Inflation Illusion or No Illusion[1]:
What did Pre- and Post-War Data Say?

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Abstract

Campbell and Vuolteenaho (2004) empirically decompose the S&P 500's dividend yield from 1927 to 2002 to derive a measure of residual mispricing attributed to inflation illusion. They argue that the strong positive correlation between the mispricing component and inflation is strong evidence for the inflation illusion hypothesis. We find evidence for structural instability in their prediction equation for the excess return. We apply the same decomposition approach to the data before and after 1952, and find that the correlation between inflation and the mispricing component is close to zero in the post-war period, when inflation and the dividend yield are strongly positively correlated. The post-war data do not support the inflation illusion hypothesis as the explanation for the positive correlation between inflation and dividend yields.

JEL: E44, E31
Key Words: inflation illusion, mispricing, structural instability, decomposition approach

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The leading practitioner model of equity valuation, the so-called "Fed model," implies that the yield on stocks (as measured by the ratio of dividends or earnings to stock prices) is highly positively correlated with inflation. Campbell and Vuolteenaho (2004, henceforth CV) argue that the inflation illusion hypothesis proposed by Modigliani and Cohn (1979) explains this correlation. According to this hypothesis, stock market investors fail to understand the effect of inflation on nominal dividend growth rates and extrapolate historical nominal growth rates even in periods of changing inflation. From the perspective of a rational investor, this implies that stock prices are undervalued when inflation is high and overvalued when it is low.

Inflation illusion has again become a prominent theme in subsequent studies, including Brunnermeier and Julliard (2006), and Piazzesi and Schneider (2006). It is critically important to take a second look into the robustness of the decomposition approach outlined by CV (2004).

In this paper, we examine the robustness of the results of CV (2004) by focusing on the sample stability issue[2]. We use their decomposition approach to examine the data before and after the Second World War, using 1952 as a break point. Polk, Thompson, and Vuolteenaho (2005) use the CAPM to generate the measure of subjective risk premium used in the decomposition approach. However, Campbell (1991), Fama and French (1992) and others find that the CAPM fails to empirically describe the cross-section of the average returns in the postwar period. It is no surprise that the measure of subjective risk premium is not as useful in predicting the equity premium in the more recent subsamples. These findings motivate our choice of the year 1952 as a possible break point.

We find that the pre- and post-war data tell dramatically different stories about inflation illusion.

1 Decomposition Approach

We use the same data and follow exactly the same VAR decomposition approach described in CV (2004) for this empirical exercise. First, the de-

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[2]CV's (2004) decompostion approach is also subject to other shortcomings, including sensitivity to the choice of state variables.

meaned log dividend yield, $d_t - p_t$, is decomposed as

$$d_t - p_t = \sum_{j=0}^{\infty} \beta^j r_{t+1+j}^e - \sum_{j=0}^{\infty} \beta^j \triangle d_{t+1+j}^e, \qquad (1)$$

where r^e denotes the log stock return less the log risk-free rate for the period, and $\triangle d^e$ denotes $\triangle d$ less the log risk-free rate for the period. Since we work with monthly data, β is set at $0.97^{\frac{1}{12}}$.

Step one of the decomposition approach is to estimate a first-order VAR model:

$$\mathbf{Z}_{t+1} = \mathbf{a} + \mathbf{\Gamma} \mathbf{Z}_t + \mathbf{u}_{t+1}, \qquad (2)$$

where $\mathbf{Z}_t$ is a column vector of the four state variables: (1) the excess log return on the S&P 500 index over the three-month Treasury bill (r^e), (2) the cross-sectional equity risk premium of Polk et al. (2005) (λ), (3) the log dividend-price ratio (dy) and (4) the exponentially smoothed moving average of inflation (π).

Step two is to obtain the fitted values of the long-run excess discount rate r^L (the first term on the right hand side of equation (1)) based on the parameter estimates of the VAR model:

$$r_t^L = \mathbf{e}_1 \left(\mathbf{I} - \beta \mathbf{\Gamma} \right)^{-1} \mathbf{\Gamma} \mathbf{Z}_t, \mathbf{e}_1 = [1, 0, ..., 0]'. \qquad (3)$$

In step three, we regress r_t^L on the cross-sectional equity premium λ_t, and label the residual of this regression, ε_t, as the mispricing component.

2 Estimation Results

2.1 Test of Sample Stability

Attempts to predict the excess return r^e have a long tradition in finance. However, Goyal and Welch (2006) present detailed evidence that most prediction models are unstable. As we find out, the prediction model used in CV (2004) is no exception. We apply the Chow-test to the first equation of the VAR system, using 1951:12 as a known break point. The hypothesis that there are no structural breaks before and after 1952 is strongly rejected. The $p-$ratio of the Chow-test statistics is 0.003.

