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The Spurious Relation between Inflation Uncertainty and Stock Returns: Evidence from the U.S.

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Abstract: The purpose of this paper is to reconsider the empirical evidence on the relation between inflation, inflation uncertainty, and stock returns. Two unprecedented proxies for inflation uncertainty are used. First, the power of inflation and inflation uncertainty to explain stock returns is compared. Both variables are separately negatively related to stock returns. However, when both are included together in the regressions, the inflation variable becomes redundant, meaning that its coefficient becomes statistically insignificantly different from zero. This means that inflation uncertainty dominates and supplants the effect of inflation. Second, this paper provides strong evidence that inflation uncertainty itself becomes redundant, and fails to explain stock returns, when two fundamental variables are included in the regressions. The two fundamental variables are the change in the cost of equity, and the growth rate of earnings. The first variable is roughly measured by the change in the baa and in the aaa corporate bond yields, while the second one is taken to be the rate of change of industrial production. The main conclusion of the paper is that both inflation and inflation uncertainty are not significantly related to stock returns when the two aforementioned fundamental variables are accounted for.

JEL Classifications: G12, G14, E44, C22

Keywords: S&P 500 log returns; Inflation; Inflation uncertainty; Gordon constant growth dividend model; Cost of equity; Corporate bond yields; Earnings; Industrial production

1. Introduction

The purpose of this paper is to show that neither US inflation nor US inflation uncertainty explain significantly the returns on the US S&P 500 stock market index when two fundamental variables are added to the regressions. These two fundamental variables, which are proxies for the change in the cost of equity and for the growth rate of earnings, follow from a theoretical model developed in the third section. A possible conceptual explanation for such a result is that inflation uncertainty affects both the discount rate of expected future cash flows, and the magnitude of these expected future cash flows, raising both, and keeping the present value and therefore stock prices unchanged. Since inflation uncertainty and inflation are positively related higher inflation uncertainty coincides with a higher nominal discount rate and with higher nominal expected future cash flows.

The paper is organized as follows. A survey of the literature follows next. The theoretical model is introduced in the third section. There are three research hypotheses in section 4 that presents the empirical results. One, inflation and inflation uncertainty, each taken separately, are both negatively related to stock returns. Two, if inflation uncertainty is included in the stock return regressions together with inflation the latter loses statistical significance. This means that the appropriate independent variable is not inflation but inflation uncertainty. Azar (2010) finds strong supportive evidence that inflation, expected inflation and unexpected inflation do not produce a differential impact on stock returns once a fundamental variable is added to the stock return regressions. This paper finds strong supportive evidence for the third research hypothesis that inflation uncertainty, in turn, does not produce a differential impact on stock returns once fundamentals are added to the stock return regressions. Section 5 summarizes and concludes.

2. Survey of the Literature

The negative relation between inflation and stock returns is well established. For a rather recent survey on the topic see Azar (2010), or else see Bodie (1976), Nelson (1976), Fama and Schwert (1977), and Jaffe and Mandelker (1977). Gultekin (1983) and Solnik (1983) provide international evidence. Jung *et al.* (2007) is a more recent study on 4 OECD countries, and they find that only unexpected inflation affects negatively stock returns. Some authors consider that, since inflation and inflation uncertainty move positively together, the appropriate relation is between inflation uncertainty, and not inflation, with stock returns. The rationale is twofold. Higher inflation uncertainty increases the required risk premium, leads to a higher discount rate, and lowers the discounted present value of expected future cash flows, thus resulting in a fall in stock prices (Malkiel, 1979). The other reason is that economic activity is adversely affected by inflation uncertainty (Friedman, 1977) and, since stock returns lead economic activity, there is a negative relation between stock returns and inflation uncertainty.

