# Hedging inflation by selecting stock industries

**Author:** D. van Antwerpen
**Student number:** 288660
**Supervisor:** Dr. L.A.P. Swinkels
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## I. Introduction

With the recession at it's end last year and the economies all over the world growing again, the expectations for inflation are rising. According to the Fisher Model (Fisher 1930), expected nominal rates of return on assets should move with expected inflation. Thus stocks should be a good hedge against inflation. However there are a lot of empirical findings that the relation between stock returns and inflation (expected and unexpected inflation) is negative. For example Bodie (1976) concluded that to hedge against inflation with stocks, one must sell them short. This is in contrary to the Fisher Model as it claims that it would compensate for inflation. However there is a possibility that stocks in a certain industry perform better as an inflation hedge than the market does.

Boudoukh et al (1994) concentrated their research on the relation between 22 industry portfolios and expected and unexpected inflation. Their conclusion was that the short term (1 quarter) relation between industry returns and inflation was negative, but the long term (1 year) relation was positive. However their research was based on a relative short sample size (1953-1990). We will try to replicate their paper with a larger sample, namely 1928-2008. We use a 1 year holding period instead of the 1 quarter holding period used by Boudoukh et al (1994). We chose a 1 year holding period because we think this is the appropriate length to see good results. Using quarters may be too short. This 1 year holding period is monthly overlapping yearly data instead of using non-overlapping quarters. The reason for using monthly overlapping yearly data is that this is a slightly more statistically better way to find the relation between industry returns and inflation. Our main objective is to find out what stock industries are the best inflation hedges.

## II Theory

*A. Dividend Discount Model*

According to the Dividend Discount Model, the stock price of today ($P_0$) is calculated by $P_0 = \sum_{t=1}^{\infty} \frac{D_t}{(1+r_t)^t}$. So when investors are expecting an higher inflation rate in the future, the level of return ($r_t$) will rise because they want a higher level of return to compensate for inflation. When the dividend ($D_t$) remains the same, the stock price of today will go down. Thus there is according to the Dividend Discount Model a negative relation between inflation and stock returns when the dividend remains the same.

When we assume that the dividend would rise with the rate of inflation and that investors want a higher rate of inflation, which is the same as the rate of inflation, nothing will happen with the stock price of today. However it is doubtful that the dividend will rise every year with the inflation rate. For example when the price of raw materials would rise, it is not always possible to let the consumer pay for the extra costs. Thus more costs and thus a lower profit will decrease the dividends. So according to the Dividend Discount Model a negative relation between inflation and stock returns will remain because it is doubtful that during inflation the dividends will rise with the rate of inflation.

*B. Empiric Results*

The main objective of this paper is to find out what stock industries are the best inflation hedges, and is based on the paper of Boudoukh et al (1994). They suggest that inflation is negative correlated with inflation. This in contrary with the

Fischer model (Fisher 1930), which suggest that expected return on assets move one-on-one with inflation: $R^{i}_{t,t+1} = \alpha_i + \beta_i E_t(\pi_{t,t+1}) + \varepsilon^{i}_{t+1}$, with $H_0$: $\beta_i = 1$. Fischer suggests that the real and monetary sectors of the economy are independent. Thus the real rate is not related to the monetary sector, but is being determined by the real factors (for example productivity and risk aversion). However Boudoukh et al's (1994) results during the period 1953-1990 showed that on short term horizons of 1 quarter the relation is negative (and thus the $H_0$ of the Fischer Model must be rejected), but on long term horizons, which is by the way not that long, of 1 year is positive.

Boudoukh and Richardson (1993) found on a 5-year horizon a positive relation between stocks and inflation using annual data during the long period of 1802-1990. Their results were particularly strong because they found the relation in both the U.S. and the U.K., while there is a low correlation between those two stock markets (however after the second world war, the markets are probably correlated). The evidence is also strong because they found this relation in different sub periods, in both expected and unexpected inflation and similarities when using different sets of instruments.

Using cointegration Ely and Robinson (1997) tested the long term relation between stock prices and goods prices for the period 1957 to 1992 for different countries. They stated that the relation between stock prices and goods prices may depend on real output and money. For the most countries they found that stocks maintain their value relative to goods following both real output and monetary shocks. However the U.S. is an exception because stocks do not maintain their value relative to goods when there has been a output shock.  Also Stulz (1986) tested the money demand explanation (a fall in money demand results in a fall of the price levels and visa versa) as a explanation for the negative relation between stock returns and unexpected inflation, and found results that agree with this explanation.

However Engsted and Tanggaard (2002) did not find any evidence in both the U.S. and Denmark that stocks are a good hedge against unexpected inflation on both short and long term horizons. The sample set for the U.S. was from 1926-1997 and for Denmark from 1922-1996. They argued that Boudoukh and Richardson (1993) used a highly persistent time-overlapping data, which is known to lead to problems. That is why they used a VAR approach to compute multi-expectations. They even found for U.S. stocks that when the horizon is increased (from 1 or 5 to 10 years), the relation weakens. However this is contrary to the Danish stock markets, where the relation is stronger when a longer horizon is used.

But the results of Boudoukh et al (1994) showed that on short term horizons of 1 quarter the relation during the period 1953-1990 is thus negative and inconsistent with the Fisher model.

Also Fama & Schwert (1977) showed results that there is a negative relation for the period 1953-1971 between a well-diversified stock portfolio and inflation, and for both expected and unexpected inflation. However they had a remark that only a little of the variation in stock returns is accounted for this relation. This would lead to relative higher standard errors and thus are the regressions not very reliable.

This is in line with the results of Bodie (1976). For the period 1953-1972 he used holding periods of 1 month, 3 months and 1 year, and for all three periods the relation between stock returns and inflation was negative. He also found that ratio of the non-inflation stochastic component can be used to see how effective stocks are as an inflation hedge. When the ratio increase, stocks perform worse as an inflation hedge.

Gultekin (1983) also found a negative relation between stock returns and inflation for the period 1947-1979 with a holding period of 1 month. However he stated that the relation is not stable, thus the results are not that robust. Also because he found differences between countries. For example he found a significant positive relation between unexpected inflation and stock returns for the U.K..

VanderHoff & VanderHoff (1986) found two significant explanations for this inconsistency during the period 1968-1982. First the spurious-correlation hypothesis: the expected inflation betas are negative due to a omitted-variable bias. Secondly the Tax hypothesis: Due to a increase in inflation-induced tax, the expected dividend will diminish, and thus stock prices will fall.

So what industries are good inflation hedges? Boudoukh et al (1994) stated that cyclical industries are more negatively correlated with inflation. So for example an industry like Food is not cyclical, and thus this industry will probably be a good hedge against inflation. They also found that industries that produce raw materials (e.g. Petroleum Products, Mining and Primary Metals) have a less negative relation between unexpected inflation and stock returns. This because a positive shock to inflation can lead to falling stock prices, because there is a negative relation between inflation and future economic activity.

Ma & Ellis (1989) found that industries with high debt levels, low sales turnover, low price per share and high profitability can perform as a good inflation hedge. They think that the market requires a higher rate of return of the risk in these variables. Disappointing is the period (1976-1982) - this is considered as an inflationary period - they used and thus we cannot say what happens when there is low rate of inflation or even deflation

## III Data

The industry portfolio stock returns are from K.R. French' website. Every stock of the NYSE, AMEX and NASDAQ is assigned to an industry portfolio based on it's SIC code, and in total there are 17 industries. Boudoukh et al (1994) used equally weighted data, so every stock has the same weight in the portfolio. This has an advantage: the big companies which normally have a big influence, are having now the same weight as small companies. Thus size does not matter when making a inflation hedge portfolio. However this has a disadvantage; small stocks, which are more volatile, have the same weight, so have more influence then they usually have in the stock market indexes. Beside using equally weighted data (see table 1 for descriptive statistics) we will also use value weighted data (see table 2 for descriptive statistics) to compensate for this disadvantage. We can clearly see the disadvantage in table 1 in contrast with table 2. Because small companies which tend to be more volatile have the same weight as big companies, the betas with the markets are almost all above 1. And thus the yearly returns and the standard deviations of the industries are above the market return. Boudoukh et al (1994) used quarterly data, so we transformed the monthly data from French into quarters. Also our own research will use monthly overlapping yearly data to get the most out of the data. So the monthly returns are transformed into annual data.

