Prices and Returns: What Is the Role of Inflation?

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Abstract

We document that both the dividend yield and earnings yield can predict the future inflation across advanced economies. The inflation predictability reinforces the return predictability and reduces the dividend growth predictability and we show both discount rates and cash flows play important roles in determining prices. We test three hypothesis related to future growth prospect, risk aversion and behavior bias to justify the positive correlation among inflation and dividend (earnings) yields. Evidence suggests that high expected inflation has tended to coincide with periods of lower real economic growth and higher discount rates which lead to the drop in today's prices. To rationalize the inflation predictability, we develop and estimate a long-run risk model featuring inflation non-neutrality. The estimated model can reproduce both the inflation predictability and the documented asset pricing facts.

JEL classification: G10, G15.

Keywords: Dividend growth, Dividend yield, Inflation, International equity markets, Money illusion, Stock return.

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1. Introduction

A fundamental question in asset pricing is to determine whether discount rate news or cash flow news move stock prices. Evidence based on US post-war data suggests most of variations come from the discount rates (Cochrane (2007, 2011)) while international evidence shows dividend price ratio can actually predict the cash flows and the contributed variation ratio from cash flows is not negligible (Engsted and Pedersen (2010), Rangvid, Schmeling, and Schrimpf (2014)). However, predictability results for both returns and dividend growth can be sensitive to the use of nominal or real terms and in this paper we extend the analysis to compare results when nominal term and real term are adopted. Our goal is to assess whether the results obtained in these studies hold when inflation is considered. Indeed we find inflation can change the big picture of return and cash flow predictability.

Inflation can be predicted by the dividend (earnings) yield from one year to twenty year horizon across all seven advanced countries. The interesting implication of this finding is that the apparent strong predictability of nominal stock returns and/or predictability of dividend (earnings) growth are an artifact of inflation predictability by the dividend (earnings) yield. The role of inflation has been rarely explored in previous literature and Engsted and Pedersen (2010) claim that they did the first research on this topic. They used data from four countries (US, UK, Denmark and Sweden) and found that inflation predictability can change the US dividend growth predictability. However they failed to draw conclusion on the role of inflation because their inflation predictability results are not robust across forecasting horizons, sub-periods, and countries. A few other papers also have looked at the international dimension of dividend growth predictability. One study by Ang and Bekaert (2006) shows that the dividend yield's predictive power to forecast future dividend growth is not robust across sample periods or countries (US, UK, France and Germany). Another international study by Rangvid et al. (2014) shows that stock returns and dividend growth predictability exist across the world. However both returns and dividend growth in their study are nominal terms. Therefore they did not show whether those results hold in real term or not and furthermore they did not explore the relationship among inflation and the dividend-price ratio.

In our main empirical results, we find that the inflation predictability can reinforce real return predictability and reduce real cash flow predictability. In the equally-weighted global portfolio, the nominal return predictability of the dividend price ratio can be documented while the short-run real return predictability can not be documented. Then the short-run nominal return predictability can be attributed to that the dividend price ratio can positively predict the inflation across different horizons. The same pattern holds when we apply the analysis to earnings yields. The nominal dividend (earnings) growth predictability of the dividend price ratio can be documented while the real dividend growth predictability can not be documented and earnings growth can only be documented in short horizon. A natural explanation is that the dividend (earnings) yield can positively predict the inflation and negatively predict the real dividend (earnings) growth which leads to that the dividend (earnings) yield cannot predict the nominal cash flows. In the value-weighted global portfolio, the dividend price ratio can predict the nominal dividend growth but the signs are in 'wrong direction'. After considering the inflation, the coefficients turn into negative and significant across horizons.

Besides different long-run decomposition and term structure results due to inflation predictability, we are interested in the mechanism behind. We start from exploring why the dividend price ratio can predict the inflation by comparing three main hypothesis. We find that the positive correlation among dividend price ratio and inflation can be backed by the Fama (1981)'s growth proxy hypothesis and risk aversion hypothesis (Brandt and Wang (2003), Bekaert and Engstrom (2010)) but not the money illusion hypothesis (Modigliani and Cohn (1979), Campbell and Vuolteenaho (2004)). The Modigliani and Cohn (1979)'s money illusion hypothesis has been well documented by Campbell and Vuolteenaho (2004)'s research. They find that in US the dividend-price ratio is positively related to past inflation and they interpret that as evidence of irrational undervaluation of stock prices when inflation is high and irrational overvaluation of stock prices when inflation is low. They propose a decomposition method to study the mispricing error and show that evidence is in accordance with the Modigliani and Cohn (1979)'s hypothesis. This finding has been backed by Cohen, Polk, and Vuolteenaho (2005), Lee (2010) and Acker and Duck (2013). However it has also been challenged by Thomas and Zhang (2007), Engsted and Pedersen (2010), Wei (2010), Bekaert and Engstrom (2010), and Wei and Joutz (2011). Engsted and Pedersen (2010)'s results are not consistent with this hypothesis. They find that in US the dividend-price ratio predicts future long-term inflation negatively, i.e. an increase (decrease) in expected inflation leads to an increase (decrease) in stock prices, the opposite of what the Modigliani and Cohn hypothesis implies. Wei (2010) finds that a fully rational dynamic general equilibrium model can generate a positive correlation between dividend yields and inflation as observed in the data by introducing a channel where the technology shock moves both inflation and dividend yields in the same direction. The theoretical results are backed by the finding in Wei and Joutz (2011). Bekaert and Engstrom (2010) argue that the positive correlations among dividend price ratios and inflation are not due to behavioral bias but due to that inflation reflects future growth prospects or habit-based risk aversion. Our results suggest both the growth proxy hypothesis and the risk aversion hypothesis can help explain the positive relationship among the dividend (earnings) yield and inflation. The high future inflation turns to coincide with periods of lower economic growth and high risk premia. Both lower cash flows and higher discount rates lead to drop in today's price and the dividend(earnings)-price ratio would be higher today, which can justify the positive relationship among inflation and the dividend (earnings) yield.

The hypothesis test results provide a more rational based explanation for the documented facts. To rationalize the inflation predictability and provide further insights, we build a cash flow model with inflation non-neutrality which is high future inflation dampens the economy growth. The framework is built on the long-run risk setup of Bansal and Yaron (2004), Bansal and Shaliastovich (2013) and Schorfheide, Song, and Yaron (2018). We extend Bansal and

Shaliastovich (2013)'s framework by jointly estimating the consumption growth, dividend growth and inflation. The estimated model can reproduce both the inflation predictability and the documented asset pricing facts. A large number studies have explained that high expected inflation has non-neutral and negative effect on future economic growth. Piazzesi, Schneider, Benigno, and Campbell (2006) highlight the role of inflation non-neutrality in explaining the nominal bond yields. Bansal and Shaliastovich (2013) build the long-run risk model featuring that the risk premia are driven by the volatilities of expected growth and expected inflation. Kung (2015) develops a stochastic endogenous growth model and argue that the low-frequency negative co-movement of growth and inflation rates is due to the firm production and price-setting decisions. Engsted and Pedersen (2018) extend the Bansal and Shaliastovich (2013) to explain the disappearance of money illusion during 1970s in U.S.. Gómez-Cram and Yaron (2019) build a long-run risk model including the preference shocks to show that the inflation-related factors are not predominant in explaining the term premia component of the nominal yield curves.