There is no theoretical basis for how to measure inflation uncertainty, yet. In this respect all measures of inflation uncertainty are ad hoc. Usually, in the literature inflation uncertainty is measured by a GARCH process of the conditional variance (Engle, 1982; Bollerslev, 1986). The earliest study that uses the GARCH methodology is Buono (1989). He finds little evidence for a negative relation between conditional variance and stock returns. However Alexakis *et al.* (1996) find a significant negative relation for a sample of emerging economies which are characterized by high inflation rates. Lee (1999), Hu and Willett (2000), and Bhar (2010) all find significant negative relations. Lee (1999) uses contemporaneous data and is mainly concerned with unexpected inflation and conditional variance, while Hu and Willett (2000) and Bhar (2010) include in their regressions lagged variables of inflation uncertainty. The problem with the latter two papers is that the Efficient Markets Hypothesis, (Fama, 1965, 1970, 1991), is presumed wrong by allowing stock returns to be a function of lagged variables, known in advance, and hence making stock returns essentially predictable. Another drawback is that, in some sample periods, GARCH estimation fails dramatically because of the inexistence of a significant relation for the conditional variance. This necessitates considering other measures of inflation uncertainty than conditional variance within a GARCH model.

This paper singles out two other and different proxies for inflation uncertainty: absolute inflation, and the square of inflation. The empirical results in section 4 show that the effect of inflation uncertainty dominates the effect of inflation, and that the effect of inflation uncertainty dissipates when the two aforementioned fundamental variables are present in the stock return regressions. As a summary, the conclusion is strong that inflation uncertainty does not affect stock prices.

3. The Model

The model in this paper borrows from a relation developed by Williams (1938) and Gordon (1962) and which is:

$$P_t = \frac{D_{t+1}}{(k-g)} = \frac{\pi E_{t+1}}{(k-g)} = \frac{\pi(1+g)E_t}{(k-g)} \quad (1)$$

where P_t is this period's stock price, D_{t+1} is next period's dividend, E_{t+1} is next period's earnings, E_t is this period's earnings, π is the payout ratio, which is assumed to be constant, k is the cost of equity, g is the constant growth rate in dividends, and is also the capital gain's yield, and t is the time period. This model is simple and literally unrealistic for individual stocks. However in the literature it is used as a valid approximation for a market equity index (see, for example, Fama and French, 2002).

In the financial literature around three factors explaining stock returns are identified (Roll and Ross, 1980). Fama and French (1992, 1993) single out three variables that explain the cross-section of stock returns: a market factor, size, and leverage. The model in equation (1) is already a market model because P is replaced by the S&P 500 market index. Size is proxied by the underlying structure of the S&P 500, which includes only large firms, and leverage is proxied by the cost of equity k. Higher leverage leads to a higher financial risk and consequently to a higher cost of equity (Modigliani and Miller, 1958, 1963; Ross *et al*., 2010). Therefore this simple model is consistent with the financial literature. Taking a Taylor series expansion of the RHS of equation (1) with respect to t, k, and E, one finds:

$$d(P) = \frac{\partial P}{\partial t} d(t) - \frac{\pi(1+g)E_t}{(k-g)^2} d(k) + \frac{\pi(1+g)}{(k-g)} d(E) \quad (2)$$

Dividing both sides of equation (2) by *P* one obtains:

$$\frac{d(P)}{P} = \frac{\partial P}{P \partial t} d(t) - \frac{1}{(k-g)} d(k) + \frac{d(E)}{E} \quad (3)$$

Using the following approximations which are close to equality with monthly data:

$$\frac{\Delta(P)}{P} \approx \Delta(log_e(P)) \text{ and } \frac{\Delta(E)}{E} \approx \Delta(log_e(E)) \quad (4)$$

where log_e is the natural logarithm, and Δ is the first-difference operator, equation (3) becomes:

$$\Delta(log_e(P)) \approx \mu - \frac{1}{(k-g)} \Delta(k) + \Delta(log_e(E)) \quad (5)$$

Equation (5) is a relation between the change in the natural logs of a stock price and the change in k, where the proportionality factor is the negative inverse of the dividend yield, $(k-g) = D_{t+1}/P_t$, which happens also to be the (Macaulay) duration, and the relative change in earnings. The constant μ should measure the average monthly drift in stock returns. Equation (5) is the equation of what is here called the fundamentals. It does not include any additional variable whether it is inflation or inflation uncertainty.