2.2 Illusion or No Illusion

Table 1 shows the estimated parameters of the VAR system for the two subsample periods. It is important to note that the regression coefficients of the excess return on lagged inflation have opposite signs in the two sample periods (approximately 0.21 in the first, and -0.22 in the second subsample period). Due to high persistence of inflation, the coefficient of the long-run excess discount rate $\left(r_t^L\right)$ on inflation (π_t) turns out to be drastically different in the two sample periods.

As shown in Table 2, when we estimate the data over the entire sample period, the regression coefficient of the long-run excess discount rate on inflation is 14.76. However, a 1% increase in inflation raises the long-run excess discount rate by 31% in the pre-war period, but reduces it by 1.5% in the post-war period. The strongly positive correlation between the long-run excess discount rate and inflation for the entire sample reflects the strong positive relationship between these two variables in the pre-war period.

We proceed to regress the long-run excess discount rate r_t^L on the measure of subjective risk premium (λ) to obtain the residual mispricing component. Since λ does not vary much with inflation, the regression coefficient of the mispricing component on inflation mirrors that of the long-run excess discount rate. Table 3 reports the regression coefficients of the three components of the log dividend yield on inflation. In the pre-war sample period, the regression coefficient of the mispricing component on inflation is 27.85 with an R^2 of 87 percent. While in the postwar period, the same coefficient is -1.0291 with an R^2 of 0.46 percent. The same regression on the data over the entire sample period yields a coefficient of 16.17 with an R^2 of 78 percent, close to CV (2004)'s results on monthly data over the same period.

The results show that in the postwar period, the mispricing component is barely related to inflation, and any relationship that does exist would be negative. According to CV's (2004) definition of the mispricing component, a negative correlation between these two variables implies that investors over-, instead of under-estimate, the nominal dividend growth rate when inflation is high in the post-war period. This implication is at odds with the inflation illusion hypothesis.

In the postwar sample period, the regression coefficient of $-\sum_{j=0}^{\infty} \beta^j \triangle d_{t+1+j}^e$ on inflation is 11.12 with an R^2 of 26%, implying a negative relation between rationally expected excess dividend growth rate and inflation, opposite to CV (2004)'s results on the entire sample period. These results support alter-

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native rational hypotheses that inflation may be positively correlated with dividend yields because it reduces the long-run expected dividend growth rate, and/or raises the real discount rate.

Figure 1 plots the time series of two variables: (1) the mispricing component of log dividend yield, ε_t; and (2) the fitted value from a regression of mispricing component on inflation, ε_t^π, computed with and without the structural break in 1952. As shown in Figure 1, when the data for the entire sample period are used, these two series plot almost perfectly on top of each other, as shown by Campbell and Vuolteenaho (2004). However, when the structural break in 1952 is considered, the fitted value ε_t^π covaries with the mispricing component in the pre-war period, but has little impact on it after 1952. The decomposition approach applied to the post-war data provides little support for the inflation illusion hypothesis.

3   Implications for Inflation Illusion Hypothesis

The evidence further challenges the inflation illusion hypothesis when we conduct a stability test in the regression of the dividend yield on inflation and the risk premium. As shown in Table 4, the hypothesis that there are no structural breaks in 1952 is strongly rejected. Interestingly, inflation and the dividend yield are more positively correlated in the post-war period, when inflation is negatively correlated with the mispricing component. These results indicate that inflation illusion, as measured by CV (2004)'s VAR decomposition approach, cannot explain the positive correlation between inflation and the dividend yield after WWII. The result is even more important considering that the post-war sample period includes the 70s and 90s, the two sample periods during which inflation and the dividend yield are strongly positively correlated.

Our results cast doubt on inflation illusion as the explanation for the positive association between inflation and the dividend yield. Furthermore, the post-war data demonstrate a negative relation between rationally expected excess dividend growth rate and inflation, consistent with the rational explanation for the positive correlation between inflation and dividend yields pursued in Wei (2007).

