effect on the valuation of real cash flows. Unfortunately, however, a convincing explanation for the negative relationship between unexpected inflation and real stock returns has not been supported by the empirical results.

The fact that unexpected inflation appears to be the relevant variable is confirmed by our portfolio analysis. An inverse relationship between systematic risk and the effect of the unexpected inflation variable is clearly supported by the data. However, this is not found when expected inflation is employed.

Finally, in order to study the impact of unexpected inflation on stock returns on the announcement date, an analysis with daily stock market data is performed. The results tend to indicate that common stock returns are significantly and negatively affected during the days surrounding the innovation on inflation.

NOTES

- 1/ See Firth (1979), Solnik (1983) and Kaul (1987). In particular, Firth (1979) analyzes the Spanish case. However, he does not distinguish between expected and unexpected inflation.
- 2/ Since real stock returns are subject to large variations which we consider as random, we cannot expect to have evidence on the effect of inflation over a short period of time, since the coefficients in the regression will have a large standard deviation.
- 3/ The empirical results of Table 2 were replicated by employing the Cochrane-Orcutt transformation to eliminate autocorrelation in the residuals. The results remained the same, except for a slightly improvement in the coefficient of the unexpected inflation during the eighties.
- 4/ The inflation series used in Table 6 are based on the ARIMA methodology.
- 5/ We thank the Instituto Nacional de Estadística (INE) for providing us with these dates.

TABLE 1

MEASURES OF EXPECTED INFLATION

	Standard deviation of error	
	ARIMA on inflation	ARIMA on real interest rates
π_t	.432	1.465
r_t	.432	1.464

TABLE 2

REAL STOCK RETURNS, INFLATION AND INDUSTRIAL PRODUCTION

$$RSR_t = \beta_0 + \beta_1 EINF_t + \beta_2 UINF_t + \beta_3 DPR_{t+1} + \epsilon_t^a$$

Period	β_0	β_1	β_2	β_3	$\overline{R}^2$	$\hat{\rho}_1^b$	$\hat{\rho}_2$	ρ_3	$\hat{\rho}_4$	$\hat{\rho}_{12}$
(1) 1976:3-1988:9	0.028 (2.37) ^c	-2.872 (-2.79)	-2.851 (-2.65)	—	0.079	0.225	-0.025	-0.218	0.010	0.057
	-0.003 (-0.55)	—	—	0.081 (0.59)	-0.004	0.272	0.041	-0.074	0.114	0.093
	0.026 (2.11)	-2.845 (-2.76)	-2.882 (-2.67)	0.081 (0.62)	0.075	0.222	-0.025	-0.216	0.021	0.059
(2) 1976:3-1980:6	0.046 (1.70)	-5.296 (-2.76)	1.411 (-1.27)	—	0.137	-0.134	-0.022	-0.039	0.007	-0.040
	-0.023 (-2.48)	—	—	-0.137 (-0.80)	-0.007	-0.098	-0.011	0.069	-0.012	0.023
	0.046 (1.69)	-5.201 (-2.66)	-1.387 (-1.23)	-0.052 (-0.32)	0.121	-0.134	-0.033	-0.044	-0.004	-0.037
(3) 1980:7-1988:9	0.017 (1.25)	-0.773 (-0.53)	-3.462 (-1.98)	—	0.019	0.299	-0.060	-0.266	-0.017	0.022
	0.006 (0.72)	—	—	0.388 (2.10)	0.034	0.256	-0.122	-0.291	0.057	0.013
	0.003 (0.21)	0.170 (0.11)	-3.188 (-1.84)	0.387 (2.00)	0.049	0.232	-0.118	-0.277	0.019	0.019

^a RSR_t = real stock returns for period t ; $EINF_t$ = expected inflation at $t-1$ for period t ; $UINF_t$ = unexpected inflation for period t ; DPR_{t+1} = annual growth rate for industrial production for period $t+1$. Inflation series based on the ARIMA methodology.