Since aggregate earnings E are hard to come by, this variable will be replaced in this paper by industrial production IP, with the additional assumption that:

$$\Delta(log_e(E)) = \theta \Delta(log_e(IP)) \quad (6)$$

where θ is a constant that measures the proportionality between the growth rate of aggregate earnings and the growth rate of industrial production.

Azar (2010) finds strong evidence that, if the inflation rate is included in a variant of equation (5), and by transforming the resulting equation into a multiple regression, the coefficient on the inflation variable turns out to be statistically insignificant, negating any effect of inflation upon stock returns. This result is robust to changing the inflation variable into expected and unexpected components, or by taking separately positive and negative components of the inflation rate, or by considering positive and negative inflation shocks, or by changing the stock market index.

This paper shows that two realistic measures of inflation uncertainty are negatively correlated with stock returns, and supplant significantly the effect on stock returns of the inflation variable. However, when the two "fundamental" variables, i.e. $\Delta(k)$, and $\Delta(log_e(E))$, are added to the regressions the coefficients on these two measures of inflation uncertainty become statistically insignificant. This applies to the whole sample and to two sub-samples, and is consistent with equation (5) which does not include any inflation uncertainty variable. A possible theoretical explanation for such a result is that inflation uncertainty affects both the discount rate of expected future cash flows, and the magnitude of these expected future cash flows, raising both, and keeping the present value and stock prices unchanged. Since inflation uncertainty and inflation are positively related higher inflation uncertainty coincides with a higher nominal discount rate and with higher nominal expected future cash flows.

4. The Empirical Results

The data series for the US monthly S&P 500 stock market index is retrieved from the web site of snp500data.blogspot.com. The data on the monthly US consumer price index, the two monthly US corporate bond yields, the baa and the aaa corporate bond yields, and the monthly industrial production index are all found on the web site of the Federal Reserve Bank of Saint Louis. Log returns for the S&P 500 index are calculated by taking the first difference of the natural logs. The continuously compounded inflation rate is calculated by taking the first difference of the natural logs of the price level. The continuously compounded industrial production rate of change is also calculated by taking the first difference of the natural logs of this index. The first differences of the two corporate bond yields, divided by 1200 to get monthly decimal figures, are utilized (separately) in the regressions.

As argued above, and in Azar (2010), the proper model specification is a regression of *nominal* stock returns upon inflation, and not *real* stock returns upon inflation. Azar (2010) shows that in the regressions of *real* stock returns on inflation the coefficient on the inflation variable is statistically insignificantly different from -1, since inflation appears on both sides of the regression with the same coefficient of -1. This implies that *nominal* stock returns are independent of inflation. Table 1 presents the results of regressions of stock returns on inflation for three sample periods: the whole sample (1950m01-2011m03), the first sub-period (1950m01-1980m11), and the second sub-period (1980m12-2011m03). The coefficient on the inflation variable is negative in the regressions for all 3 samples, but is statistically significantly different from zero for the first two samples only.

Two proxies for inflation volatility or uncertainty are singled out: absolute inflation, and the square of inflation. The choice of these two measures of inflation uncertainty, which are different from the estimates in the literature, is dictated by the fact that a GARCH estimate of the conditional variance is impossible for specific periods in which the conditional variance equation fails to hold (Hu and Willett, 2000). If these two proxies of inflation uncertainty are relevant, and if the theoretical framework applies, including each in a regression with the presence of the inflation variable should produce statistically insignificant coefficients on the latter, but statistically significant negative coefficients on the former. The empirical literature has discovered the same outcome with different measures of inflation uncertainty. This is exactly what happens econometrically in this paper with the two measures of inflation uncertainty (Table 1). The t-statistics on the coefficient of the inflation variable for the full sample are 1.2438 and 0.2252 for the two regressions that include absolute inflation and that include the square of inflation respectively. The t-statistics for the other two sub-periods on the coefficients on inflation range respectively between -0.0306 and 0.7515, and between -1.0655 and -0.1007 respectively. Therefore empirically the presence of the two proxies for inflation uncertainty renders the inflation variable statistically with no explanatory power, as documented in the literature for other measures of inflation uncertainty. In addition, the coefficients on these two proxies of inflation uncertainty are all negative, and the lowest absolute t-statistic is 1.8580, the next lowest is 2.2251, and the highest is 3.6533.