For inflation we use the monthly Consumer Price Index, which is found on R.J. Shiller's website. To turn that into monthly inflation, we used the following formula:

$$\pi_t = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \tag{2.1}$$

**Table 1: Descriptive Statistics for equally weighted data**

The Average Yearly Return is calculated by the Average Monthly Return x 12. The Standard Deviation is calculated by the Monthly Standard Deviation x SQRT(12). The Market is the value-weighted return on all NYSE, AMEX, and NASDAQ stocks.

| | Average Yearly Return | Standard Deviation | Best Month Return | Worst Month Return | Beta with Market | Correlation with Market |
|---|---|---|---|---|---|---|
| **Food** | 13,66% | 21,53% | 60,35% | -28,80% | 0,98 | 0,86 |
| **Mining and Minerals** | 15,91% | 30,36% | 94,11% | -32,37% | 1,13 | 0,71 |
| **Oil and Petroleum Products** | 16,79% | 28,11% | 59,71% | -34,69% | 1,10 | 0,74 |
| **Textiles, Apparel & Footware** | 12,81% | 27,72% | 84,15% | -30,74% | 1,19 | 0,81 |
| **Consumer Durables** | 13,03% | 30,50% | 114,96% | -33,61% | 1,31 | 0,81 |
| **Chemicals** | 14,73% | 25,06% | 65,71% | -30,61% | 1,20 | 0,91 |
| **Drugs, Soap, Parfums, Tobacco** | 15,11% | 23,18% | 43,68% | -31,18% | 1,03 | 0,84 |
| **Construction and Construction Materials** | 14,20% | 28,43% | 87,55% | -32,82% | 1,28 | 0,85 |
| **Steel Works** | 15,47% | 31,81% | 87,64% | -33,78% | 1,46 | 0,87 |
| **Fabricated Products** | 14,84% | 27,44% | 92,77% | -32,74% | 1,20 | 0,83 |
| **Machinery and Business Equipment** | 16,06% | 29,17% | 62,37% | -33,20% | 1,36 | 0,89 |
| **Automobiles** | 13,54% | 31,70% | 75,10% | -34,73% | 1,43 | 0,86 |
| **Transportation** | 14,78% | 30,06% | 76,86% | -34,57% | 1,31 | 0,82 |
| **Utilities** | 13,23% | 23,50% | 65,60% | -32,02% | 0,94 | 0,76 |
| **Retail Stores** | 13,07% | 25,67% | 67,28% | -29,98% | 1,14 | 0,84 |
| **Financial Companies** | 15,10% | 25,76% | 79,05% | -36,92% | 1,17 | 0,86 |
| **Other** | 15,62% | 28,93% | 78,24% | -31,64% | 1,33 | 0,87 |
| **Market** | 10,46% | 18,95% | 38,37% | -29,01% | 1,00 | 1,00 |

**Table 2: Descriptive Statistics for value weighted data**

The Average Yearly Return is calculated by the Average Monthly Return x 12. The Standard Deviation is calculated by the Monthly Standard Deviation x SQRT(12). The Market is the value-weighted return on all NYSE, AMEX, and NASDAQ stocks.

| | Average Yearly Return | Standard Deviation | Best Month Return | Worst Month Return | Beta with Market | Correlation with Market |
|---|---|---|---|---|---|---|
| **Food** | 11,50% | 17,01% | 33,41% | -28,23% | 0,76 | 0,85 |
| **Mining and Minerals** | 11,06% | 23,50% | 31,70% | -32,63% | 0,84 | 0,68 |
| **Oil and Petroleum Products** | 13,14% | 21,37% | 39,10% | -29,60% | 0,87 | 0,77 |
| **Textiles, Apparel & Footware** | 9,70% | 21,44% | 44,01% | -31,47% | 0,89 | 0,79 |
| **Consumer Durables** | 10,40% | 27,00% | 70,53% | -36,31% | 1,25 | 0,88 |
| **Chemicals** | 11,32% | 21,96% | 46,56% | -33,36% | 1,02 | 0,88 |
| **Drugs, Soap, Parfums, Tobacco** | 11,68% | 17,31% | 38,06% | -25,94% | 0,73 | 0,80 |
| **Construction and Construction Materials** | 11,00% | 23,94% | 43,11% | -31,41% | 1,16 | 0,92 |
| **Steel Works** | 10,94% | 29,53% | 80,84% | -32,52% | 1,35 | 0,86 |
| **Fabricated Products** | 10,52% | 21,15% | 42,63% | -29,85% | 0,96 | 0,86 |
| **Machinery and Business Equipment** | 12,21% | 25,01% | 49,28% | -32,68% | 1,21 | 0,92 |
| **Automobiles** | 11,93% | 27,13% | 80,48% | -34,84% | 1,20 | 0,84 |
| **Transportation** | 10,84% | 24,87% | 62,09% | -33,27% | 1,15 | 0,88 |
| **Utilities** | 10,16% | 19,82% | 43,16% | -32,96% | 0,80 | 0,76 |
| **Retail Stores** | 11,28% | 20,73% | 37,05% | -30,16% | 0,94 | 0,86 |
| **Financial Companies** | 11,50% | 23,98% | 59,85% | -39,47% | 1,16 | 0,92 |
| **Other** | 9,83% | 17,89% | 33,37% | -25,20% | 0,88 | 0,94 |
| **Market** | 10,46% | 18,95% | 38,37% | -29,01% | 1,00 | 1,00 |

We also need to calculate expected inflation because when investors believe there will be rising inflation, they tend to move from bonds to stocks, thus stock prices will rise. In the financial literature there are different ways to calculate expected inflation. We use two ways for expected inflation so we can check if that makes any difference. The first way is using past inflation (moving average) as expected inflation for the future. Although this sounds quite simple, the question is how many months do we have to use to forecast expected inflation. We decided to find out what is the best period. So for forecasting the expected inflation for 1 year in the future we use the following formula, with n as the months to choose.

$$E(\pi_t) = 12 \times \frac{1}{n} \sum_{i=1}^{n} \pi_{t-n} \tag{2.2}$$

We calculated  the annualized expected inflation with 3, 6, 12, 18 and 24 months to see which is the best. First we calculated the correlation (formula 2.3) between the

$$\rho(E(\pi_t), \pi_t) \tag{2.3}$$

calculated expected inflation and inflation. Then the beta of expected inflation with inflation (formula 2.4).

$$E(\pi_t) = \alpha + \beta\pi_t + e \tag{2.4}$$

Table 3 shows the results.

**Table 3: Months in the past to forecast future inflation**

| Months | Correlation with Inflation | Beta with Inflation |
|---|---|---|
| **3** | 0.610 | 0.770 |
| **6** | 0.646 | 0.723 |
| **9** | 0.647 | 0.678 |
| **12** | 0.630 | 0.636 |
| **18** | 0.573 | 0.549 |
| **24** | 0.518 | 0.473 |

The differences are not very big. Because we use for our research monthly overlapping yearly periods, we choose 12 months, which is the same length as the holding period.

The error between the real inflation and expected inflation is used as unexpected inflation.

$$UE(\pi_t) = \pi_t - E(\pi_t) \tag{2.5}$$

Secondly we use the same way as Boudoukh et al (1994) to calculate expected inflation. Namely a ordinary least squares (OLS) regression of the current inflation rate on past inflation and the current risk free rate.

$$E(\pi_t) = \alpha + \beta_1 \pi_{t-1} + \beta_2 I_t + \varepsilon \tag{2.6}$$

Boudoukh et al (1994) were not clear on what they used as the current risk free rate. We used two different risk free rates with different length to see which is the best. First we use the 1-month treasury bill, which can be found on K.R. French' website, but is provided by Ibbotson. Secondly we use the 10-year from R.J. Shiller's website. Also on past inflation were Boudoukh et al (1994) they were not clear, because they did not tell how many months they used. We can assume that they used 1 quarter as past inflation because their holding period is 1 quarter. Table 4 shows the difference between 1-month and 10-year treasury bill.

**Table 4: Difference 1-month and 10-year as current risk free rate**

| | Correlation with Inflation | Beta with Inflation |
|---|---|---|
| **1-Month** | 0.577 | 0.332 |
| **10-Year** | 0.570 | 0.325 |

Although the differences are not very big, we choose 1-month treasury bill as our risk free rate. So for the replication of the Boudoukh et al (1994) paper we use 1 quarter as past inflation. For our own research we use, again, the past 12 months as past inflation, because our holding period is a year. Again formula (2.5) is used to calculate unexpected inflation.

## IV Quarterly Investment Horizon

*A.Full Sample Equally Weighted*

First let see how industry returns relates with inflation during the period 1928-2008, before splitting inflation in expected and unexpected inflation. We used the formula (4.1).The data is quarterly, non-overlapping, and the standard errors are corrected for heteroskedasticity.

$$R_t = \alpha + \beta_1(\pi_t) + \varepsilon \qquad (4.1)$$

We can clearly see in table 5, the first column, that a lot of beta's (5 of them are negative) are positive, however none of them are significant. Only the beta of 1.75 for Oil and Petroleum Products is significant at a level of 10%.

**Table 5: Industry Returns and Inflation, Expected Inflation and Unexpected Inflation (1928-2008)**

| | Inflation | | Expected Inflation | | Unexpected Inflation | |
|---|---|---|---|---|---|---|
| **Industry** | **Beta** | **P-value** | **Beta** | **P-value** | **Beta** | **P-value** |
| Drugs, Soap, Parfums, Tobacco | -0,253 | 0,702 | -1,755 | 0,384 | 0,496 | 0,649 |
| Oil and Petroleum Products | 1,749 | 0,056 | -1,802 | 0,419 | 3,518 | 0,025 |
| Utilities | 0,141 | 0,870 | -1,858 | 0,442 | 1,137 | 0,379 |
| Financial Companies | -0,184 | 0,856 | -2,450 | 0,387 | 0,952 | 0,494 |
| Chemicals | 0,521 | 0,550 | -2,649 | 0,344 | 2,101 | 0,184 |
| Food | 0,111 | 0,875 | -2,703 | 0,269 | 1,513 | 0,247 |
| Machinery and Business Equipm. | 0,115 | 0,905 | -2,949 | 0,312 | 1,641 | 0,326 |
| Retail Stores | 0,053 | 0,951 | -3,083 | 0,251 | 1,615 | 0,293 |
| Fabricated Products | 0,079 | 0,929 | -3,164 | 0,283 | 1,695 | 0,318 |
| Construction and Constr. Materials | 0,020 | 0,983 | -3,702 | 0,298 | 1,874 | 0,319 |
| Other | 0,039 | 0,968 | -3,797 | 0,686 | 1,951 | 0,286 |
| Transportation | 0,177 | 0,869 | -3,893 | 0,227 | 2,204 | 0,216 |
| Steel Works | 0,479 | 0,662 | -4,362 | 0,231 | 2,890 | 0,138 |
| Consumer Durables | -0,028 | 0,978 | -4,389 | 0,271 | 2,144 | 0,315 |
| Automobiles | -0,048 | 0,967 | -4,650 | 0,260 | 2,244 | 0,326 |
| Mining and Minerals | 0,890 | 0,391 | -4,653 | 0,133 | 3,650 | 0,049 |
| Textiles, Apparel & Footware | -0,196 | 0,844 | -4,705 | 0,160 | 2,050 | 0,273 |