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Table 1: VAR Parameter Estimates

The table shows the OLS parameter estimates for a first-order VAR model including a constant, the log excess market return (r^e), the subjective risk premium measure (λ), log dividend-price ratio (dy), and smoothed inflation (π) in the two sample periods. Each row corresponds to a different dependent variable. The first four columns report coefficients on the explanatory variables except for the constant, and the last column shows R^2. Bootstrap standard errors (in parentheses) are computed from 2500 realizations simulated from the estimated system.

	r_t^e	λ_t	dy_t	π_t	$R^2\,(\%)$
Sample Period: 1928:12-1951:12 (277 obs)					
r_{t+1}^e	0.0814	0.0725	0.0091	0.2058	3.86
	(0.0594)	(0.0418)	(0.0253)	(0.3570)	
λ_{t+1}	−0.0206	0.8589	0.0699	−0.2733	87.14
	(0.0470)	(0.0313)	(0.0187)	(0.2789)	
dy_{t+1}	−0.3636	−0.0345	0.9463	0.1629	92.78
	(0.0557)	(0.0378)	(0.0232)	(0.3206)	
π_{t+1}	0.0087	0.0003	−0.0012	0.9980	99.32
	(0.0026)	(0.0018)	(0.0010)	(0.0182)	
Sample Period: 1952:01-2001:12 (600 obs)					
	r_t^e	λ_t	dy_t	π_t	$R^2\,(\%)$
r_{t+1}^e	0.0208	0.0078	0.0152	−0.2195	1.75
	(0.0416)	(0.0177)	(0.0092)	(0.1940)	
λ_{t+1}	−0.0539	0.9413	0.0137	−0.2002	91.79
	(0.0377)	(0.0159)	(0.0078)	(0.1690)	
dy_{t+1}	−0.0038	0.0003	0.9880	0.2025	98.64
	(0.0438)	(0.0186)	(0.0098)	(0.2026)	
π_{t+1}	−0.0038	0.0002	−0.0004	1.0020	99.63
	(0.0014)	(0.0006)	(0.0003)	(0.0084)	

Test for Structural Stability (the excess return equation)
$$F(5, 867) = 3.6069, p-\text{ratio} = 0.0031$$

Table 2: Mapping of the Long-Run Excess Discount Rate

This table reports derived statistics implied by the VAR model of Table 1. It shows the linear functions that map the VAR state variables into the long run excess discount rate, r_t^L, according to equation (3). The VAR state variables are the log excess market return (r^e), the subjective risk premium measure (λ), log dividend-price ratio (dy), and smoothed inflation (π). Standard errors (in parentheses) are computed from 2500 simulations from the VAR of Table 1.

		Pre-War Sample Period:1928:12-1951:12 (277 obs)			
r_t^L	$=$	$0.2457r_t^e$	$+0.6107\lambda_t$	$+0.3112dy_t$	$+31.1187\pi_t$
		(0.13)	(0.23)	(0.19)	(0.12)
		Post-War Sample Period: 1952:01-2001:12 (600 obs)			
r_t^L	$=$	$0.0150r_t^e$	$+0.1327\lambda_t$	$+1.2301dy_t$	$-1.5040\pi_t$
		(0.0261)	(0.0908)	(0.1407)	(4.4813)
		Entire Sample Period: 1928:12-2001:12 (877 obs)			
r_t^L	$=$	$-0.0439r_t^e$	$+0.4531\lambda_t$	$+0.6338dy_t$	$+14.7605\pi_t$
		(0.0654)	(0.1723)	(0.2121)	(8.0103)

Table 3: Regressions of Dividend Yield's Components on Inflation

We first decompose the demeaned log dividend yield, dy_t, into three components: (1) The negative of long-run expected dividend growth, $-\sum_{j=0}^{\infty} \beta^j \triangle d_{t+1+j}^e$, where $\triangle d_{t+1+j}^e$ is the demeaned excess dividend growth; (2) the subjective risk premium component, $\gamma \lambda_t$; and (3) the mispricing component. The subjective risk premium and mispricing components are defined as the fitted values and residuals of the regression $\sum_{j=0}^{\infty} \beta^j r_{t+1+j}^e = \gamma \lambda_t + \varepsilon_t$, where r_{t+1+j}^e is the demeaned excess log return on S&P 500 and λ_t the demeaned cross-sectional risk premium. This table shows the simple regression coefficients of these three components on smoothed inflation π_t and the corresponding regression R^2. Bootstrap standard errors (in parentheses) are computed from 2500 realizations simulated from the estimated system. We implement the above procedure on the data in the pre-war, post-war periods and the entire sample period.

VAR specifications	$-\sum_{j=0}^{\infty} \beta^j \triangle d_{t+1+j}^e$	$R^2\%$	$+\gamma\lambda_t$	$R^2\%$	$+\varepsilon_t$	$R^2\%$
Pre-War Period	-29.53	98.14	2.73	12.68	27.85	87.03
(1928:12-1951:12)	(10.12)	(33.12)	(2.36)	(12.14)	(8.85)	(30.37)
Post-War Period	11.12	25.98	-0.73	2.89	-1.03	0.46
(1952:01-2001:12)	(4.68)	(34.04)	(2.47)	(10.62)	(8.79)	(20.48)
Entire Sample	-12.66	92.97	-0.79	12.33	16.17	78.06
(1928:12-2001:12)	(7.68)	(33.16)	(3.92)	(14.87)	(7.34)	(27.32)