Table 1. Ordinary Least Squares (OLS) regression analysis
The dependent variable is the log returns of the S&P 500 stock market index.

Sample range [N]	constant	Coefficient on inflation	Coefficient on absolute inflation	Coefficient on the square of inflation	Adjusted R-Square	Log likelihood	Durbin-Watson statistic	AIC
1950m01 2011m03 [735] ↓	0.00920 (4.3137)	-1.05500 (2.2169)			0.00531	1285.733	1.89104	-3.49315
	0.01285 (5.3170)		-1.9999 (3.7067)		0.01706	1290.102	1.91152	-3.50504
	0.00893 (5.0575)			-148.045 (3.4831)	0.01494	1289.310	1.90284	-3.50289
	0.01294 (5.3515)	0.98465 (1.2438)	-2.90061 (3.2124)		0.01779	1290.878	1.92085	-3.50443
	0.00867 (4.0633)	0.14677 (0.2252)		-157.089 (2.6852)	0.01366	1289.336	1.90360	-3.50023
1950m01 1980m11 [371] ↓	0.00980 (3.4677)	-1.19992 (2.1432)			0.00962	676.7385	1.96798	-3.63740
	0.01081 (3.4844)		-1.36688 (2.2251)		0.01057	676.9162	1.95722	-3.63836
	0.00782 (3.3099)			-87.3245 (1.8580)	0.00658	676.1711	1.94075	-3.63435
	0.01076 (3.2970)	-0.06109 (0.0306)	-1.30252 (0.5947)		0.00788	676.9167	1.95775	-3.63297
	0.00991 (3.2271)	-1.29702 (1.0655)		9.16920 (0.0899)	0.00695	676.7425	1.97047	-3.63204
1980m12 2011m03 [364] ↓	0.00847 (2.6074)	-0.81360 (0.9558)			-0.00024	612.7073	1.83549	-3.35554
	0.01687 (4.2980)		-3.43062 (3.3343)		0.02712	617.7539	1.90055	-3.38326
	0.01100 (4.1507)			-320.530 (3.6533)	0.03290	618.8382	1.92711	-3.38922
	0.01630 (4.0769)	0.72306 (0.7515)	-3.86266 (3.2758)		0.02595	618.0384	1.91305	-3.37933
	0.01120 (3.4033)	-0.08697 (0.1007)		-318.349 (3.5183)	0.03024	618.8433	1.92588	-3.38375

Notes: Absolute t-statistics in parentheses. The sample size N is in brackets. The inflation rate is continuously compounded. AIC stands for the Akaike Information Criterion.

For the whole sample and for the first sub-period, the minimum Akaike Information Criterion (AIC: Akaike, 1974) selects the regression with absolute inflation as the only independent variable. The same criterion selects the regression with the square of inflation as the only independent variable for the second sub-period. The models that include in the regressions the inflation variable together with the estimates of inflation uncertainty are not selected. In all cases the Durbin-Watson statistics find no evidence for first-order serial correlation of the residuals. All this ascertains the appropriateness of the two proxies for inflation uncertainty.