Second we perform a regression (OLS) with the same period as Boudoukh et al (1994), namely 1953-1990. The regression of the industry return on expected (calculated with a regression, formula (2.6)) and unexpected inflation is done using formula (4.2):

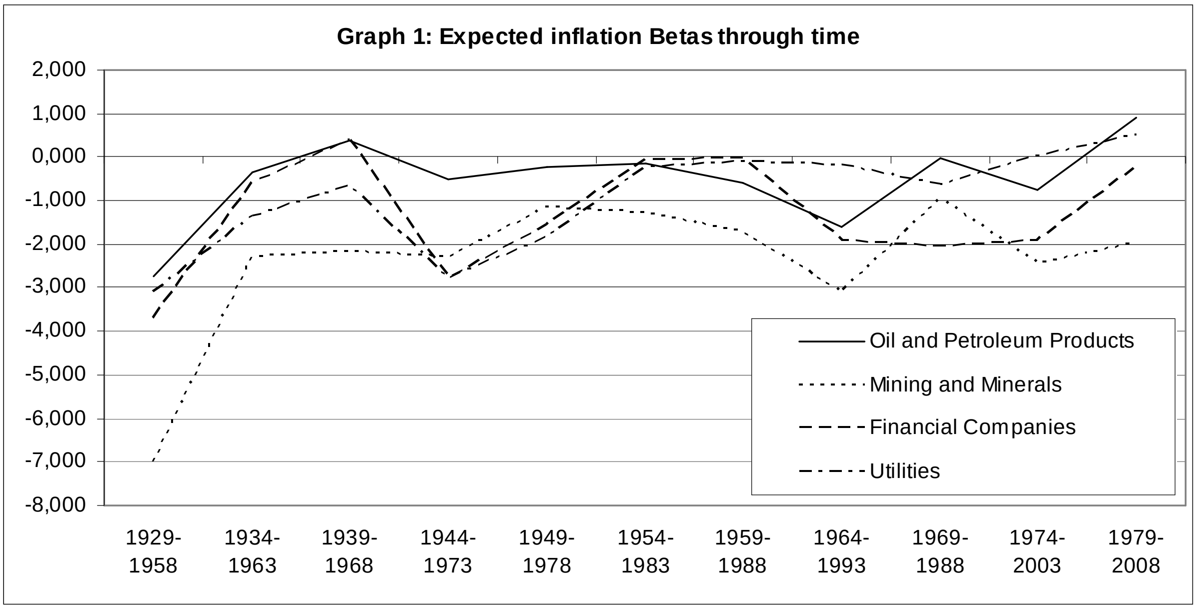
$$R_t = \alpha + \beta_1 E(\pi_t) + \beta_2 UE(\pi_t) + \varepsilon \qquad (4.2)$$

We see only positive betas for unexpected inflation (column three in table 5), although there are only two betas significant at a 5% level, namely Oil and Petroleum Products with a beta of 3.52, and Mining and Minerals with a beta of 3.65. The expected inflation betas (the second column in table 5) are all negative but not significant.

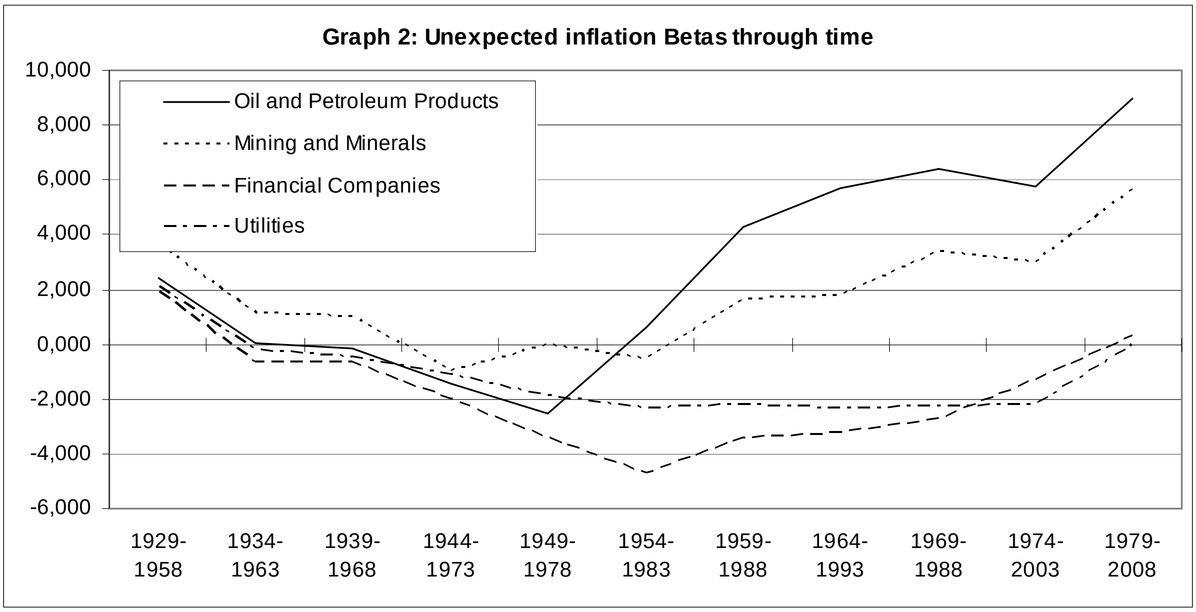
*B. Betas through time*

Although the betas show their relation with inflation, they are not constant through time. To see how they change through time, we use time periods of 30 years starting with 1929-1958. The next period is 5 years later, so 1934-1963. This will be repeated until the last period 1979-2008. We are still using the same formula (4.2). We have chosen for the industries Oil and Petroleum Products, Mining and Minerals, Financial Companies and Utilities because they have shown some significant betas in the results above.

As we can see in Graph 1, the expected inflation beta's are moving almost the whole time between the range 0.5 and -3 (with the exception of the first period). So We can conclude that the expected inflation beta's are quite stable.




The unexpected inflation betas are not stable, we can see some kind of a U-shape. Starting positive, going negative and since the 50's going up again. For Oil and Petroleum Products and Mining and Minerals, which are according to the results above the best unexpected inflation hedges, we can see that they are almost the whole period positive, thus a good hedge against unexpected inflation. But keep in mind they are not stable, so we can see a decline in the future.



*C. Comparison with Boudoukh et al (1994)*

But we still haven not compared with Boudoukh et al (1994). We use again formula (4.2), with quarterly, non-overlapping data, but now on their period (1953-1990), for the expected and unexpected inflation betas. The standard errors are corrected for heteroskedasticity. Again we do not exactly know what they used as past inflation and as the risk free rate. We have chosen the industries which are almost in line with ours, thus some industries are deleted because we cannot compare them.

**Table 6: Comparison between our results and the results from Boudoukh et al (1994).**

| | Expected Inflation | | Unexpected Inflation | |
|---|---|---|---|---|
| **Industry** | **Beta** | **P-value** | **Beta** | **P-value** |
| Food | -0.305 | 0.805 | -2.287 | 0.132 |
| Food & Beverage | 0.044 | 0.969 | -4.421 | 0.001 |
| | | | | |
| Utilities | -0.336 | 0.745 | -2.336 | 0.004 |
| Utilities | -0.209 | 0.848 | -3.161 | 0.000 |
| | | | | |
| Chemicals | -0.650 | 0.610 | -1.960 | 0.231 |
| Chemical | -0.674 | 0.572 | -3.639 | 0.008 |
| | | | | |
| Machinery and Business Equipment | -1.285 | 0.453 | -2.603 | 0.202 |
| Electrical Machinery | -1.123 | 0.491 | -4.648 | 0.020 |
| Nonelectrical Machinery | -1.582 | 0.271 | -3.548 | 0.053 |
| | | | | |
| Construction and Construction Materials | -1.405 | 0.389 | -3.003 | 0.155 |
| | | | | |
| Transportation | -1.429 | 0.313 | -2.857 | 0.116 |
| Transportation Equipment | -1.447 | 0.325 | -4.919 | 0.009 |
| | | | | |
| Textiles, Apparel & Footware | -1.567 | 0.310 | -3.576 | 0.068 |
| Apparel | -1.457 | 0.369 | -5.270 | 0.010 |
| Textiles | -1.393 | 0.363 | -5.902 | 0.003 |
| | | | | |
| Steel Works | -1.359 | 0.336 | -1.311 | 0.446 |
| Primary Metals | -1.186 | 0.361 | -2.207 | 0.167 |
| | | | | |
| Oil and Petroleum Products | -1.150 | 0.560 | 3.883 | 0.049 |
| Petroleum Products | -0.629 | 0.614 | -0.218 | 0.884 |
| | | | | |
| Mining and Minerals | -2.049 | 0.251 | 1.184 | 0.547 |
| Mining | -0.868 | 0.001 | 1.677 | 0.352 |

The results in Tabel 6 show that we have found betas which are close with their results, but Boudoukh et al (1994) have found more significant results for unexpected inflation then we. For expected inflation they also found no significant results. The biggest difference can be found for unexpected inflation and Oil and Petroleum products where we found a rather large positive beta, but where they found a small negative beta. But their beta is not significant at all, and as stated above we do not have the same groups. So we can say we both find negative expected and unexpected betas (with the exception of Oil & Petroleum Products) for the period 1953-1990.