^b $\hat{\rho}_k$ = residual autocorrelation at lag k .

^c t-statistic in parenthesis.

TABLE 3

REAL STOCK RETURNS, INFLATION AND INDUSTRIAL
PRODUCTION ON MONTHLY BASIS

$$RSR_t = \beta_0 + \beta_1 EINF_t + \beta_2 UINF_t + \beta_3 DPR_{t+1} + \epsilon_t^a$$

Period	β_0	β_1	β_2	β_3	$\bar{R}^2$	$\hat{\rho}_1^b$	$\hat{\rho}_2$	$\hat{\rho}_3$	ρ_4	$\hat{\rho}_{12}$
(1) 1976:3-1988:9	-0.002 (-0.35) ^c	—	—	0.080 (0.89)	-0.001	0.269	0.050	-0.073	0.111	0.087
	0.028 (2.43)	-2.976 (-2.89)	-2.894 (-2.70)	0.108 (1.25)	0.082	0.213	-0.008	-0.210	0.022	0.049
(2) 1976:3-1980:6	-0.027 (-3.73)	—	—	-0.165 (-1.36)	0.016	-0.098	0.021	0.077	0.011	-0.016
	0.043 (1.51)	-5.100 (-2.49)	-1.356 (-1.19)	-0.037 (-0.30)	0.121	-0.131	-0.022	-0.040	-0.001	-0.045
(3) 1980:7-1988:9	0.011 (1.58)	—	—	0.192 (1.69)	0.019	0.292	-0.030	-0.251	0.058	-0.005
	0.017 (1.21)	-0.777 (-0.54)	-3.246 (-1.86)	0.176 (1.56)	0.034	0.290	-0.030	-0.258	0.009	0.003

^a RSR_t = real stock returns for period t ; $EINF_t$ = expected inflation at $t - 1$ for period t ; $UINF_t$ = unexpected inflation for period t ; DPR_{t+1} = monthly growth rate of industrial production for period $t + 1$. Inflation series based on the ARIMA methodology.

^b $\hat{\rho}_k$ = residual autocorrelation at lag k .

^c t -statistic in parenthesis.

TABLE 4

REAL STOCK RETURNS, INFLATION AND INDUSTRIAL PRODUCTION
INFLATION SERIES BASED ON FAMA-GIBBONS (1984)

$$RSR_t = \beta_0 + \beta_1 EINF_t + \beta_2 UINF_t + \beta_3 DPR_{t+1} + \epsilon_t^a$$

Period	β_0	β_1	β_2	β_3	$\overline{R}^2$	$\hat{\rho}_1^b$	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_{12}$
(1) 1980:7-1988:9	0.024	-1.540	-2.391	-----	0.005	0.303	-0.061	-0.278	-0.010	0.030
	(1.87) ^c	(-1.14)	(-1.42)							
	0.013	-0.817	-1.986	0.350	0.028	0.269	-0.108	-0.290	0.030	0.029
	(0.89)	(-0.58)	(-1.19)	(1.81)						

^a RSR_t = real stock returns for period t ; $EINF_t$ = expected inflation at $t - 1$ for period t ; $UINF_t$ = unexpected inflation for period t ; DPR_{t+1} = annual growth rate of industrial production for period $t + 1$. Inflation series based on the FAMA-GIBBONS (1984) methodology.

^b $\hat{\rho}_k$ = residual autocorrelation at lag k .

^c t-statistic in parenthesis.