In Azar (2010), the inflation variable becomes insignificant when one “fundamental variable” is included in the regressions. This fundamental variable is a proxy for the change in the time-variable equity return $\Delta(k)$. It is estimated by two different series: the change in the baa and the change in the aaa corporate bond yields, granted that the first series should be more appropriate because it has a higher default risk premium, and is therefore closer to the cost of equity. If Azar (2010) is right then the same should happen with inflation variability. In other terms the coefficient on the inflation uncertainty variable should become statistically insignificant when fundamental variables are included in the regressions. The second additional fundamental variable in this paper is a proxy for the growth rate in earnings. Evidence for the irrelevance of inflation uncertainty is provided in Tables 2, 3, and 4. Table 2 presents the results for the full sample, while Tables 3 and 4 present the results for the two sub-periods.

Table 2. Results of regression, with the sample from 1950m01 to 2011m03, i.e. 735 observations

Conditional mean equation						
Constant	0.00799	0.006322	0.006828	0.00942	0.00705	0.00780
	(4.6705)	(3.7102)	(3.9065)	(4.1812)	(3.1008)	(3.3926)
Coefficient on absolute inflation				-1.03206	-0.45690	-0.7589
				(2.3363)	(0.9676)	(1.6508)
Coefficient on the square of inflation	-95.8367	-16.5180	-46.0693			
	(2.8009)	(0.4324)	(1.2336)			
Coefficient on Δ(baa)		-61.7837			-55.9840	
		(7.1165)			(6.3078)	
Coefficient on Δ(aaa)			-52.7776			-45.3477
			(6.2553)			(5.6240)
Coefficient on $\Delta(\log_e(IP))$		0.06337	0.07259		0.09150	0.09929
		(0.5678)	(0.6455)		(0.8078)	(0.8708)
Conditional variance equation	*GARCH*	*GARCH*	*GARCH*	$\log_e(GARCH)$	$\log_e(GARCH)$	$\log_e(GARCH)$
Constant	0.00010	0.0000848	0.0000924	-0.79719	-0.67584	-0.69355
	(3.1520)	(2.7891)	(2.9654)	(2.7878)	(2.8666)	(2.8093)
Coefficient on $RESID(-1)^{\wedge}2$	0.10697	0.11193	0.11233			
	(4.4711)	(3.7773)	(4.0244)			
Coefficient on $GARCH(-1)$	0.84010	0.84316	0.83877			
	(28.6316)	(25.4240)	(25.7727)			
Coefficient on $ABS(RESID(-1)/\sqrt{GARCH(-1)})$				0.20410	0.21553	0.21797
				(3.3550)	(3.2298)	(3.4058)
Coefficient on $RESID(-1)/\sqrt{GARCH(-1)}$				-0.09098	-0.04916	-0.05546
				(3.9224)	(2.3945)	(2.7420)
Coefficient on $LOG(GARCH(-1))$				0.90044	0.92418	0.91876
				(22.432)	(30.124)	(27.498)
Adjusted R-Square	0.01291	0.05557	0.04309	0.04198	0.05819	0.04558
Log likelihood	1311.723	1330.962	1326.514	1319.216	1334.145	1330.017
AIC	-3.555710	-3.607526	-3.595405	-3.573378	-3.613475	-3.602227
Q(6)	0.082	0.243	0.240	0.095	0.225	0.228
Q(12)	0.411	0.505	0.658	0.451	0.506	0.665
$Q^2(6)$	0.987	0.918	0.977	0.981	0.969	0.986
$Q^2(12)$	0.933	0.918	0.936	0.949	0.969	0.971
Normality test	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Notes: The dependent variable in the conditional mean equation is the log returns of the S&P 500 stock market index. Absolute t-statistics are in parentheses. The inflation rate is continuously compounded. AIC stands for the Akaike Information Criterion. Q(k) is the actual p-value of the Ljung-Box Q-statistic for lag length k on the standardized residuals (Ljung and Box, 1978). $Q^2(k)$ is the actual p-value of the Ljung-Box Q-statistic for lag length k on the squares of the standardized residuals (Ljung and Box, 1978). The actual p-value for the Jarque-Bera normality test is reported (Jarque and Bera, 1981, 1987). The two corporate bond yields are the baa and the aaa corporate bond yields. The operator Δ is for the first difference.