The rest of the paper is organized as follows. In the next section, we describe our return, dividend and inflation data on international equity markets and we show that both dividend price ratios and earnings price ratio can predict future inflation. Section 3 contains the main findings of our paper, namely that inflation predictability changes the picture of return and cash flow predictability. In Section 4, we test three main hypothesis to justify the positive correlation among the dividend (earnings) yield and inflation. Section 5 presents the economic model with inflation non-neutrality to rationalize the documented facts. Additional results on dividend predictability and dividend smoothing are shown in Section 6. Section 7 concludes.

2. Dividend Yields, Earnings Yields and Inflation

2.1. Data and Variables

We analyze a total of seven largest advanced economies for which dividend yields, earnings yields, share prices, total returns and inflation data are available. We employ a quarterly frequency and the total sample period runs from the first quarter of 1973 to the third quarter of 2018. We use the total return indices, dividends and dividend (earnings) yields from Datastream. The advantage of using the Datastream data is that we do not have to back out dividends from time series of total returns and price returns. For all countries the rate of inflation is computed from the price index used to convert nominal variables into real variables. Here we choose the consumer price index as the main price index and use the production price index for robust results. For our empirical analysis below, we form two kinds of aggregate portfolios from our individual country data: an equally-weighted (EW) global portfolio and a value-weighted (VW) global portfolio. We use each market's capitalization (at the end of the previous quarter) as a fraction of total world-market capitalization (at the end of the previous quarter) as weights in the value-weighted portfolio. In other words, in the value-weighted portfolio we use dynamic weights, such that a market that grows in size relative to another market will also be given a larger weight. The value-weighted portfolio is highly dominated by large countries such as the U.S. (roughly 53% market share on average) and Japan (about 23% market share on average) implying that results for the value-weighted portfolio should be expected to closely resemble results from the earlier literature (e.g. Ang and Bekaert (2006) find no clear evidence for linear cash-flow predictability in these countries). Results for the EW portfolio, on the other hand, more closely resemble the behavior of the aggregate markets: in the equally-weighted portfolio, the share given to the U.S. is only $1/7 = 14.3\%$ in the whole sample period.

Descriptive statistics for nominal (real) total returns, nominal (real) dividend growth, nominal (real) earnings growth, the average dividend yield, the average earnings yield, and

Table 1: Descriptive Statistics

This table reports descriptive statistics for the nominal log stock return, nominal log dividend growth, nominal log earnings growth, real log stock return, real log dividend growth, real log earnings growth, dividend yield, earnings yield and inflation. The equity portfolios consist of the equal-weighted index (EW) and value-weighted index (VW). The sample corresponds to quarterly data for the 1973:Q1-2018Q3 period and all statistics are represented in percent(%).

	Ret_{Nom}		Div_{Nom}		$Earn_{Nom}$		Ret_{Real}		Div_{Real}		$Earn_{Real}$		DP		EP		$Inflation$	
Country	*avg*	*std*	*avg*	*std*	*avg*	*std*	*avg*	*std*	*avg*	*std*	*avg*	*std*	*avg*	*std*	*avg*	*std*	*avg*	*std*
Canada	9.5	17.0	12.1	13.8	12.5	24.2	5.7	17.4	8.3	13.3	8.7	23.8	3.00	0.98	7.03	2.67	3.8	3.1
France	10.6	26.3	12.0	17.2	13.1	20.6	6.6	27.1	8.1	17.6	9.2	20.1	3.70	1.32	8.07	2.67	4.0	3.9
Germany	9.3	22.4	8.7	17.0	8.5	22.3	6.9	22.7	6.3	17.5	6.1	22.5	2.67	0.86	6.97	1.68	2.5	1.8
Italy	7.1	30.7	11.3	27.0	8.8	25.1	1.1	31.6	5.2	28.0	6.0	24.9	2.99	1.18	6.23	1.92	6.0	5.7
Japan	7.3	25.4	8.4	13.6	7.1	20.0	5.2	26.1	6.3	14.3	4.9	20.2	1.38	0.65	3.81	1.83	2.1	4.0
UK	11.5	20.2	10.3	8.6	9.7	15.5	6.5	20.4	5.3	8.0	4.7	15.4	4.17	1.24	7.96	3.30	5.0	5.1
US	10.4	17.3	8.1	6.2	8.5	12.6	6.5	17.8	4.3	5.9	4.7	12.0	2.91	1.39	6.85	2.74	3.8	2.9
EW	9.5	18.5	10.1	9.8	9.9	14.6	5.6	19.1	6.3	10.0	6.3	14.3	2.97	0.85	6.81	2.05	3.8	3.5
VW	9.9	17.6	8.9	6.5	8.2	12.4	6.5	18.1	5.6	6.6	4.9	12.0	2.63	0.99	6.13	2.15	3.4	2.9

the average inflation for the individual countries are reported in Table 1. There are large differences among the real term and the nominal term and there are large differences in inflation across countries. The highest average inflation rate is Italy (6.0%) whereas the lowest average inflation rate is found in Japan (2.1%). For benchmark valuation ratios, the dividend price ratios and earnings price ratios vary across different countries. For instance, among those countries we find the highest average dividend yield is UK (4.17%) whereas the lowest average dividend yield is found in Japan (1.38%) and the highest average earnings yield is France (8.07%) whereas the lowest average earnings yield is found in Japan (3.81%). For the two global portfolios, we see that the equally-weighted portfolio has a higher standard deviation for returns and dividend growth, and a higher dividend yield and earnings yield on average when compared to the value-weighted portfolio.

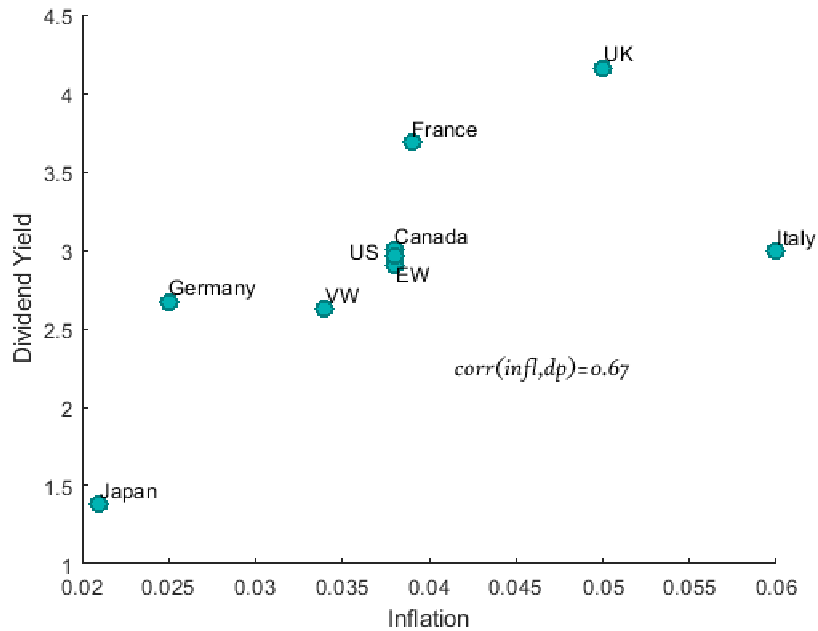
2.2. *Dividend Yields, Earnings Yields and Inflation*