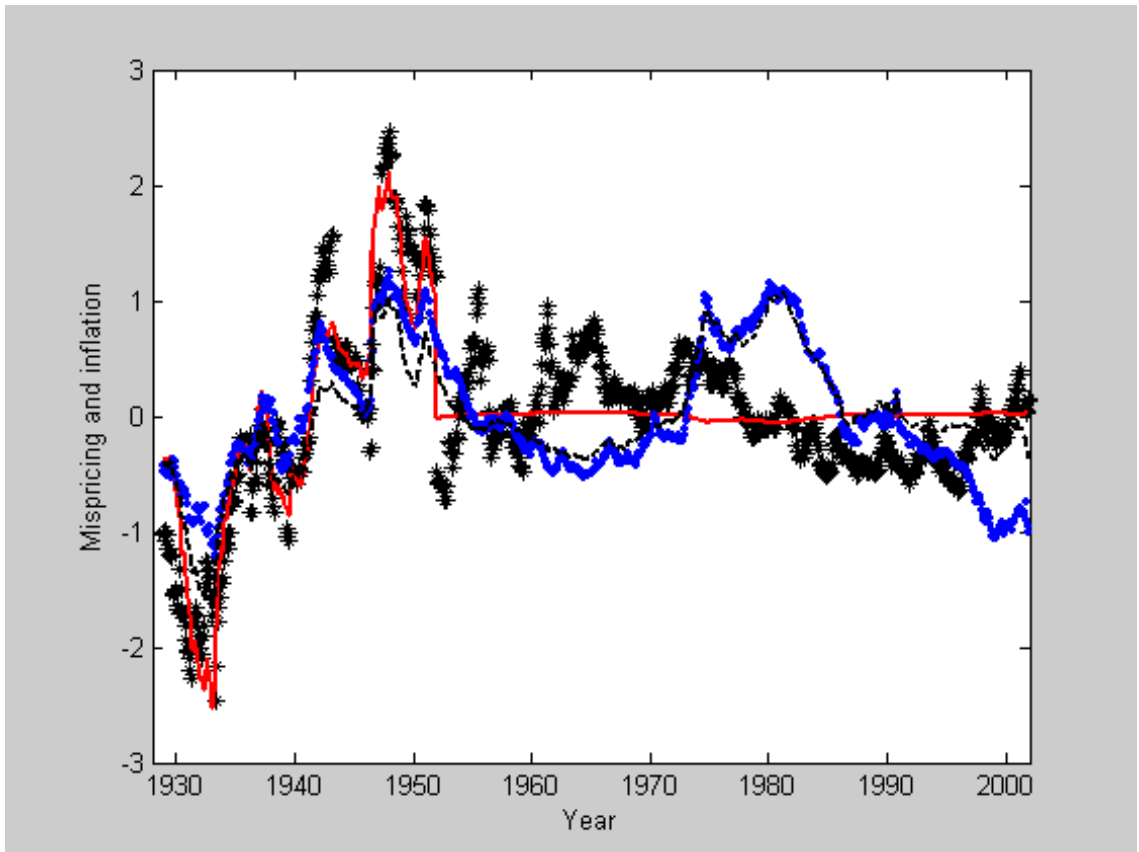## Table 4: Regression of Dividend Yields on Inflation

This table shows the unrestricted OLS regression of dividend yields (DY_t) on the cross-sectional risk premium (λ_t) and smoothed inflation (π_t). The dummy variable D_t is equal to 1 in the post-war period. The statistics in the parentheses are $p-$ratios. The regressions are estimated from the full sample period 1928:12-2001:12, 877 monthly observations. The Chow-test strongly rejects the hypothesis that there are no structural breaks in 1952.

DY_t	=	0.0458	+0.043	$\times \lambda_t$	+0.1076	$\times \pi_t$
		(0.00)	(0.00)		(0.05)	
		$-0.0166 \times D_t$	-0.0163	$\times D_t \lambda_t$	+0.2383	$\times D_t \pi_t$
		(0.00)	(0.23)		(0.00)	

Test for Structural Stability
$F(3, 871) = 83.03, p - ratio \rightarrow 0$

Figure 1: Inflation and Mispricing

This figure plots the time-series of two variables computed with and without the structural break in 1952: (1) The mispricing component of log dividend yield, computed with a structural break in 1952, marked with *s; (2) The fitted value from a regression of mispricing component on inflation, computed with a structural break in 1952, marked with a solid line; (3) The mispricing component of log dividend yield, computed using data for the entire sample period, marked with dots; and (4) the fitted value from a regression of mispricing component on inflation, computed using data for the entire sample period, marked with a dashed line.