First it must be ascertained that the two proxies of inflation uncertainty have negative and statistically significant coefficients when present alone in the regressions. This is crucial because the econometric specification of the model is now different from the Ordinary Least Squares (OLS) specification in Table 1 and includes an additional model for the conditional variance. For the square of the inflation variable the t-statistics are -2.8009 (Table 2), -1.6701 (Table 3), and -2.9339 (Table 4) for the three samples respectively. For the absolute inflation variable the t-statistics are respectively -2.3363, -2.4576, and -2.4970. Hence this shows that the two proxies for inflation uncertainty have the required negative sign and the required statistical significance when present alone in the regressions. Absolute inflation seems a better estimate of inflation uncertainty than the square of inflation.

Table 3. Results of regression, with the sample from 1950m01 to 1980m11, i.e. 371 observations

Conditional mean equation						
Constant	0.00732	0.00742	0.00763	0.01036	0.00920	0.00991
	(2.930)	(2.9454)	(3.0019)	(3.2643)	(2.7698)	(3.0228)
Coefficient on absolute inflation				-1.28443	-0.46722	-0.7598
				(2.4576)	(0.6855)	(1.1985)
Coefficient on the square of inflation	-61.1880	15.0986	-11.3223			
	(1.6701)	(0.3109)	(0.2479)			
Coefficient on Δ(baa)		-63.5339			-57.5614	
		(3.7185)			(3.2739)	
Coefficient on Δ(aaa)			-60.3982			-56.0491
			(3.7848)			(3.4863)
Coefficient on $\Delta(\log_e(IP))$		-0.06104	-0.04394		-0.07791	-0.0613
		(0.4322)	(0.3119)		(0.5515)	(0.4375)
Conditional variance equation	*GARCH*	*GARCH*	*GARCH*	*GARCH*	*GARCH*	*GARCH*
Constant	0.00018	0.000170	0.000180	0.000180	0.000178	0.000185
	(1.6296)	(1.5050)	(1.5564)	(1.7250)	(1.5337)	(1.6043)
Coefficient on $RESID(-1)$^2	0.09128	0.10306	0.09665	0.09773	0.10172	0.09813
	(2.3799)	(2.4454)	(2.3968)	(2.5012)	(2.4711)	(2.4697)
Coefficient on $GARCH(-1)$	0.79253	0.78424	0.78369	0.78577	0.7799	0.77848
	(8.4135)	(7.7335)	(7.7104)	(8.6153)	(7.4998)	(7.6370)
Adjusted R-Square	0.00573	0.03155	0.03127	0.01051	0.03594	0.03596
Log likelihood	684.5371	688.6114	687.9021	685.8009	688.8040	68.5206
AIC	-	-3.684387	-3.680552	-3.670086	-3.685427	-3.683895
Q(6)	3.663273	0.343	0.372	0.175	0.333	0.374
Q(12)	0.147	0.343	0.411	0.242	0.360	0.426
$Q^2(6)$	0.215	0.736	0.861	0.970	0.742	0.860
$Q^2(12)$	0.986	0.493	0.705	0.863	0.466	0.665
Normality test	0.913	0.12114	0.068602	0.01749	0.121124	0.076147
	0.00966					

Notes: See notes under Table 2.

If the change in the baa corporate bond yield and the growth rate of industrial production are included in the regressions next to either one of the two proxies for inflation uncertainty, the t-statistics on the latter become insignificant as expected. For the regressions with the square of inflation the t-statistics are -0.4324, +0.3109, and -1.6950 for the three samples respectively. For the regressions with absolute inflation the t-statistics are -0.9676, -0.6855, and -1.3896 for the three samples respectively.