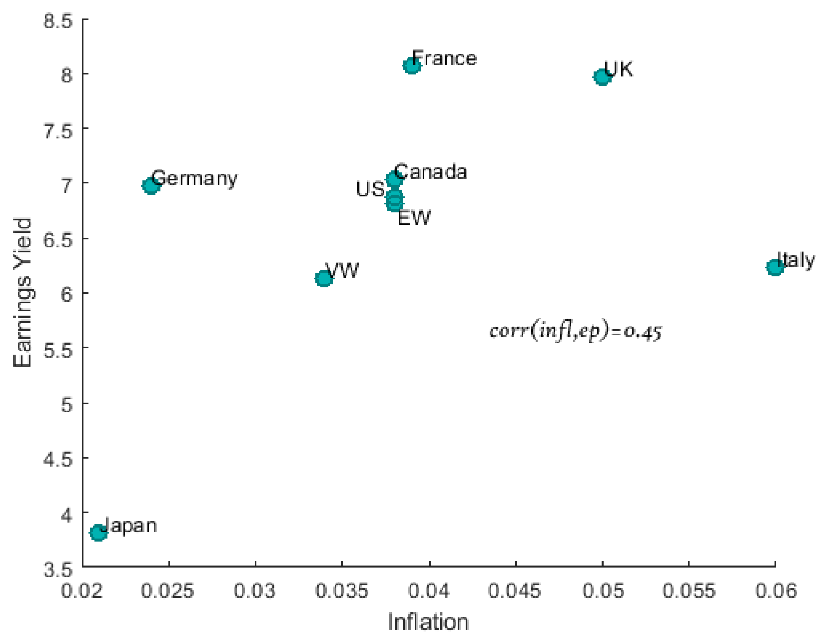
Turn to the positive correlation among dividend yield, earnings yield and inflation, we document that the higher dividend price ratio and earnings price ratios correspond to the higher inflation rate as shown in figure 1. The documented cross-country correlations are 0.67 and 0.45 respectively for sample period 1973Q1 to 2018Q3. The positive relationship among dividend yield and inflation has been widely documented in US post-war data (e.g. Asness (2003), Asness (2003), Cohen et al. (2005), Wei (2010), Acker and Duck (2013)) but has rarely been explored in an international setting.

The fact that the post-war US dividend yield predicts the future inflation has also been documented by Engsted and Pedersen (2010) and they extended the analysis to UK, Denmark and Sweden. However they cannot draw a conclusion on the role of inflation because their inflation predictability results are not robust across forecasting horizons, sub-periods, and countries. Here we find new and robust evidence that dividend price ratios can positively predict future inflation across horizons and across countries, which allows us to explore the mechanism behind this relationship (see Section 4). We also extend the analysis to earnings yield and find that the inflation predictability relationship holds.

We report results from regressions of inflation on dividend price ratios and earnings price ratios from one year to twenty year horizon. All coefficients are significant positive from short run to long run for both portfolios. The significance are according to Newey and West (1987) standard errors in brackets. For the cross-section regressions, the R^2 range from 14% to 23% in the dividend yield regressions and range from 23% to 37% in the earnings yield regressions; for the portfolio-based regressions, the R^2 range from 32% to 56% in the dividend yield regressions and range from 26% to 54% in the earnings yield regressions, all suggesting high explanatory power from the financial ratios. Previous evidence suggests the dividend yield positively predicts returns and negatively predicts dividend growth. If we take inflation predictability into consideration, the nominal return predictability may come from the inflation predictability and real dividend growth predictability can be hidden when

Fig. 1. Dividend Yields, Earnings Yields and Inflation: This figure plots inflation of individual countries (horizontal axis) against dividend yield and earnings yield on the vertical axis.





we use the nominal terms. Therefore, we should pay attention to nominal or real term when dealing with discount rates and cash flow predictability.

Table 2: Predictive Regressions

This table shows results for predictive regressions of inflation on the log dividend yield or log earnings yield for the CS, EW and VW cases. Panel A reports results about log dividend yield and Panel B reports results about log earnings yield. The forecast horizon is from one year to twenty years. For each case, predictive coefficients are highlighted reported in first row, the t-stat (Newey/West HAC) are reported in second row and the R^2 are reported in the third row.

Panel A	$Inflation$ on dp_t								
Horizon	1	2	3	4	5	7	10	15	20
CS	0.037	0.034	0.032	0.030	0.029	0.027	0.027	0.023	0.020
	[13.22]	[13.21]	[13.09]	[12.67]	[12.59]	[12.59]	[13.96]	[14.26]	[12.44]
	0.14	0.15	0.16	0.16	0.17	0.18	0.21	0.23	0.22
EW	0.074	0.071	0.068	0.064	0.061	0.058	0.055	0.043	0.039
	[5.16]	[5.21]	[5.16]	[4.99]	[4.88]	[4.97]	[6.66]	[6.98]	[7.02]
	0.38	0.40	0.41	0.40	0.41	0.43	0.54	0.56	0.52
VW	0.041	0.038	0.036	0.034	0.032	0.029	0.024	0.019	0.018
	[4.00]	[3.89]	[3.82]	[3.77]	[3.76]	[3.77]	[4.64]	[6.00]	[5.59]
	0.32	0.34	0.34	0.34	0.34	0.35	0.43	0.56	0.53
Panel B	$Inflation$ on ep_t								
Horizon	1	2	3	4	5	7	10	15	20
CS	0.047	0.044	0.041	0.037	0.035	0.032	0.030	0.024	0.018
	[19.08]	[18.79]	[18.38]	[17.26]	[16.85]	[16.43]	[17.19]	[17.30]	[13.38]
	0.23	0.25	0.25	0.25	0.25	0.25	0.31	0.37	0.37
EW	0.078	0.073	0.068	0.063	0.059	0.056	0.052	0.040	0.034
	[5.89]	[5.76]	[5.64]	[5.40]	[5.23]	[5.24]	[6.57]	[6.98]	[5.72]
	0.41	0.41	0.40	0.37	0.37	0.39	0.45	0.49	0.42
VW	0.043	0.039	0.036	0.033	0.031	0.029	0.024	0.021	0.019
	[4.11]	[3.88]	[3.71]	[3.59]	[3.58]	[3.64]	[4.66]	[6.20]	[6.21]
	0.29	0.29	0.28	0.26	0.26	0.28	0.36	0.54	0.52

3. Empirical Results

A fundamental question in asset pricing is whether stock prices move because of news to expected returns or news to expected cash flows. The framework for the dividend yield is based on the decomposition by Campbell and Shiller (1988).

$$dp_t \simeq -\frac{\kappa}{1-\rho} + E_t \sum_{j=1}^{\infty} \rho^{j-1} r_{t+j} - E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta d_{t+j} \tag{1}$$

where $\rho = \frac{1}{1+exp(E[dp])}$ is a (log-linearization) discount coefficient that depends on the mean of dp and $\kappa = -log(\rho) + (1-\rho)log(\frac{1}{\rho} - 1)$. Under this present-value relation, the current log dividend-to-price ratio (dp) is positively correlated with future log returns (ret) and negatively correlated with future log dividend growth (Δd).

For earnings yield decomposition, we follow the Chen, Da, and Priestley (2012) and Maio and Xu (2018)'s method:

$$ep_t \simeq -\frac{\kappa}{1-\rho} - (1-\rho) E_t \sum_{j=1}^{\infty} \rho^{j-1} de_{t+j} + E_t \sum_{j=1}^{\infty} \rho^{j-1} r_{t+j} - E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta e_{t+j} \tag{2}$$

where ep is the log earnings price ratio, de is the log payout ratio and Δe is the earnings growth rate. Under this present-value relation, the current log earnings-to-price ratio (ep) is positively correlated with future log returns (ret) and negatively correlated with future log earnings growth (Δe). The remainder of this section explores empirically how inflation changes the picture of return and cash flow predictability and which of these two drivers dominates in international equity markets. In the following section 4 we explore what the underlying economic drivers of inflation predictability are.