TABLE 5

REAL STOCK RETURNS, INFLATION AND INDUSTRIAL PRODUCTION

$$(A) \quad RSR_t = \beta_0 + \beta_1 EINF_t + \beta_2 DEINF_t + \beta_3 DPR_{t+1} + \epsilon_t^a$$

Period	β_0	β_1	β_2	β_3	$\bar{R}^2$	$\hat{\rho}_1^b$	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_{12}$
(1) 1976:3-1988:8	0.042	-4.290	-2.265	—	0.062	0.221	-0.041	-0.195	0.006	0.036
	(3.05) ^c	(-3.43)	(-2.00)							
	0.041	-4.260	-2.244	0.046	0.056	0.221	-0.040	-0.192	0.015	0.038
	(2.83)	(-3.39)	(-1.98)	(0.35)						

$$(B) \quad RSR_t = \beta_0 + \beta_1 EINF_t + \beta_2 DEINF_t + \beta_3 UINF_t + \epsilon_t^a$$

Period	β_0	β_1	β_2	β_3	$\bar{R}^2$	$\hat{\rho}_1$	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_{12}$
(1) 1976:3-1988:8	-0.001	—	0.367	-2.911	0.030	0.258	0.029	-0.122	0.085	0.087
	(-0.23)		(0.37)	(-2.57)						
	0.038	-3.915	-1.662	-2.431	0.085	0.220	-0.040	-0.228	-0.004	0.037
	(2.80)	(-3.14)	(-1.44)	(-2.19)						

^a RSR_t = real stock returns for period t ; $EINF_t$ = expected inflation at $t - 1$ for period t ; $UINF_t$ = unexpected inflation for period t ; DPR_{t+1} = annual growth rate of industrial production for period $t + 1$; $DEINF_t$ = changes in expected inflation for period t . Inflation series based on the ARIMA methodology.

^b $\hat{\rho}_k$ = residual autocorrelation at lag k .

^c t-statistic in parenthesis.

TABLE 6

UNEXPECTED INFLATION AND SYSTEMATIC RISK

$$RSR_{it} = \beta_0 + \beta_1 EINF_t + \beta_2 UINF_t + \epsilon_t^a; \quad i = 1, \dots, 10$$

1976:3-1987:12	β_0	β_1	β_2	$\bar{R}^2$	DW ^b	BETA
BETA 1	0.006 (1.25) ^c	—	-1.888 (-1.96)	0.020	1.34	0.497
	0.039 (3.67)	-3.177 (-3.44)	-1.785 (-1.92)	0.090	1.44	
BETA 2	0.009 (1.59)	—	-2.336 (-2.12)	0.024	1.47	0.681
	0.031 (2.48)	-2.153 (-1.99)	-2.266 (-2.07)	0.044	1.56	
BETA 3	0.008 (1.39)	—	-2.596 (-2.27)	0.029	1.56	0.782
	0.026 (1.99)	-1.738 (-1.54)	-2.540 (-2.23)	0.036	1.60	
BETA 4	0.008 (1.26)	—	-2.683 (-2.16)	0.025	1.50	0.890
	0.033 (2.33)	-2.411 (-1.98)	-2.605 (-2.12)	0.045	1.57	
BETA 5	0.010 (1.52)	—	-3.397 (-2.67)	0.042	1.67	0.954
	0.025 (1.72)	-1.489 (-1.18)	-3.349 (-2.63)	0.044	1.71	
BETA 6	0.013 (1.79)	—	-2.503 (-1.73)	0.014	1.60	1.040
	0.029 (1.77)	-1.586 (-1.10)	-2.451 (-1.69)	0.015	1.60	
BETA 7	0.010 (1.44)	—	-3.269 (-2.29)	0.029	1.43	1.119
	0.027 (1.62)	-1.569 (-1.11)	-3.218 (-2.25)	0.031	1.47	
BETA 8	0.008 (1.02)	—	-3.977 (-2.51)	0.036	1.49	1.225
	0.024 (1.34)	-1.567 (-1.00)	-3.926 (-2.48)	0.036	1.52	
BETA 9	0.014 (1.37)	—	-4.271 (-2.13)	0.024	1.68	1.332
	0.045 (1.97)	-3.022 (-1.52)	-4.174 (-2.09)	0.033	1.75	
BETA 10	0.011 (0.96)	—	-4.562 (-2.07)	0.023	1.31	1.502
	0.038 (1.48)	-2.579 (-1.18)	-4.479 (-2.03)	0.026	1.36	
MARKET	0.026 (2.04)	-2.801 (-2.51)	-2.765 (-2.46)	0.071	1.53	