If, alternatively, the change in the aaa corporate bond yield is included in the regressions next to either one of the two proxies of inflation uncertainty, the t-statistics on the latter become also close to insignificant. For the regressions with the square of inflation the t-statistics on the coefficients of this variable are -1.2336, -0.2479, and -1.9701 for the three samples respectively. For the regressions with absolute inflation the same t-statistics are -1.6508, -1.1985, and -1.5106 for the three samples respectively. Although one t-statistic is significant at the 5% two-tailed marginal significance level, but not at the 1% marginal significance level, the general conclusion is that the two proxies for inflation uncertainty become insignificant, or close to insignificant, as explanatory independent variables, when the two fundamental variables are included in the regressions. The t-statistic that is marginally significant may be due to the inappropriateness of the aaa corporate bond yield as a proxy for k, or else due to just sampling error. Again absolute inflation seems a better estimate of inflation uncertainty than the square of inflation.

In Table 2, columns 5, 6 and 7, when the conditional variance equation is modeled by an Exponential GARCH (EGARCH) process (Nelson, 1991) there is evidence of a statistically significant leverage effect, a finding which is in conformity to the literature: negative innovations in returns increase financial leverage which, in turn, increases the conditional variance (Black, 1976; Christie, 1982).

Table 4 . Results of regression, with the sample from 1980m12 to 2011m03, i.e. 364 observations

Conditional mean equation						
Constant	0.00976	0.00560	0.00619	0.01272	0.00709	0.00772
	(3.9438)	(2.3229)	(2.4841)	(3.7087)	(2.1459)	(2.2888)
Coefficient on absolute inflation				-2.01153	-1.11524	-1.2027
				(2.4970)	(1.3896)	(1.5106)
Coefficient on the square of inflation	-224.663	-134.320	-152.985			
	(2.9339)	(1.6950)	(1.9701)			
Coefficient on Δ(baa)		-61.8518			-62.6250	
		(6.0330			(5.9946)	
Coefficient on Δ(aaa)			-50.6679			-51.0460
			(5.1935)			(5.1690)
Coefficient on $\Delta(\log_e(IP))$		0.5705	0.6041		0.5755	0.6039
		(2.0220)	(2.0756)		(2.0196)	(2.0548)
Conditional variance equation	*GARCH*	*GARCH*	*GARCH*	*GARCH*	*GARCH*	*GARCH*
Constant	0.00007	0.000046	0.000048	0.00007	0.000046	0.000048
	(1.7793)	(1.4828)	(1.5429)	(1.7665)	(1.4678)	(1.5425)
Coefficient on $RESID(-1)^{\wedge}2$	0.11650	0.1175	0.12278	0.11569	0.11834	0.12451
	(3.5970)	(2.5665)	(2.6612)	(3.6252)	(2.5830)	(2.6971)
Coefficient on $GARCH(-1)$	0.86077	0.86767	0.86268	0.86237	0.86718	0.86163
	(26.2884)	(20.1885)	(20.4200)	(26.3601)	(20.1216)	(20.513)
Adjusted R-Square	0.02969	0.09501	0.07435	0.02198	0.09022	0.06628
Log likelihood	630.7430	648.1022	644.3430	629.7354	647.4947	643.4828
AIC	-	-3.522539	-3.501885	-	-	-
Q(6)	3.438148	0.418	0.618	3.432612	3.519202	3.497158
Q(12)	0.699	0.623	0.883	0.675	0.425	0.619
$Q^2(6)$	0.900	0.997	0.999	0.889	0.624	0.885
$Q^2(12)$	0.994	0.980	0.967	0.995	0.996	0.999
Normality test	0.964	0.00000	0.00000	0.968	0.980	0.974
	0.00000			0.00000	0.00000	0.00000

Notes: See notes under Table 2.

According to the AIC criterion, the best regressions in Tables 2, 3 and 4 are the ones with the change in the baa corporate bond yield as the fundamental variable. This is reasonable and is as expected because this series is closer to the cost of equity than the aaa corporate bond yield. The baa corporate bond yield features a much higher default risk premium.