3.1. Predictive Long-Horizon Regressions

We provide results of the return and cash flow predictability by the dividend (earnings) yield in an international portfolio setting. We run four time-series regressions of future values of cash flows and future values of stock returns on current dividend (earnings) yields:

$$
\begin{aligned}
ret_{t,t+H} &= a_r^H + b_r^H dp_t + \epsilon_{t,t+H}^r; \\
\Delta d_{t,t+H} &= a_{\Delta d}^H + b_{\Delta d}^H dp_t + \epsilon_{t,t+H}^d; \\
H &= 1, \cdots, 5
\end{aligned}
\tag{3}
$$

and

$$
\begin{aligned}
ret_{t,t+H} &= a_r'^H + b_r'^H ep_t + \epsilon_{t,t+H}^r; \\
\Delta e_{t,t+H} &= a_{\Delta e}^H + b_{\Delta e}^H ep_t + \epsilon_{t,t+H}^e; \\
H &= 1, \cdots, 5
\end{aligned}
\tag{4}
$$

where $ret_{t,t+H} \equiv \frac{1}{H}\sum_{j=1}^{H} r_{t+j}$, $\Delta d_{t,t+H} \equiv \frac{1}{H}\sum_{j=1}^{H} \Delta d_{t+j}$ and $\Delta e_{t,t+H} \equiv \frac{1}{H}\sum_{j=1}^{H} \Delta e_{t+j}$. Here we generally work with an annual forecast horizon in order to avoid potential seasonality issues with the dividend growth series. H indexes the forecasting horizon from 1 year to 5 year. Predictability results under both nominal and real terms are reported in table 3.

The big picture here is that inflation predictability can affect the return and cash flow predictability a lot (both coefficients' magnitudes and signs). For the cross-sectional results, both nominal and real returns are positively predicted by dividend (earnings) yields and both nominal and real cash flows are negatively predicted by dividend (earnings) yields. However, the coefficients' magnitudes and the R^2 are overestimated in return regressions and are underestimated in cash flow regressions. This can be justified by the fact that the dividend (earnings) yield can positively predict the inflation across all horizons. It suggests that the inflation predictability reinforces real return predictability and reduces the real cash flow predictability.

For the portfolio-based results, the nominal returns can be positively predicted by dividend (earnings) yields from one-year to five-year horizon. However, in real returns regressions, the short-run returns cannot be predicted and long-run predictability holds. Both coefficients' magnitudes and R^2 increase in nominal return regressions. This can be justified by the fact that the dividend (earnings) yield can positively predict the inflation across all horizons. It suggests that the inflation predictability reinforces real return predictability and the short-run nominal returns predictability could come from the inflation predictability. In nominal dividend growth regressions, the dividend growth can not be predicted by the dividend yield in the equally-weighted portfolio and can be predicted in the 'wrong direction' in the value-weighted portfolio. In real dividend growth regressions, the dividend growth can be negatively predicted in equally-weighted portfolio but cannot be predicted in the value-weighted portfolio. In nominal earnings growth regressions, the earnings growth can only be predicted by the earnings yield at one-year horizon in the equally-weighted portfolio and cannot be predicted across all horizons in the value-weighted portfolio. In real earnings growth regressions, the earnings growth can be negatively predicted across all horizons in the equally-weighted portfolio and within two-year horizon in the value-weighted portfolio. It suggests that the inflation predictability reduces (in EW) or changes direction of (in VW) real cash flow predictability. Two points to address here: the first is the changing direction of dividend growth. The reason is that if inflation is sufficiently positively predictable by the dividend-price ratio, it may generate significant predictability of nominal dividend growth in the 'wrong' (i.e. positive) direction. The second is that dividend price ratio cannot predict real dividend growth in value-weighted portfolio. This is simply due to the US account for a large portion in value-weighted setting and US dividend growth cannot be predicted by dividend yields. The losing predictability of dividend yield has been interpreted by Rangvid et al. (2014) that the failure of dividend predictability is due to the dividend smoothing in large and developed equity markets, which is also the argument made by Engsted and Pedersen (2010). We also provide evidence to justify this argument by showing average firm size and cash volatility matter in determining dividend smoothing. Results are consistent with Rangvid et al. (2014)'s and presented in section 6. Another simple way to resolve this is that the earnings yield can predict the earnings growth even in the value-weighted portfolio which suggests cash flows can be predicted by the financial ratio.

The general impressions are that returns can be predicted by the dividend yield and the dividend growth can not be predicted in the US based literature (Cochrane (2007),Cochrane (2011)). In the international dimension of return and dividend growth predictability, Engsted and Pedersen (2010) investigate long time series for four countries (U.S., U.K., Denmark, and Sweden) and show that dividend yields do not predict returns in Denmark and Sweden but do so in US and dividend yields do not predict dividend growth rates in the U.K. and U.S. but do so in Denmark and Sweden. They also claim that they first analyzed the differences between nominal and real long-horizon predictability but they did not make further conclusion about the role of inflation due to inconsistent inflation predictability evidence. Another paper based on international data is written by Rangvid et al. (2014). They used a global sample of fifty stock markets over the period from 1973 to 2009 to show that market-wide dividends are highly predictable by the dividend yield in smaller and medium-sized equity markets, but generally not in large markets such as the U.S. However, their results are based on nominal returns and provide no evidence or theory to emphasize the role of inflation predictability. We adopt a similar setting as Rangvid et al. (2014) but all returns and dividend growth are measured in both nominal and real terms in our research. The contribution here is that we show that predictability patterns for returns and dividend growth are very sensitive to whether these variables are measured in real or nominal terms. We confirm Engsted and Pedersen (2010)'s finding that many of the conclusions for nominal returns and dividend growth are turned upside down when these variables are measured in real terms.

Table 3: Predictive Regressions

This table shows results for predictive regressions of total returns (left panel) and dividend growth or earnings growth (right panel) on the log dividend yield or log earnings yield for the CS, EW, and VW cases. Panel A reports results about log dividend yield and Panel B reports results about log earnings yield. The forecast horizon is from one year to five years. For each case, predictive coefficients are highlighted reported in first row, the t-stat (Newey/West HAC) are reported in second row and the R^2 are reported in the third row.