*D. Equally Weighted vs. Value Weighted*

Boudoukh et al (1994) used equally weighted returns which has a advantage, however it also has a disadvantage: small companies which are much more volatile have the same weight as the big companies. To find out if this makes any difference, we now compare the equally weighted returns with the returns of value weighted. Tabel 7 shows the results for the period 1953-1990, and Tabel 8 for the period 1928-2008.

The major difference we see is the significance of the unexpected inflation betas. Almost all of them are significant at a 10% level, except  Mining and Minerals, Oil and Petroleum products and Steel Works. Also we see that Machinery and Business Equipment is significant at a 10% level.  The betas for expected inflation are not that different, but they tend to be smaller, but the unexpected inflation betas tend to be bigger.

**Table 7: Value weighted Industry Returns and Expected and Unexpected Inflation for 1953-1990.**

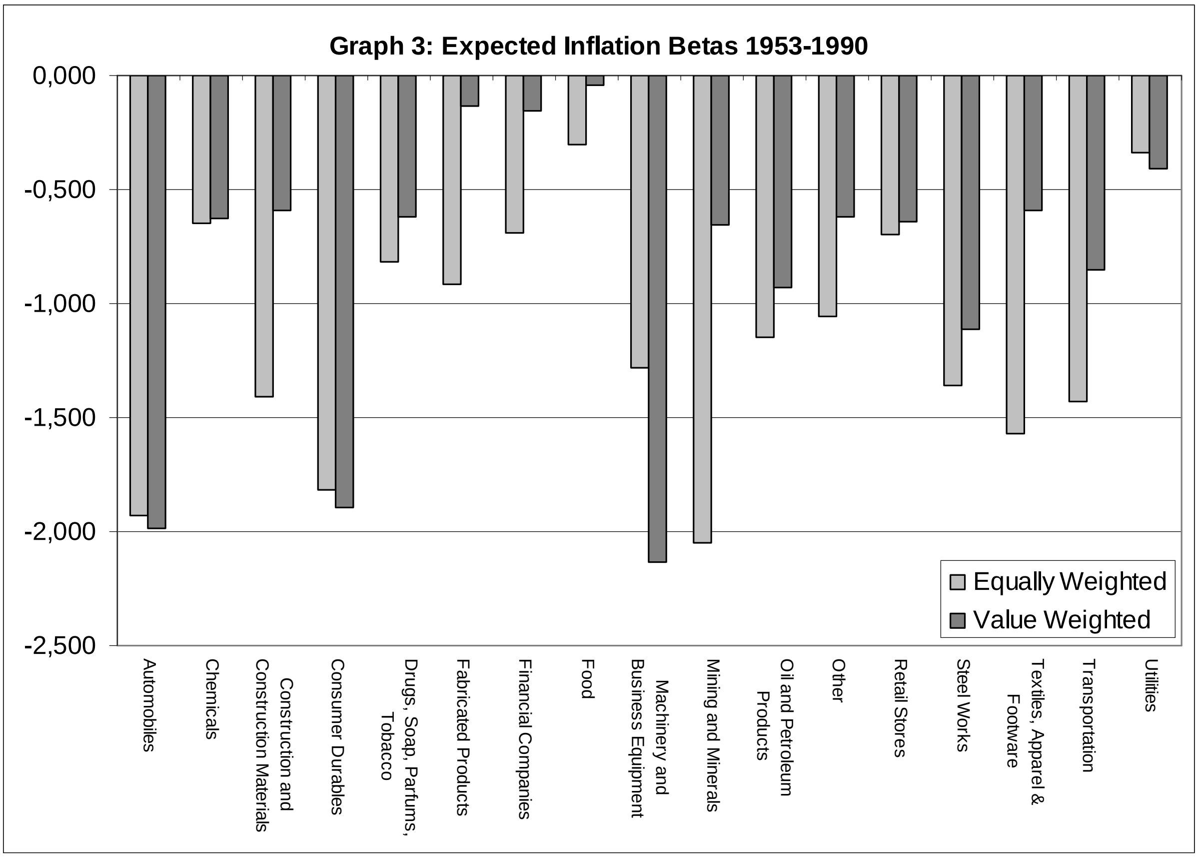
| | Expected Inflation | | Unexpected Inflation | |
|---|---|---|---|---|
| **Industry** | **Beta** | **P-value** | **Beta** | **P-value** |
| Food | -0.040 | 0.972 | -4.017 | 0.001 |
| Fabricated Products | -0.134 | 0.911 | -3.087 | 0.019 |
| Financial Companies | -0.155 | 0.903 | -4.107 | 0.002 |
| Utilities | -0.411 | 0.695 | -2.490 | 0.002 |
| Construction and Construction Materials | -0.593 | 0.677 | -4.051 | 0.020 |
| Textiles, Apparel & Footware | -0.595 | 0.662 | -3.894 | 0.030 |
| Other | -0.616 | 0.543 | -3.566 | 0.003 |
| Drugs, Soap, Parfums, Tobacco | -0.616 | 0.585 | -3.905 | 0.002 |
| Chemicals | -0.630 | 0.599 | -3.382 | 0.013 |
| Retail Stores | -0.642 | 0.632 | -4.234 | 0.008 |
| Mining and Minerals | -0.651 | 0.680 | -0.248 | 0.892 |
| Transportation | -0.855 | 0.490 | -4.144 | 0.005 |
| Oil and Petroleum Products | -0.933 | 0.481 | 0.578 | 0.660 |
| Steel Works | -1.110 | 0.444 | -1.841 | 0.192 |
| Consumer Durables | -1.893 | 0.133 | -4.783 | 0.001 |
| Automobiles | -1.988 | 0.132 | -3.430 | 0.057 |
| Machinery and Business Equipment | -2.131 | 0.073 | -3.561 | 0.018 |

**Table 9: Value weighted Industry Returns and Expected and Unexpected Inflation for 1928-2008.**

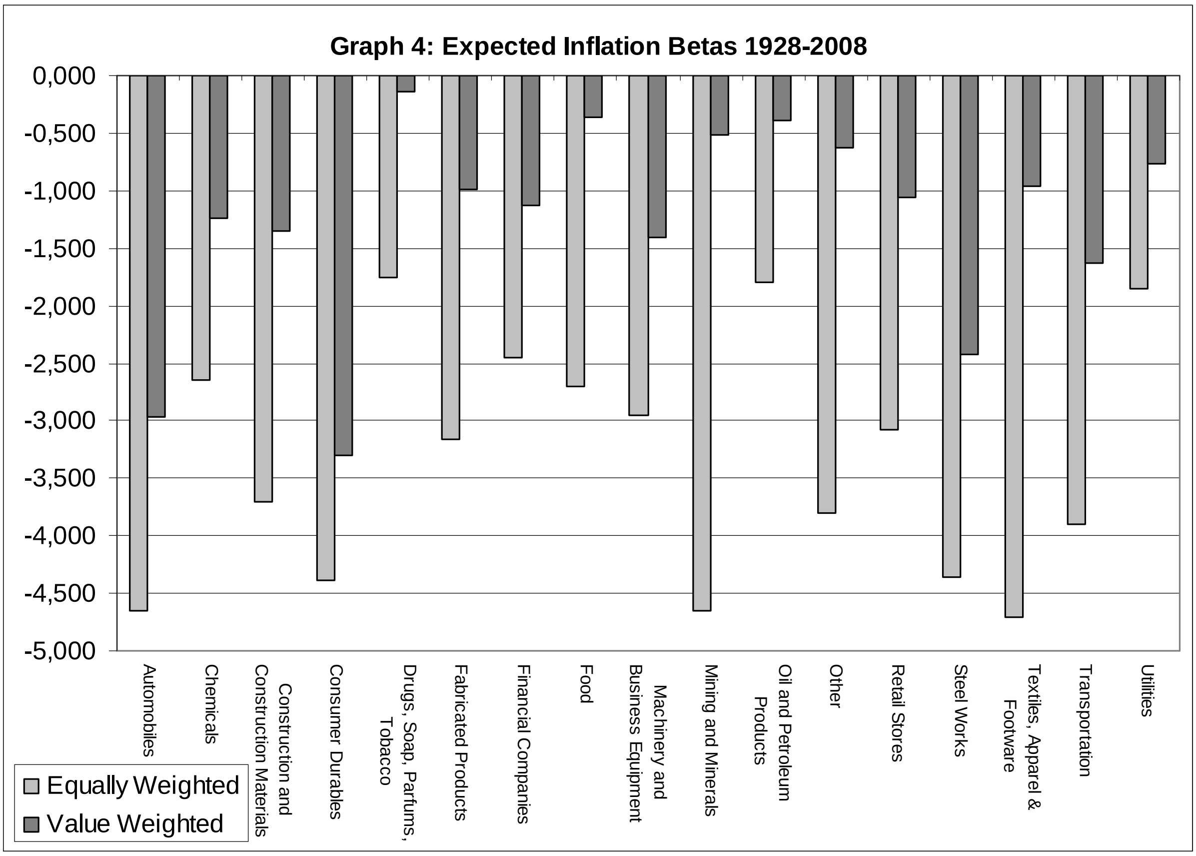
| | Expected Inflation | | Unexpected Inflation | |
|---|---|---|---|---|
| **Industry** | **Beta** | **P-value** | **Beta** | **P-value** |
| Drugs, Soap, Parfums, Tobacco | -0.141 | 0.916 | -0.648 | 0.302 |
| Food | -0.369 | 0.797 | -0.128 | 0.858 |
| Oil and Petroleum Products | -0.389 | 0.778 | 1.871 | 0.053 |
| Mining and Minerals | -0.521 | 0.663 | 1.975 | 0.049 |
| Other | -0.622 | 0.651 | 0.188 | 0.807 |
| Utilities | -0.770 | 0.610 | 0.340 | 0.711 |
| Textiles, Apparel & Footware | -0.962 | 0.541 | 0.584 | 0.588 |
| Fabricated Products | -0.983 | 0.543 | 0.135 | 0.880 |
| Retail Stores | -1.062 | 0.533 | 0.207 | 0.810 |
| Financial Companies | -1.125 | 0.599 | 0.296 | 0.801 |
| Chemicals | -1.240 | 0.537 | 0.761 | 0.485 |
| Construction and Construction Materials | -1.345 | 0.570 | 0.488 | 0.691 |
| Machinery and Business Equipment | -1.410 | 0.475 | 0.511 | 0.644 |
| Transportation | -1.623 | 0.500 | 0.715 | 0.533 |
| Steel Works | -2.424 | 0.360 | 2.138 | 0.141 |
| Automobiles | -2.969 | 0.307 | 1.104 | 0.481 |
| Consumer Durables | -3.306 | 0.324 | 0.164 | 0.345 |