The coefficients on the rate of change of industrial production are only statistically significantly different from zero for the second subsample (Table 4). The reasons for such a finding are unclear, and leading the industrial production variable does not materially affect the results. In addition, these statistically significant coefficients are statistically no different from +1, with t-statistics ranging between -1.5220 and -1.3478. It seems that a 1% increase in industrial production points to a 1% increase in earnings.

It is note-worthy to mention that, in Tables 2, 3, and 4, the minimum actual p-value of the Ljung-Box Q-statistics for two lag lengths (6 and 12) on the standardized residuals is 0.082, while the minimum actual p-value of the same statistic on the squares of the standardized residuals is 0.466. This is evidence that the standardized residuals are properly behaved and that all models do not suffer from misspecification. However the hypothesis of normality of the standardized residuals is rejected for the whole sample and for the second sub-sample, while this hypothesis fails to be rejected in 5 out of 6 regressions in the first sub-sample. Since OLS (Ordinary Least Squares) is robust to departure from normality, and since asymptotic normality and the central limit theorem can be invoked because the sample sizes are large, the problem of non-normality should have little consequence.

There is an issue of measurement error. If the changes in the two corporate bond yields measure the change in the cost of equity with error, a classic case of measurement error, the coefficient on these bond yields should be biased towards zero (Verbeek, 2012). As mentioned earlier the absolute values of the coefficients on the change in these yields are estimates of the inverse of the average market dividend yield. If these coefficients are biased towards zero, then the dividend yields should be overstated. For all regressions this dividend yield varies between 1.597% and 2.205%. These estimates cannot be considered exaggerated. Quite the opposite these estimates are lower than the actual average of the historical market dividend yield, which is 4.3256%, estimated over the monthly period from 1880m12 till 2012m3, with data retrieved from www.multpl.com/s-p-500-dividend-yield/table. Other estimates from the literature are 3.70% for the period 1951/2000 (Fama and French, 2002), and 3.1% (Ross *et al.*, 2010). This is evidence that the regressions do not seem to be affected by measurement errors. Quite to the opposite, instead of obtaining coefficients that are biased towards zero, these coefficients are biased away from zero.

5. Conclusion

The present paper reconsiders the relation between inflation, inflation uncertainty and stock returns. The following is a summary of the findings. As in the literature there is a negative relation between inflation and inflation uncertainty, taken separately, with stock returns. However when both inflation and inflation uncertainty enter together in the regressions of stock returns the former variable becomes redundant, i.e. its coefficient becomes statistically insignificantly different from zero, while the coefficient on the inflation uncertainty proxy remains negative and statistically significant. This means that inflation uncertainty dominates and supplants the effect of inflation and is econometrically the “correct” regressor. This implies indirectly that the two proxies for inflation uncertainty, which are adopted in this paper, i.e. the absolute value and the square of inflation, are appropriate and valid.

In addition, this paper retests the relation between inflation uncertainty and stock returns. When two fundamental variables are added to the regressions of stock returns, the effect of inflation uncertainty wanes and disappears. These fundamental variables are the change in the cost of equity and the growth rate of earnings. They derive from the Gordon constant growth dividend model. The first variable is approximated by the change in the baa and in the aaa corporate bond yields, while the second is estimated by the growth rate of industrial production. Therefore, the evidence is strong that, when these two fundamental variables are included in the regressions on stock returns, inflation uncertainty has no longer a significant impact on stock returns. The choice of the baa corporate bond yield, instead of the aaa corporate bond yield, provides better statistical results, and this is reasonable and is as expected because the former includes a higher default risk premium, and is closer to the cost of equity. Finally, and in order to avoid misspecification, a conditional variance equation is modeled for all regressions.

There is a theoretical rationale behind the irrelevance of inflation and inflation uncertainty to stock returns. Since higher inflation occurs with higher inflation uncertainty, inflation uncertainty increases the risk premium in the discount rate but at the same time the expected future cash flows are higher because inflation is higher, leading to no change in the present value of these expected future cash flows, and consequently stock prices remain unchanged, and stock returns are not affected.

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