Panel A: dp_t			*Return*					*Dividend*		
Horizon	1	2	3	4	5	1	2	3	4	5
$CS_{nominal}$	0.127	0.122	0.109	0.101	0.098	-0.075	-0.050	-0.038	-0.032	-0.028
	[7.49]	[10.47]	[12.01]	[13.36]	[15.35]	[-6.37]	[-5.31]	[-4.64]	[-4.31]	[-4.22]
	0.03	0.07	0.09	0.12	0.15	0.00	0.00	0.00	0.00	0.00
CS_{real}	0.090	0.088	0.077	0.071	0.069	-0.112	-0.084	-0.071	-0.062	-0.057
	[5.13]	[7.16]	[8.02]	[8.91]	[10.38]	[-9.47]	[-8.99]	[-8.66]	[-8.58]	[-8.82]
	0.01	0.03	0.03	0.04	0.06	0.03	0.03	0.03	0.03	0.03
$EW_{nominal}$	0.157	0.150	0.141	0.142	0.145	-0.055	-0.021	-0.002	0.013	0.018
	[2.16]	[2.42]	[2.89]	[4.12]	[5.18]	[-1.12]	[-0.55]	[-0.06]	[0.46]	[0.75]
	0.06	0.12	0.17	0.24	0.34	0.03	0.01	0.00	0.00	0.01
EW_{real}	0.083	0.079	0.073	0.079	0.084	-0.129	-0.092	-0.070	-0.051	-0.043
	[1.06]	[1.15]	[1.33]	[1.92]	[2.45]	[-2.78]	[-2.49]	[-2.24]	[-1.85]	[-1.70]
	0.02	0.03	0.04	0.07	0.12	0.14	0.11	0.08	0.06	0.05
$VW_{nominal}$	0.130	0.130	0.128	0.124	0.124	0.010	0.024	0.033	0.036	0.036
	[2.59]	[3.19]	[3.77]	[4.42]	[5.03]	[0.47]	[1.50]	[2.34]	[2.98]	[3.37]
	0.08	0.17	0.25	0.31	0.40	0.00	0.03	0.08	0.13	0.18
VW_{real}	0.089	0.092	0.092	0.091	0.092	-0.031	-0.014	-0.003	0.003	0.004
	[1.61]	[1.99]	[2.34]	[2.68]	[2.99]	[-1.45]	[-0.84]	[-0.20]	[0.20]	[0.29]
	0.04	0.08	0.12	0.16	0.22	0.03	0.01	0.00	0.00	0.00
Panel B: ep_t			*Return*					*Earnings*		
Horizon	1	2	3	4	5	1	2	3	4	5
$CS_{nominal}$	0.131	0.121	0.108	0.098	0.102	-0.152	-0.081	-0.045	-0.028	-0.015
	[7.47]	[10.11]	[11.58]	[12.29]	[15.00]	[-9.48]	[-6.80]	[-4.56]	[-3.31]	[-1.96]
	0.04	0.07	0.10	0.11	0.16	0.03	0.01	0.00	0.00	0.00
CS_{real}	0.084	0.078	0.068	0.061	0.067	-0.199	-0.125	-0.085	-0.066	-0.050
	[4.61]	[6.15]	[6.87]	[7.25]	[9.37]	[-12.91]	[-10.82]	[-8.97]	[-8.03]	[-6.94]
	0.01	0.03	0.03	0.04	0.06	0.07	0.04	0.03	0.02	0.01
$EW_{nominal}$	0.139	0.124	0.114	0.111	0.120	-0.147	-0.067	-0.033	-0.020	-0.009
	[1.90]	[1.97]	[2.29]	[3.02]	[4.06]	[-1.98]	[-1.25]	[-0.77]	[-0.62]	[-0.32]
	0.04	0.08	0.10	0.14	0.22	0.08	0.03	0.01	0.01	0.00
EW_{real}	0.061	0.051	0.046	0.048	0.060	-0.214	-0.129	-0.091	-0.073	-0.058
	[0.79]	[0.75]	[0.83]	[1.15]	[1.75]	[-3.17]	[-2.58]	[-2.18]	[-2.30]	[-2.33]
	0.01	0.01	0.02	0.03	0.06	0.18	0.11	0.09	0.09	0.08
$VW_{nominal}$	0.116	0.111	0.110	0.104	0.107	-0.061	-0.014	0.001	0.003	0.004
	[2.23]	[2.55]	[2.86]	[3.21]	[3.66]	[-1.38]	[-0.45]	[0.04]	[0.13]	[0.24]
	0.05	0.10	0.15	0.18	0.25	0.03	0.00	0.00	0.00	0.00
VW_{real}	0.073	0.072	0.074	0.072	0.076	-0.103	-0.053	-0.034	-0.029	-0.026
	[1.32]	[1.51]	[1.74]	[1.96]	[2.25]	[-2.54]	[-1.79]	[-1.38]	[-1.38]	[-1.40]
	0.02	0.04	0.07	0.08	0.12	0.09	0.04	0.03	0.04	0.04

The dividend-price ratio can be a strong signal of future long-term inflation which will bias the estimates of factor loadings. The positive relationship can be potentially related to the future economic prospects, the rising required risk premia or even the behavior bias(e.g. inflation illusion). In section 4, we provide evidence that strongly supports the growth proxy hypothesis and the risk aversion hypothesis but rejects the money illusion hypothesis. For results related to earnings yield, Maio and Xu (2018) show that most of the price variations come from discount rates but not future earnings growth based on US post-war data while Myers et al. (2017) show earnings growth expectations are the main driver of earnings yields based on US survey data. Both two studies use the nominal term in determining the earnings growth predictability and our results show the cash flow predictability exists when earnings growths are measured in real terms.

3.2. VAR-Based Results

Here we provide the results based on VAR system because Stambaugh (1999) argues that the OLS estimator's finite-sample properties can depart substantially from the standard regression setting if the equations' innovations are correlated with the dividend-price ratio. We adopt a way which is firstly proposed by Cochrane (2007) and applied by many papers like Lettau and Van Nieuwerburgh (2007), Maio and Santa-Clara (2015), and Golez and Koudijs (2018). We can formulate in terms of the following three predictive regressions:

$$ret_{t+1} = \alpha_r + \beta_r dp_t + \epsilon^r_{t+1} \tag{5}$$

$$\Delta d_{t+1} = \alpha_{\Delta d} + \beta_{\Delta d} dp_t + \epsilon^{\Delta d}_{t+1} \tag{6}$$

$$dp_{t+1} = \alpha_{dp} + \beta_{dp} dp_t + \epsilon^{dp}_{t+1} \tag{7}$$

By combining the VAR above with the Campbell and Shiller (1988) present value relation, we obtain an identity involving the predictability coefficients associated with dp and a relationship which represents the variance decomposition shown in Cochrane (2007):

$$\beta_r - \beta_{\Delta d} + \rho\beta_{dp} = 1 \tag{8}$$

Similarly to Cochrane (2008), (2011), we also compute the variance decomposition for an infinite-horizon case:

$$\beta_r^{LR} = \sum_{j=1}^{\infty}(\rho\beta_{dp})^{j-1}\beta_r = \frac{\beta_r}{1-\rho\beta_{dp}} \tag{9}$$

$$\beta_{\Delta d}^{LR} = \sum_{j=1}^{\infty}(\rho\beta_{dp})^{j-1}\beta_{\Delta d} = \frac{\beta_{\Delta d}}{1-\rho\beta_{dp}} \tag{10}$$

In this long-run decomposition, all the variations in the current dividend yield is tied to either return or dividend growth predictability, since the predictability of the future dividend yield vanishes out at a very long horizon. We have the relationship as

$$\beta_r^{LR} - \beta_{\Delta d}^{LR} = 1 \tag{11}$$

For results related to the earnings yield, we follow the same estimation way as the dividend yield by making approximation on the payout ratio term. Compare equation (1) and equation (2) and we can find the additional component in equation (2) is the payout ratio term $E_t \sum_{j=1}^{\infty} \rho^{j-1} de_{t+j}$. Since the payout term's loading $1-\rho$ is close to 0, movements in the future payout ratio do not play a large role in explaining movements in the price-earnings ratio. Maio and Xu (2018) documented the long-run variance contribution from payout ratio is less than 1% using US post-war data and our later analysis (table (12)) suggest the long-run variation contribution from payout ratio is dominated by the other two sources in international portfolios. Therefore we ignore the payout ratio's movements and the equation (2) is reduced to equation (12).

$$ep_t \simeq -(\frac{\kappa}{1-\rho} + \overline{de}) + E_t \sum_{j=1}^{\infty} \rho^{j-1} r_{t+j} - E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta e_{t+j} \tag{12}$$

where $\overline{de}$ is the mean of log payout ratio. Here we conduct estimation the same way as analyzing dividend yield and provide additional results in section 6.2 where the payout ratio variations are considered in estimation.