^a RSR_{it} = real stock returns for 10 beta sorted portfolios, $EINF_t$ = expected inflation at $t - 1$ for period t , $UINF_t$ = unexpected inflation for period t

^b DW = Durbin-Watson

^c t-statistic in parentheses

TABLE 7

TEST OF HYPOTHESIS THAT INFLATION BETAS ARE EQUAL
ACROSS ALL BETA SORTED PORTFOLIOS. 1976-1987

Portfolios	F-Statistic ^a	Degrees of Freedom	Significance Level
10 beta sorted portfolios	2.007	(9, 1400)	0.035

^a The F-test allows for a different intercept and a full covariance matrix of residuals.

TABLE 8

REAL STOCK RETURNS AND UNEXPECTED INFLATION:
ANNOUNCEMENT EFFECTS USING THE ARIMA METHODOLOGY
1984-1988

$$RSR_t = \beta_0 + \beta_1 UINF_t + \varepsilon_t^a$$

Days Relative to the Announcement Date	β_0	β_1	$\bar{R}^2$	D-W ^b
-5	-0.0003 (-0.17) ^c	0.166 (0.37)	-0.015	1.872
-4	0.002 (1.29)	0.242 (0.56)	-0.012	1.770
-3	-0.0005 (-0.33)	-0.738 (-1.97)	0.046	2.458
-2	0.003 (2.20)	-0.892 (-2.22)	0.063	2.044
-1	0.001 (0.96)	-0.183 (-0.54)	-0.012	2.272
0	0.001 (0.92)	-0.664 (-1.70)	0.031	2.019
+1	-0.002 (-0.98)	-0.995 (-2.09)	0.054	1.691
+2	-0.002 (-1.12)	0.035 (0.10)	-0.017	1.978
+3	0.017 (1.39)	0.018 (0.06)	-0.017	1.987
+4	0.001 (0.65)	-0.641 (-1.29)	0.011	1.212
+5	0.002 (1.13)	-1.071 (-2.27)	0.066	1.770

^a RSR_t = real stock return for period t relative to the announcement day; $UINF_t$ = unexpected inflation for period t . Inflation series based on the ARIMA methodology.

^b D-W = Durbin-Watson statistic.

^c t -statistic in parenthesis.

TABLE 9

REAL STOCK RETURNS AND UNEXPECTED INFLATION:
ANNOUNCEMENT EFFECTS USING THE FAMA-GIBBONS METHODOLOGY
1984-1988

$$RSR_t = \beta_0 + \beta_1 UINF_t + \epsilon_t^a$$

Days Relative to the Announcement Date	β_0	β_1	$\bar{R}^2$	D-W ^b
-5	-0.0004 (-0.25) ^c	0.186 (0.51)	-0.013	1.859
-4	0.002 (1.22)	0.031 (0.09)	-0.017	1.765
-3	0.00008 (0.06)	-0.539 (-1.75)	0.034	2.465
-2	0.004 (2.68)	-0.750 (-2.31)	0.068	2.035
-1	0.001 (1.09)	-0.198 (-0.72)	-0.008	2.261
0	0.002 (1.27)	-0.554 (-1.75)	0.034	1.980
+1	-0.001 (-0.57)	-0.729 (-1.87)	0.041	1.633
+2	-0.002 (-1.21)	0.238 (0.82)	-0.005	1.989
+3	0.002 (1.42)	-0.097 (-0.37)	-0.015	1.995
+4	0.002 (0.87)	-0.310 (-0.76)	-0.007	1.172
+5	0.003 (1.54)	-0.689 (-1.77)	0.035	1.737

^a RSR_t = real stock returns for period t relative to the announcement day; $UINF_t$ = unexpected inflation for period t . Inflation series based on the Fama-Gibbons (1984) methodology.

^b D-W = Durbin-Watson statistic.

^c t-statistic in parenthesis.

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