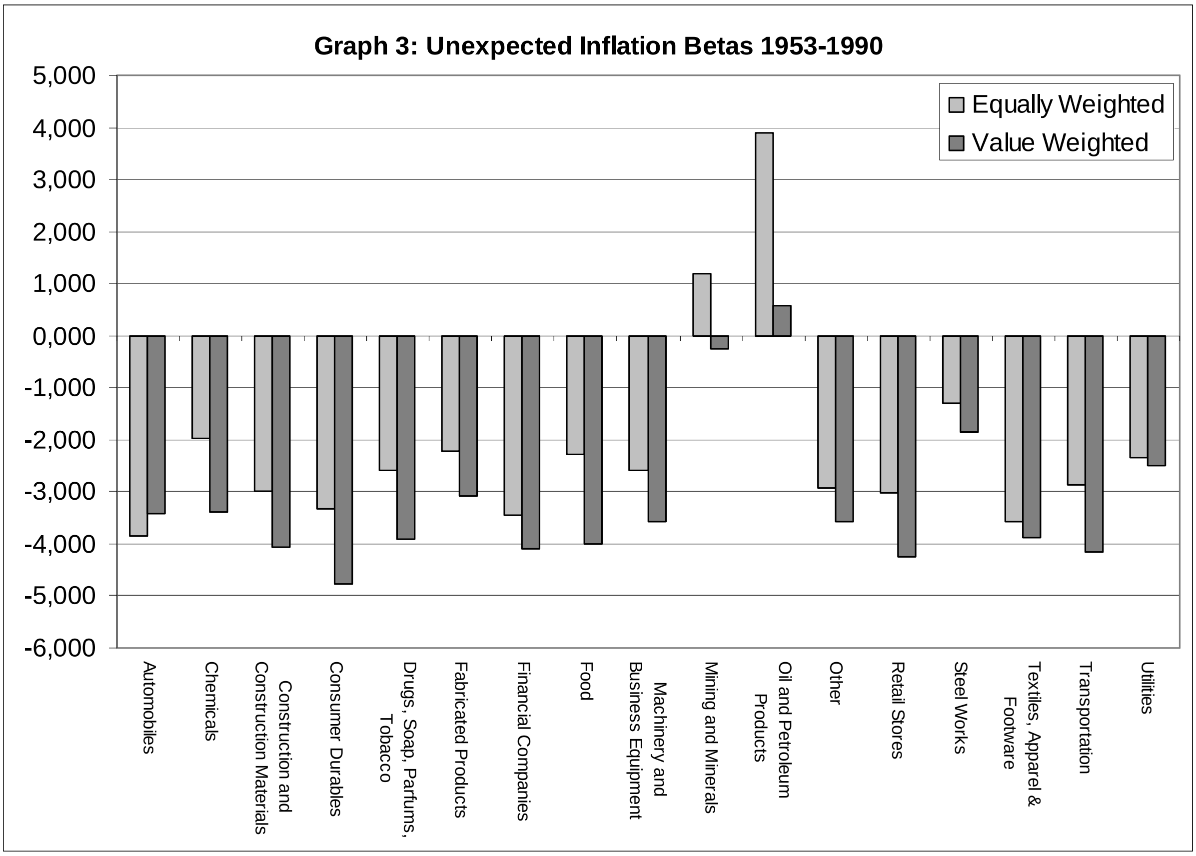
Compared to equally weighted returns the betas of both the expected and unexpected inflation tend to be smaller, but no big differences. The only significant betas are again the unexpected inflation betas of Oil and Petroleum Products and Mining and Minerals. The betas are however smaller, respectively 1.871 and 1.975, which can be due to the lower volatility of value weighted portfolios.

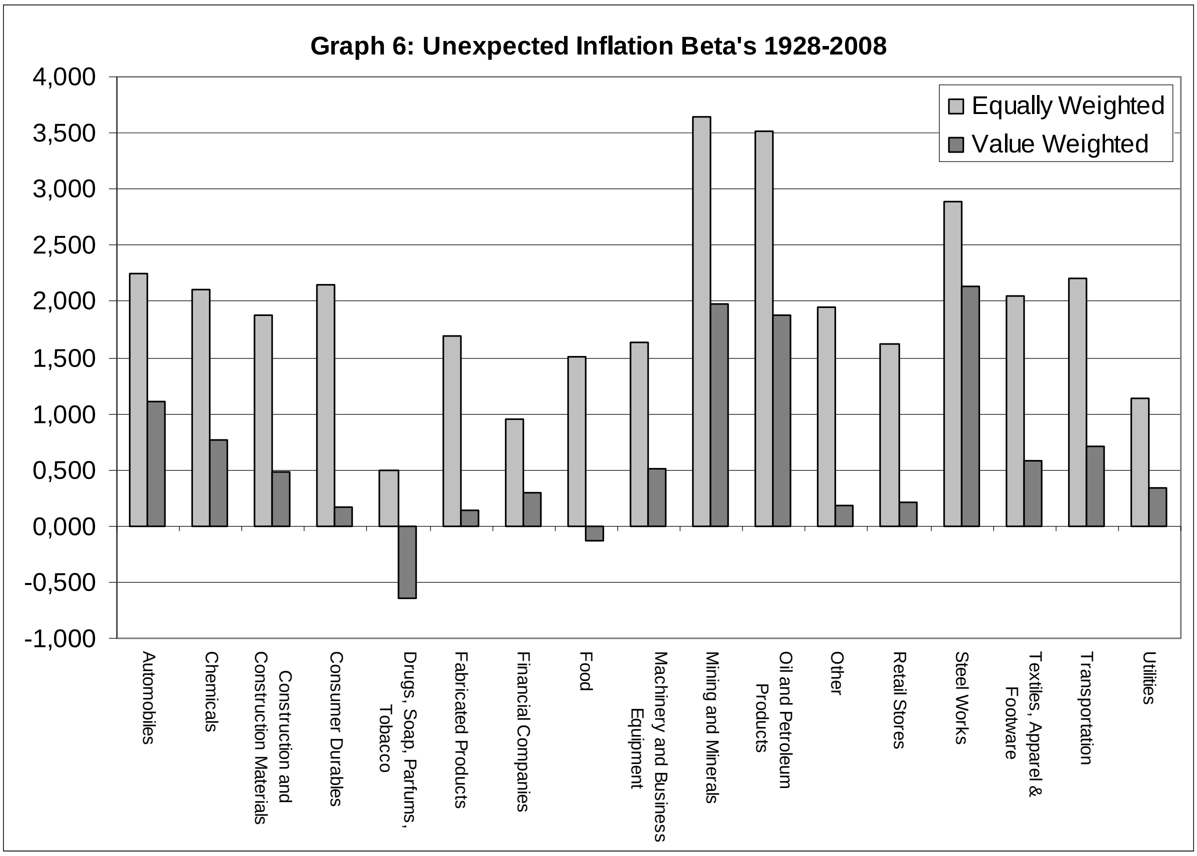
To show the differences between equally weighted and value weighted, we made 4 graphs. Graph 3 shows the expected betas for expected inflation for 1953-1990. Graph 4 shows the expected inflation betas for 1928-2008. The unexpected inflation betas for 1953-1990 are shown in graph 5, and for 1928-2008 in graph 6.




Graph 3 and 4 show that all the betas for expected inflation are negative, but the betas for equal weighted tend to be more negative. Especially for the 1928-2008 period. Because small stocks are much more volatile, it's not strange the betas tend to be bigger. But clearly the correlation between stocks and expected inflation is negative.