Table 4: VAR-Based Results

This table reports the one-period VAR estimation results for EW and VW cases of real(nominal) returns and real(nominal) dividend(earnings) growth. The variables in the VAR are the log stock return (ret), log dividend growth (Δd) or log earnings growth (Δe), and log dividend-to-price ratio (dp) or log earnings-to-price ratio (ep). Panel A reports results about log dividend yield and Panel B reports results about log earnings yield. β denotes the VAR slopes associated with lagged dp or lagged ep, while t denotes the respective Newey and West (1987) t-statistics. β^{Delta} denotes the slope estimates implied from the variance decomposition constraint, and t denotes the respective asymptotic t-statistics computed under the delta method. R^2 are the coefficient of determination for each equation in the VAR. β^{LR} denotes the long-run coefficients (infinite horizon). The sample corresponds to quarterly data from 1973:Q1 to 2018:Q3.

Panel A: dp_t		β	t	R^2	β^{Delta}	t	R^2	β^{LR}
$EW_{nominal}$	ret	0.17	[3.84]	0.08	0.17	[3.90]	0.08	0.76
	Δd	-0.05	[-2.12]	0.03	-0.05	[-2.23]	0.03	-0.24
	dp	0.80	[19.29]	0.68	0.80	[19.67]	0.68	-
EW_{real}	ret	0.10	[2.16]	0.03	0.10	[2.17]	0.03	0.44
	Δd	-0.13	[-5.26]	0.14	-0.13	[-5.41]	0.14	-0.56
	dp	0.80	[19.25]	0.68	0.80	[19.62]	0.68	-
$VW_{nominal}$	ret	0.14	[4.72]	0.11	0.13	[4.44]	0.11	1.04
	Δd	0.01	[0.79]	0.00	0.01	[0.41]	0.00	0.04
	dp	0.86	[26.00]	0.80	0.89	[31.08]	0.79	-
VW_{real}	ret	0.11	[3.35]	0.06	0.10	[3.02]	0.06	0.73
	Δd	-0.03	[-2.29]	0.03	-0.03	[-2.87]	0.03	-0.27
	dp	0.86	[26.00]	0.80	0.89	[31.08]	0.79	-
Panel B: ep_t		β	t	R^2	β^{Delta}	t	R^2	β^{LR}
$EW_{nominal}$	ret	0.14	[3.01]	0.05	0.14	[3.27]	0.05	0.50
	Δe	-0.14	[-3.90]	0.08	-0.14	[-3.93]	0.08	-0.50
	ep	0.72	[15.53]	0.58	0.73	[15.83]	0.58	-
EW_{real}	ret	0.06	[1.24]	0.01	0.07	[1.61]	0.01	0.25
	Δe	-0.21	[-6.13]	0.18	-0.21	[-6.15]	0.18	-0.75
	ep	0.73	[15.53]	0.58	0.73	[15.85]	0.58	-
$VW_{nominal}$	ret	0.12	[3.47]	0.06	0.12	[3.47]	0.06	0.65
	Δe	-0.06	[-2.46]	0.03	-0.06	[-2.60]	0.03	-0.35
	dp	0.83	[22.53]	0.74	0.83	[22.90]	0.74	-
VW_{real}	ret	0.08	[2.18]	0.03	0.08	[2.19]	0.03	0.42
	Δe	-0.10	[-4.28]	0.10	-0.11	[-4.48]	0.10	-0.58
	ep	0.83	[22.46]	0.74	0.83	[22.84]	0.74	-

In table 4, we document a clear pattern that the return predictability has been reinforced by the inflation predictability and the cash flow predictability has been reduced by the inflation predictability. For instance, in EW regressions, the R^2 of return regression increase from 3% in real to 8% in nominal (Panel A) and from 1% in real to 5% in nominal (Panel B) while the R^2 of dividend growth regression decrease from 14% in real to 3% in nominal (Panel A) and the R^2 of earnings growth regression decrease from 18% in real to 8% in nominal (Panel B). We also compare coefficients from raw VAR to ones implied from variance constraint and we find magnitudes are quite close which suggest the one-period VAR can fit the variance decomposition quite well and approximation errors are small. An interesting result is that the dividend price ratio can actually predict the dividend growth in the value-weighted setting which suggests there exists correlations among dividend growth innovations and the dividend-price ratio that affect the estimated results. A similar example is that Engsted and Pedersen (2010) documented a puzzle that in the post-war period UK long-horizon dividend growth is significantly predictable in the 'wrong' direction. Here we can simply attribute this to correlations among the residuals and the predictor and we can resolve this puzzle by estimating the coefficients in a VAR system by GLS method. For dividend yields predictability, we find the dividend yield of the equally-weighted portfolio is less persistent than the value-weighted with an auto-regressive slope of 0.80 versus 0.86. The R^2 is 0.68 and much lower than the value-weighted case 0.80. For earnings yields predictability, we find the earnings yield of the equally-weighted portfolio is less persistent than the value-weighted with an auto-regressive slope of 0.73 versus 0.83. The R^2 is 0.58 and much lower than the value-weighted case 0.74.

For the long run decomposition, we can see the inflation plays an important role in determining dividend price composition ratio. For the equally-weighted setting in Panel A, we find the discount rates ratio decrease from 76% in nominal to 44% in real while the cash flows ratio increase from 24% in nominal to 56% in real. For the value-weighted setting in Panel A, we find the discount rates ratio decrease from 104% in nominal to 73% in real while the cash flows ratio increase from 4% (positive) in nominal to 27% (negative) in real. For the equally-weighted setting in Panel B, we find the discount rates ratio decrease from 50% in nominal to 25% in real while the cash flows ratio increase from 50% in nominal to 75% in real. For the value-weighted setting in Panel B, we find the discount rates ratio decrease from 65% in nominal to 42% in real while the cash flows ratio increase from 35% in nominal to 58% in real. After inflation being considered, cash flows become no longer negligible and even account for more than half variations.

3.3. The Term Structure of Coefficients

In previous section we discuss the estimation for a one-period VAR system and here we present the variance decomposition results for multi-period. Following Cochrane (2008), (2011), we estimate coefficients of future log returns, log dividend growth, and log dividend-to-price ratio regressions.

$$\sum_{j=1}^{H} \rho^{j-1} r_{t+j} = \alpha_R^H + \beta_r^H dp_t + \epsilon_{t,t+H}^r \tag{13}$$

$$\sum_{j=1}^{H} \rho^{j-1} \Delta d_{t+j} = \alpha_{\Delta d}^H + \beta_{\Delta d}^H dp_t + \epsilon_{t,t+H}^{\Delta d} \tag{14}$$

$$\rho^{H-1} dp_{t+H} = \alpha_{dp}^H + \beta_{dp}^H dp_t + \epsilon_{t,t+H}^{dp} \tag{15}$$

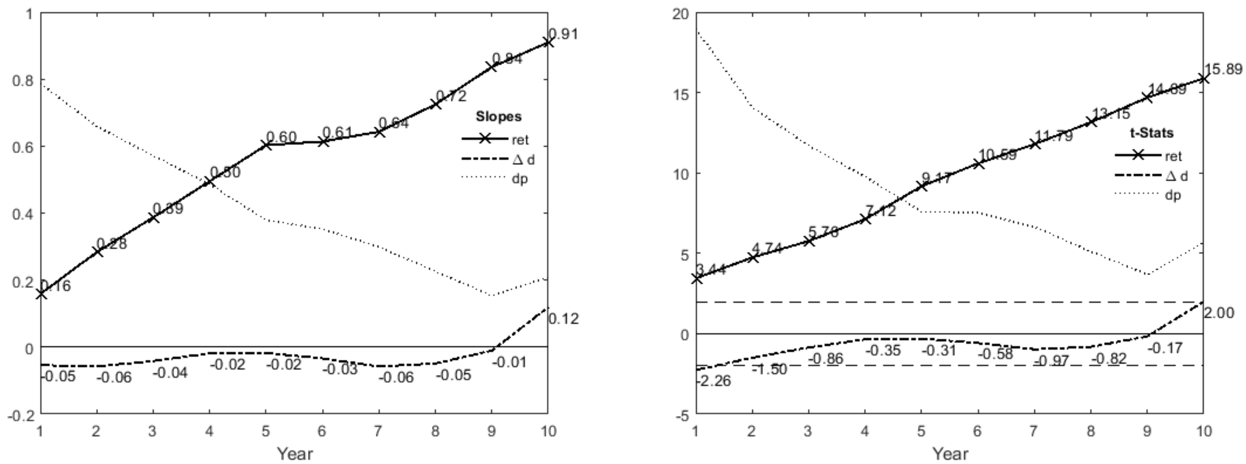
Similarly to Cochrane (2011), by combining the present-value relation with the predictive regressions above, we obtain an identity involving the predictability coefficients associated with dp, at each horizon H.

$$\beta_r^H - \beta_{\Delta d}^H + \rho \beta_{dp}^H = 1 \tag{16}$$

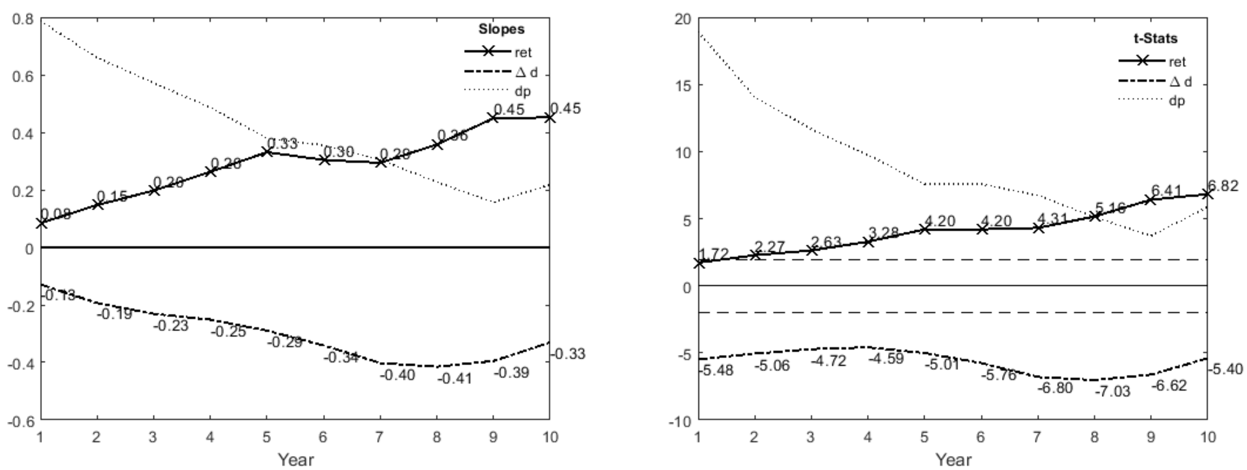
which can be interpreted as a variance decomposition for the log dividend yield. The predictive coefficients β_r^H, $-\beta_{\Delta d}^H$, and β_{dp}^H represent the fraction of the variance of current dp

attributable to return, dividend growth, and dividend yield predictability, respectively.

Fig. 2. Nominal and Real Term Structure of Coefficients of *dp*: EW. This figure plots the nominal VAR-based term structure of the long-horizon predictive coefficients and respective t-statistics for the equal-weighted case. The predictive slopes are associated with the log return (*ret*), log dividend growth (Δd), and log dividend-to-price ratio (*dp*). The forecasting variable is the log dividend-to-price ratio in all three equations. The long-run coefficients are measured in percent, and horizon is 10 years ahead. The horizontal lines in right figures represent the 5% critical values (-1.96, 1.96). The sample is 1973:Q1 to 2018Q3.



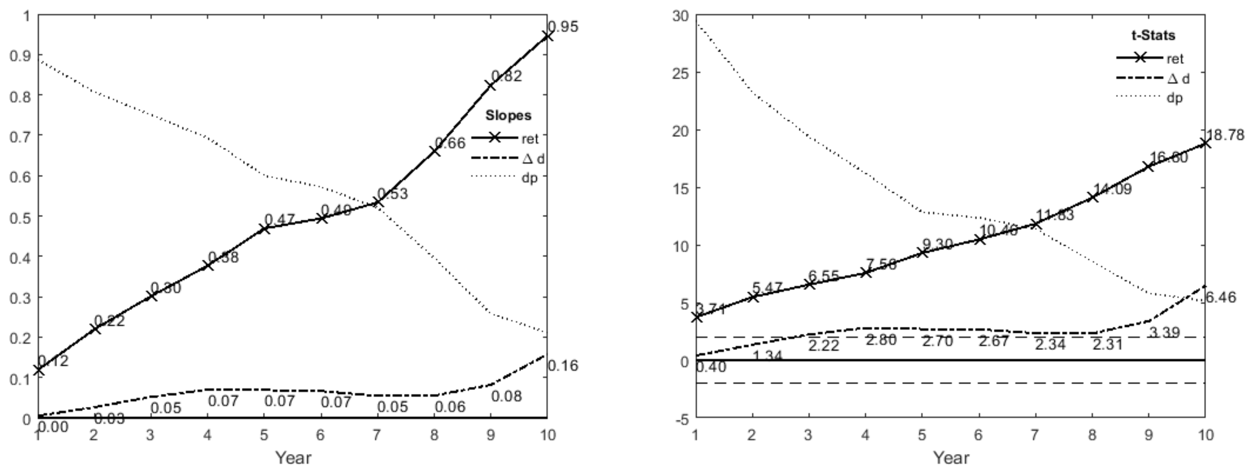
(Nominal-EW: Slopes and t-Stats)



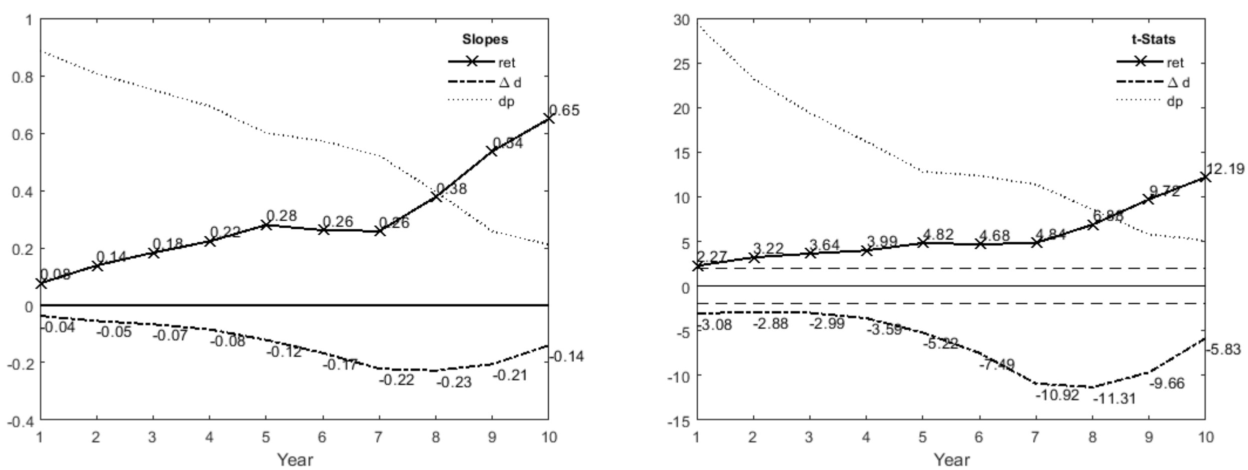
(Real-EW: Slopes and t-Stats)