Graph 4: Expected Inflation Betas 1928-2008
0,000
-0,500
-1,000
-1,500
-2,000
-2,500
-3,000
-3,500
-4,000
-4,500
-5,000
Automobiles
Chemicals
Construction and Construction Materials
Consumer Durables
Drugs, Soap, Parfums, Tobacco
Fabricated Products
Financial Companies
Food
Machinery and Business Equipment
Mining and Minerals
Oil and Petroleum Products
Other
Retail Stores
Steel Works
Textiles, Apparel & Footware
Transportation
Utilities
Equally Weighted
Value Weighted


Graph 3: Unexpected Inflation Betas 1953-1990
5,000
4,000
3,000
2,000
1,000
0,000
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
Equally Weighted
Value Weighted
Automobiles
Chemicals
Construction and Construction Materials
Consumer Durables
Drugs, Soap, Parfums, Tobacco
Fabricated Products
Financial Companies
Food
Machinery and Business Equipment
Mining and Minerals
Oil and Petroleum Products
Other
Retail Stores
Steel Works
Textiles, Apparel & Footware
Transportation
Utilities



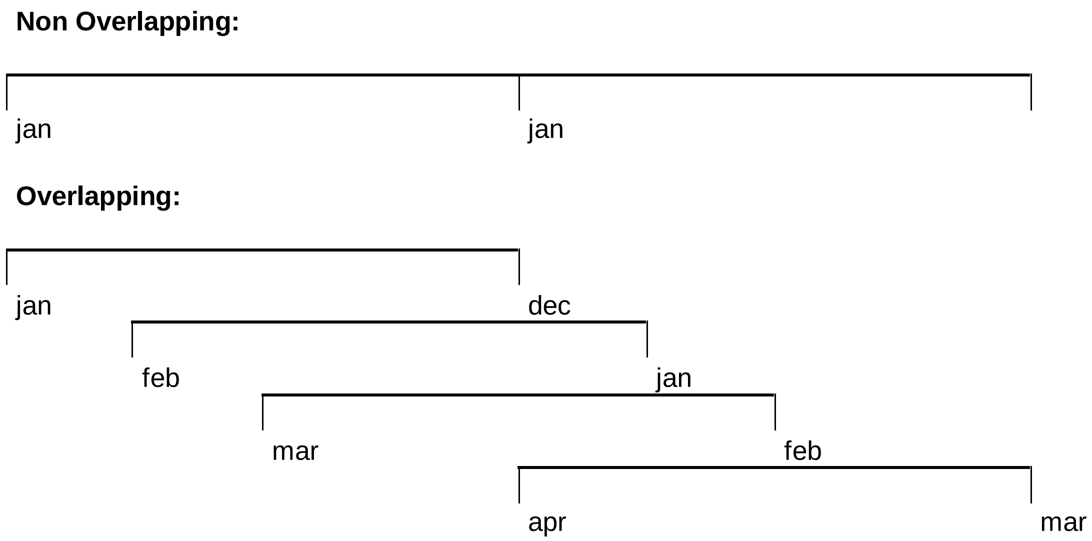

We see the big difference between graph 5 & 6, and thus the periods 1953-1990 and 1928-2008; the negative and positive betas for unexpected inflation. We see that the betas for equally weighted returns are smaller for 1953-1990, but bigger than 1928-2008.

Thus we conclude that there is almost no difference in positive or negative betas between value weighted and equally weighted. However for the period 1928-2008 the betas tend to be more negative for expected inflation betas, and bigger for the unexpected  betas. The positive unexpected inflation betas from table 5 & 8 were also be found by Gultekin (1983) in the U.K., but in contrary to the results of Fama & Schwert (1977). The negative expected inflation betas from table 5 & 8 are in line with the results of Bodie (1976), Boudoukh et al (1994) and Gultekin (1983).

## V Annual Investment Horizon

*A.Full Sample Equally Weighted*

We use a year as holding period so we can clearly see the results, because a quarter may be too short, and monthly overlapping to get to most out of the data. We use again equally weighted because we have seen there is no big difference, only the betas tend to be more negative for expected inflation, and bigger for unexpected inflation. To show the difference between overlapping and non overlapping, look at the graph below.




As you can see at non-overlapping, we only have only 2 observations when we have 2 years. When we use monthly overlapping you can see that we use the same first observation as non-overlapping however the next observation is 11/12 from year one, and 1/12 from year 2. The next observation, a month further is thus 10/12 from year one and 2/12 from year two. And so on. Thus when we have 2 years with a holding period of 1 year, non overlapping would have 2 observations, and overlapping would have 13 observations. However the 13 observations are not independent from each other. That is why we have to correct the standard errors for autocorrelation.

We use first the same way as Boudoukh et al (1994) to calculate expected inflation. Than we use formula (5.1) and (5.2) to calculate the relation between stock

$$R_t = \alpha + \beta_1(\pi_t) + \varepsilon \tag{5.1}$$

$$R_t = \alpha + \beta_1 E(\pi_t) + \beta_2 UE(\pi_t) + \varepsilon \tag{5.2}$$

returns, inflation, expected inflation and unexpected inflation. The standard errors are corrected for heteroskedasticity and autocorrelation.

**Table 10: Industry Returns and Inflation, Expected Inflation and Unexpected Inflation (1928-2008)**

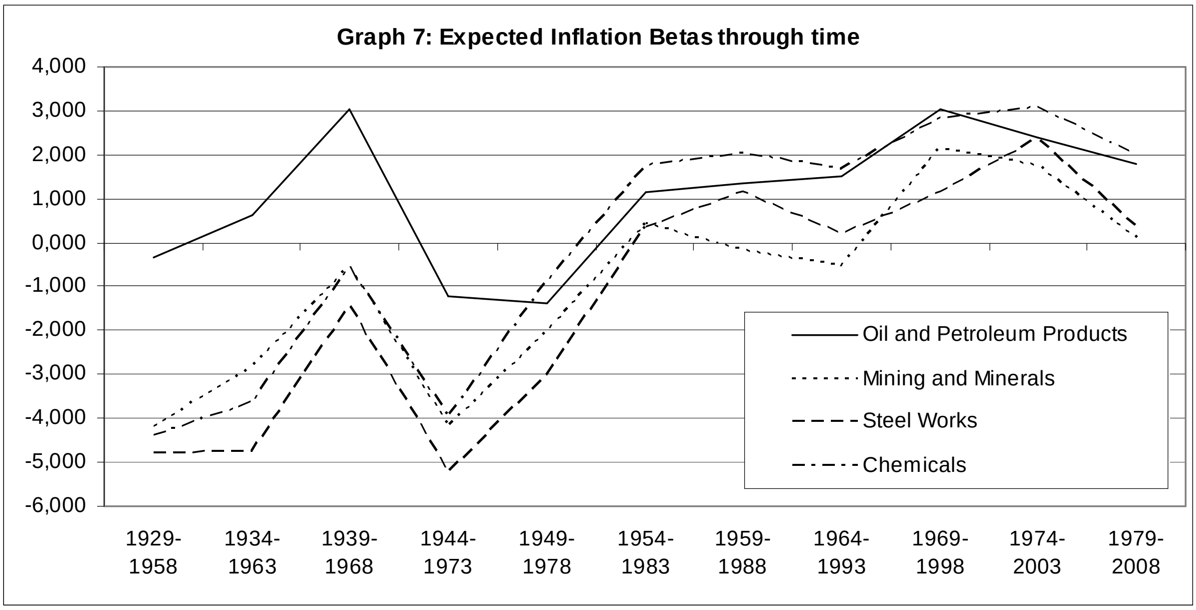
| | Inflation | | Expected Inflation | | Unexpected Inflation | |
|---|---|---|---|---|---|---|
| **Industry** | **Beta** | **P-value** | **Beta** | **P-value** | **Beta** | **P-value** |
| Utilities | 0.136 | 0.849 | 1.542 | 0.124 | -0.903 | 0.230 |
| Drugs, Soap, Parfums, Tobacco | 0.062 | 0.929 | 0.424 | 0.744 | -0.206 | 0.806 |
| Financial Companies | 0.178 | 0.846 | 0.316 | 0.818 | 0.075 | 0.940 |
| Oil and Petroleum Products | 1.963 | 0.040 | 0.130 | 0.934 | 3.318 | 0.007 |
| Retail Stores | 0.198 | 0.813 | -0.339 | 0.841 | 0.596 | 0.624 |
| Machinery & Business Equipment | 0.385 | 0.687 | -0.871 | 0.610 | 1.313 | 0.318 |
| Transportation | 0.257 | 0.797 | -0.894 | 0.618 | 1.108 | 0.393 |
| Other | 0.292 | 0.769 | -0.990 | 0.620 | 1.240 | 0.358 |
| Consumer Durables | 0.149 | 0.886 | -1.167 | 0.595 | 1.122 | 0.465 |
| Automobiles | -0.203 | 0.836 | -1.370 | 0.495 | 0.660 | 0.670 |
| Textiles, Apparel & Footware | -0.435 | 0.620 | -1.484 | 0.440 | 0.340 | 0.773 |
| Food | -0.205 | 0.824 | -1.516 | 0.422 | 0.763 | 0.445 |
| Construction and Constr. Materials | 0.030 | 0.976 | -1.645 | 0.453 | 1.268 | 0.367 |
| Fabricated Products | -0.180 | 0.860 | -1.645 | 0.423 | 0.900 | 0.500 |
| Chemicals | 0.275 | 0.773 | -1.891 | 0.344 | 1.877 | 0.152 |
| Mining and Minerals | 0.381 | 0.722 | -2.326 | 0.219 | 2.381 | 0.059 |
| Steel Works | 0.063 | 0.954 | -2.872 | 0.161 | 2.233 | 0.116 |

The biggest difference with the results we found using Boukdoukh et al's (1994) way (thus quarters and non overlapping) are the expected inflation betas. Using that way the betas were all negative and tend to be more negative than what we see in Table 10. In Table 10 we find some positive betas, however all betas are not significant. When we look at the unexpected inflation betas and compare those to that of Boudoukh et al's (1994) way, we do not see big differences. Again only Oil and Petroleum (beta of 3.318) is significant at a 5% and Mining and Minerals (beta of

2.381) is significant at a 6% level, and thus tend to be a good hedge against unexpected inflation.

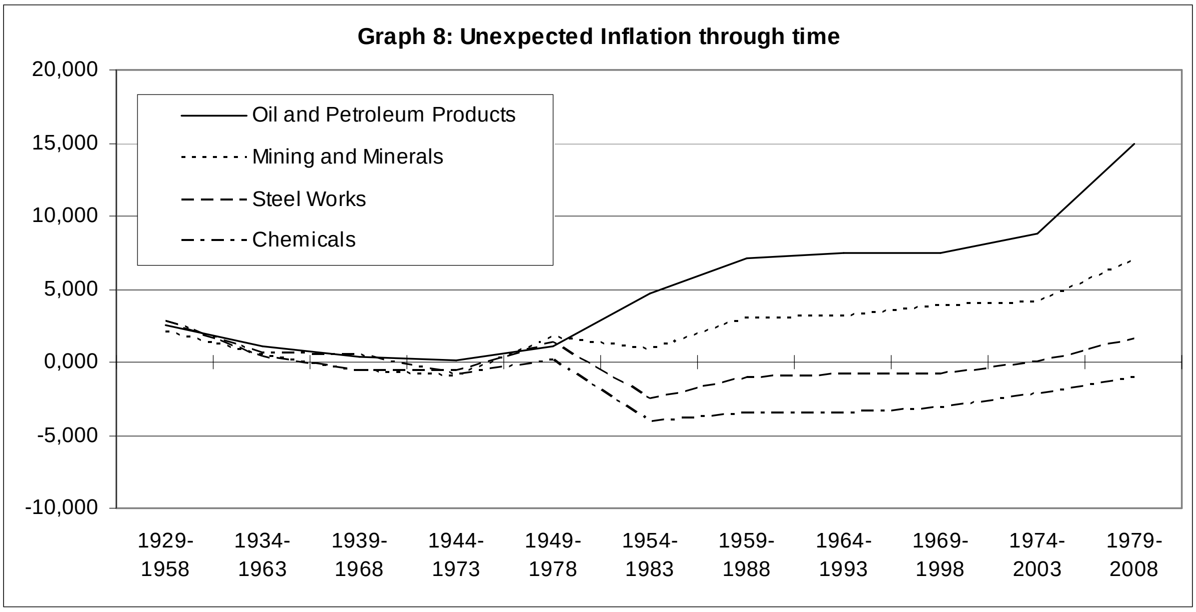
*B. Betas through time*

As we said, betas are not stable over time. To show this, look at graph 7 and 8 below. They are created using formula (5.2). The periods are 30 years, and the observations move on with 5 years. We haven chosen for the 4 industries with the lowest p-value in table 10.



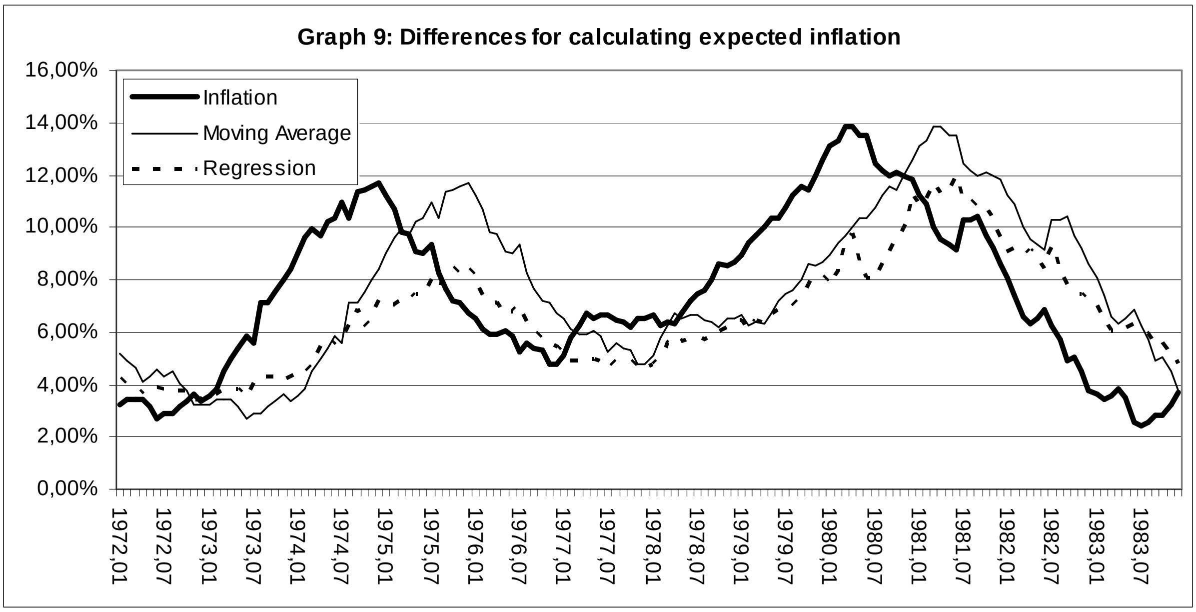

As we can see, the expected inflation betas are quite stable (between 0 and 3) and positive since 1954. During the period 1929-1954 they are quite volatile.

For the unexpected inflation betas we have to look at graph 8 below. As we can see they are rising since 1954 and not stable. The Oil and Petroleum Products and Mining and Minerals betas are almost the whole period positive.




*C. A different way for calculating expected inflation*

The second way is a moving average of the last 12 months. We use formula (5.1) and (5.2) to calculate the relation between stock returns and inflation, expected inflation and unexpected inflation.




To see the differences between inflation and both ways for calculating expected inflation for the period 1972-1983, when inflation was high, see graph 9. We can see that both ways are lagging the real rate of inflation. However graph 9 does not show which way for calculating expected inflation is the best, or how big the differences are.

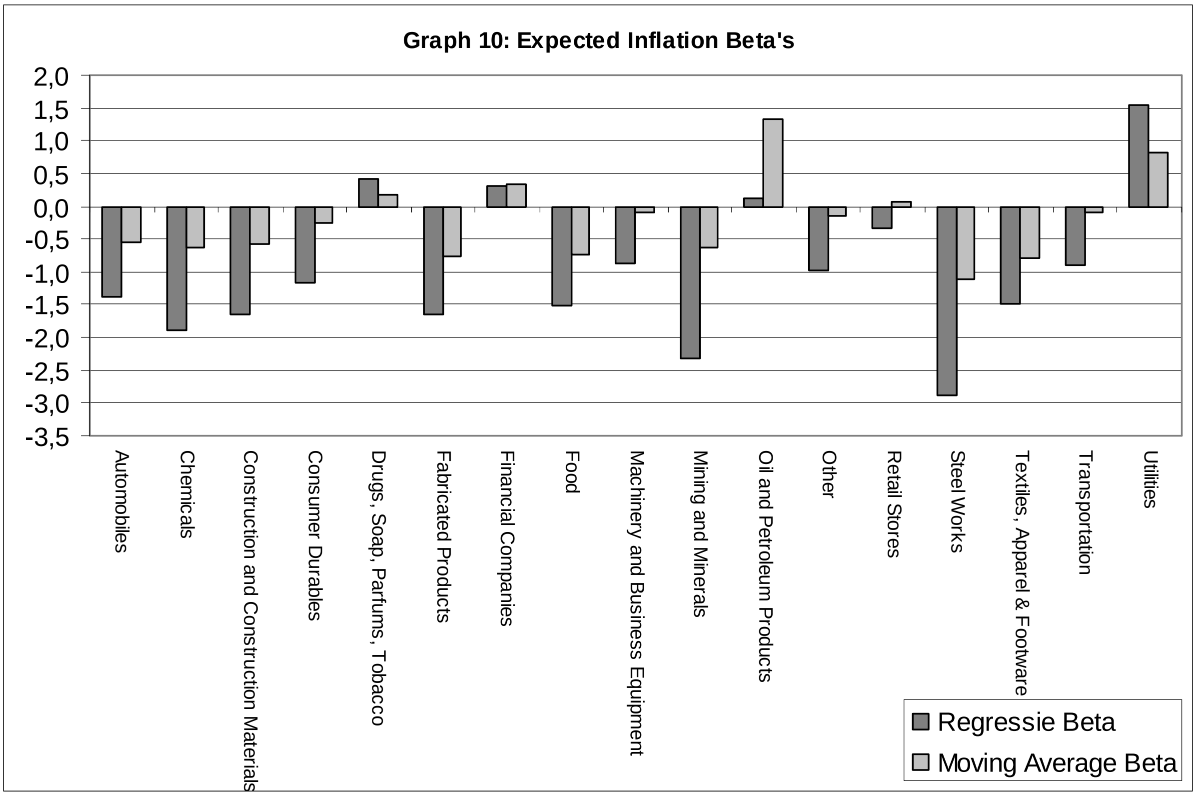
To show the differences, we recreated table 10, but than for the moving average way. The results are in table 11. The standard errors are corrected for heteroskedasticity and autocorrelation.

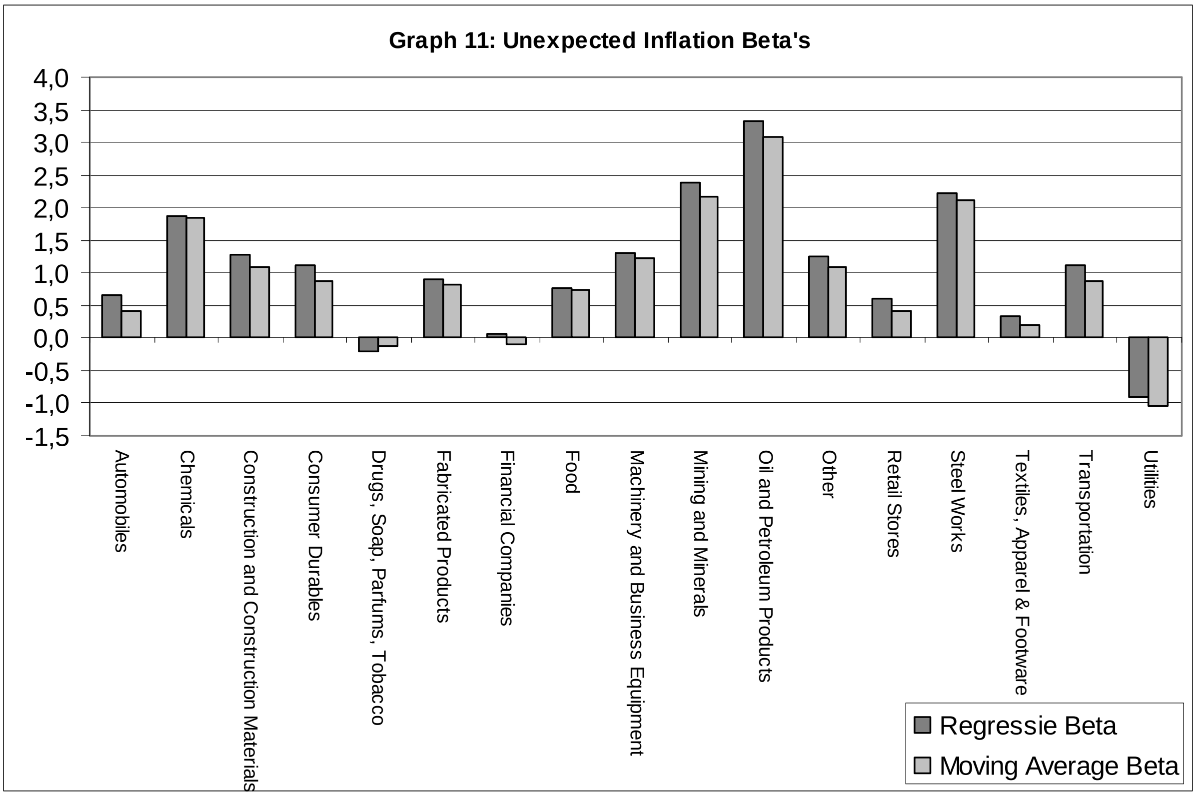
**Table 11: Industry Returns and Inflation, Expected Inflation and Unexpected Inflation (1928-2008)**

| | Inflation | | Expected Inflation | | Unexpected Inflation | |
|---|---|---|---|---|---|---|
| **Industry** | **Beta** | **P-value** | **Beta** | **P-value** | **Beta** | **P-value** |
| Oil and Petroleum Products | 1.963 | 0.040 | 1.322 | 0.238 | 3.081 | 0.007 |
| Utilities | 0.136 | 0.849 | 0.817 | 0.331 | -1.052 | 0.170 |
| Financial Companies | 0.178 | 0.846 | 0.339 | 0.756 | -0.105 | 0.915 |
| Drugs, Soap, Parfums, Tobacco | 0.062 | 0.929 | 0.167 | 0.851 | -0.121 | 0.882 |
| Retail Stores | 0.198 | 0.813 | 0.069 | 0.950 | 0.423 | 0.718 |
| Transportation | 0.257 | 0.797 | -0.090 | 0.943 | 0.864 | 0.483 |
| Machinery & Business Equipment | 0.385 | 0.687 | -0.098 | 0.934 | 1.226 | 0.324 |
| Other | 0.292 | 0.769 | -0.157 | 0.906 | 1.076 | 0.405 |
| Consumer Durables | 0.149 | 0.886 | -0.259 | 0.855 | 0.861 | 0.560 |
| Automobiles | -0.203 | 0.836 | -0.550 | 0.667 | 0.403 | 0.789 |
| Construction and Constr. Materials | 0.030 | 0.976 | -0.574 | 0.685 | 1.086 | 0.418 |
| Chemicals | 0.275 | 0.773 | -0.622 | 0.632 | 1.841 | 0.132 |
| Mining and Minerals | 0.381 | 0.722 | -0.642 | 0.633 | 2.166 | 0.056 |
| Food | -0.205 | 0.824 | -0.743 | 0.560 | 0.734 | 0.438 |
| Fabricated Products | -0.180 | 0.860 | -0.753 | 0.583 | 0.818 | 0.518 |
| Textiles, Apparel & Footware | -0.435 | 0.620 | -0.797 | 0.516 | 0.196 | 0.864 |
| Steel Works | 0.063 | 0.954 | -1.116 | 0.427 | 2.122 | 0.104 |

The results in table 11 are not that different of that of table 10 above. Again no significant expected inflation betas and for unexpected inflation again Oil and Petroleum Products and Mining and Minerals are significant.

When we compare the betas we can say that the expected inflation betas (see graph 10) are quite the same, however the betas tend to be more negative using the moving average way for calculating expected inflation. which way we choose.


Graph 10: Expected Inflation Beta's
2,0
1,5
1,0
0,5
0,0
-0,5
-1,0
-1,5
-2,0
-2,5
-3,0
-3,5
Automobiles
Chemicals
Construction and Construction Materials
Consumer Durables
Drugs, Soap, Parfums, Tobacco
Fabricated Products
Financial Companies
Food
Machinery and Business Equipment
Mining and Minerals
Oil and Petroleum Products
Other
Retail Stores
Steel Works
Textiles, Apparel & Footware
Transportation
Utilities
Regressie Beta
Moving Average Beta


Graph 11: Unexpected Inflation Beta's
4,0
3,5
3,0
2,5
2,0
1,5
1,0
0,5
0,0
-0,5
-1,0
-1,5
Automobiles
Chemicals
Construction and Construction Materials
Consumer Durables
Drugs, Soap, Parfums, Tobacco
Fabricated Products
Financial Companies
Food
Machinery and Business Equipment
Mining and Minerals
Oil and Petroleum Products
Other
Retail Stores
Steel Works
Textiles, Apparel & Footware
Transportation
Utilities
Regressie Beta
Moving Average Beta

For the unexpected inflation betas we can say that they are almost the same, see graph 11. So we can conclude that both ways give the same results, and it thus does not matter.

*D. Comparison with the literature*

When using quarters we have the same results as Boudoukh et al (1994) for the expected inflation betas; they are negative. We also found this when using monthly overlapping years, however they are less negative, and some of them turned positive. This is in line with the results of Bodie (1976), Boudoukh et al (1994) and Gultekin (1983).

The unexpected inflation betas gave us a big difference between the two sample periods. When we are using quarters and the sample period 1953-1990 they are negative (which was also found by Fama & Schwert (1997)), but for our sample period, 1928-2008, they are positive (also found by Gultekin (1993) in the U.K.). This is in line with when using monthly overlapping years, they are almost all positive.

## VI Conclusion

For hedging expected inflation with stock industries we did not find any significant results. But our results show that for hedging unexpected inflation with stock industries, the best choice is buying stocks from the industries Oil and Petroleum products and Mining and Minerals because they have significant positive betas. However we have to say that the unexpected inflation betas are not stable. They are rising the last decades. This in contrary with the expected inflation betas, which seems to be quite stable for the last decades. Value weighted or equally weighted portfolios do not matter, however the betas of equally weighted portfolios tend to be bigger. We find both relations when using quarters and monthly overlapping years. Besides that we also used two ways for calculating expected inflation, and they gave us the same results.

## References


1. Bodie, Z., 1976, "Common stocks as a hedge against inflation", *The Journal of Finance*, vol. 31, no. 2, pp. 459-470.
2. Boudoukh, J. & Richardson, M., 1993, "Stock returns and inflation: A long horizon perspective", *American Economic Review*, vol. 83, no. 5, pp. 1346-1355.
3. Boudoukh, J., Richardson, M., Whitelaw, R.F., 1994, "Industry Returns and the Fischer Effect", *The Journal of Finance*, vol. 49, no. 5, pp. 1595-1615.
4. Ely, D.P. & Robinson, K.J., 1997, "Are stocks a hedge against inflation? International evidence using a long-run approach", *Journal of International Money and Finance,* vol. 16, no. 1, pp. 141-167.
5. Engsted, T. & Tanggaard, C., 2002, "The relation between asset returns and inflation at short and long horizons", *Journal of International Financial Markets, Institutions and Money,* no. 12, pp. 101-118.
6. Fama, E.F. & Schwert, G.W., 1977, "Asset returns and inflation", *Journal of Financial Economics, vol. 5, pp. 115-146.*
7. Fischer, I., 1930, *The Theory of Interest*, Macmillan, New York.
8. Gultekin, N.B., 1983, "Stock market returns and inflation: Evidence from other countries", *The Journal of Finance,* vol. 38, no. 1, pp. 49-65.
9. Ma, K. & Ellis, M.E., 1989, "Selecting industries as inflation hedges", *The Journal of Portfolio Management,* vol. 15, no. 4, pp. 45-48.
10. Stulz, R.M., 1986, "Asset pricing and expected inflation", *The Journal of Finance*, vol. 41, no. 1, pp. 209-223.
11. VanderHoff, J. & VanderHoff, M., 1986, "Inflation and stock returns: An industry analysis", *Journal of Economics and Business,* vol. 38, pp. 341-352.