In Figure 2 we present both the nominal and real term structure of the equally-weighted portfolio. When we use nominal returns and nominal dividend growth, we will document that most of the price variations come from the discount rates. The contribution from cash flows is insignificant from one year to nine year horizon and significant contribution at 10 year horizon suggesting the 'wrong' predictability direction. When real terms are applied in the framework, we find both discount rates and cash flows significantly contribute to the price variations and contribution ratios from these two sources are comparable.

Fig. 3. Nominal and Real Term Structure of Coefficients of dp: VW. This figure plots the real VAR-based term structure of the long-horizon predictive coefficients and respective t-statistics for the value-weighted case. The predictive slopes are associated with the log return (ret), log dividend growth (Δd), and log dividend-to-price ratio (dp). The forecasting variable is the log dividend-to-price ratio in all three equations. The long-run coefficients are measured in percent, and horizon is 10 years ahead. The horizontal lines in right figures represent the 5% critical values (-1.96, 1.96). The sample is 1973:Q1 to 2018Q3.



(Nominal-VW: Slopes and t-Stats)



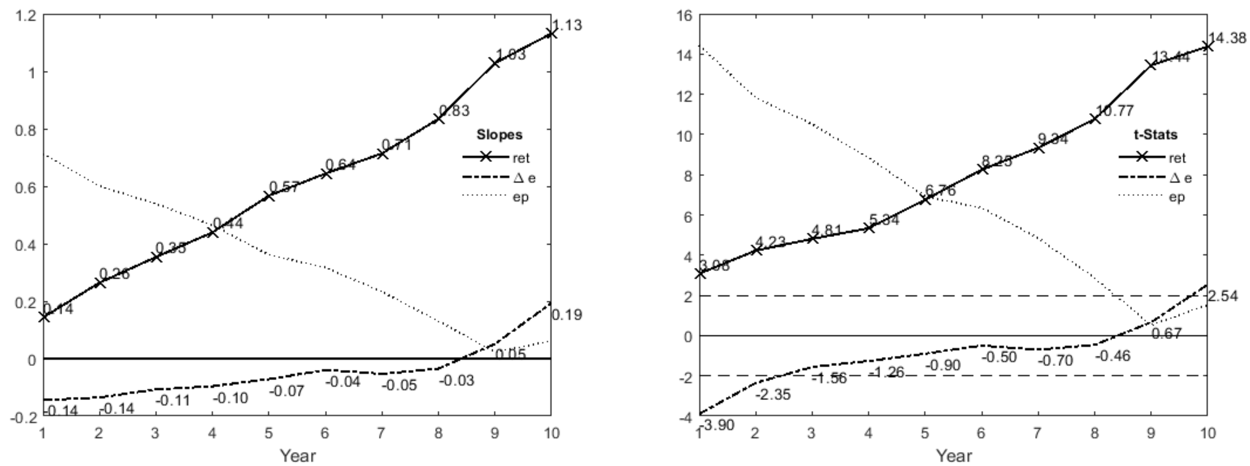
(Real-VW: Slopes and t-Stats)

In Figure 3 we present both the nominal and real term structure of the value-weighted portfolio. When we use nominal returns and nominal dividend growth, we will document that most of the price variations come from the discount rates. The contribution from cash flows is significant from year three but the signs of contribution suggest the 'wrong' predictability direction which is higher dividend yield corresponds to higher dividend growth. When real terms are applied in the framework, we find both discount rates and cash flows contribute to the price variation and the contributions are significant across horizons. The contribution ratios from cash flow sources are not negligible within ten year horizons but discount rates variation dominate in longer horizon.

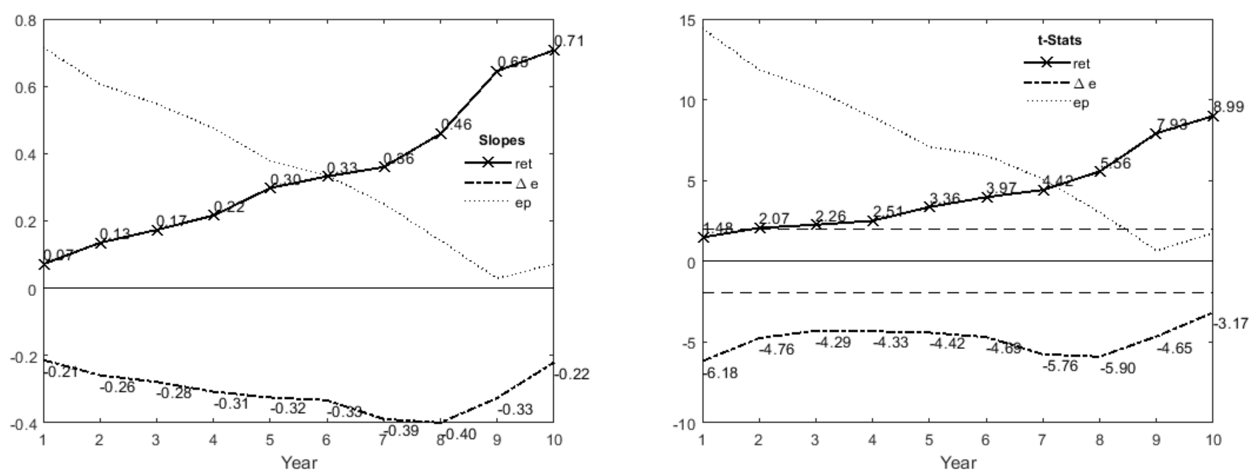
We consider the earnings growth as an alternative measure of future cash flows and we documented a similar pattern that both the discount rate and cash flows contribute to variations of current financial ratios as we seen in dividend yield case. For the earning yield, we apply the same estimation to the term structure of coefficients and results are presented in Figure 4 and Figure 5.

In Figure 4 we present both the nominal and real term structure of the equally-weighted portfolio. When we use nominal returns and nominal earnings growth, we will document that most of the price variations come from the discount rates especially in the long horizons. The contribution from cash flows become insignificant from three year to nine year horizon and significant contribution at 10 year horizon suggesting the 'wrong' predictability direction. When real terms are applied in the framework, we find both discount rates and cash flows significantly contribute to the price variations and the contribution from cash flows is not negligible.

Fig. 4. Nominal and Real Term Structure of Coefficients of ep: EW. This figure plots the nominal VAR-based term structure of the long-horizon predictive coefficients and respective t-statistics for the equal-weighted case. The predictive slopes are associated with the log return (ret), log earnings growth (Δe), and log earnings-to-price ratio (ep). The forecasting variable is the log earnings-to-price ratio in all three equations. The long-run coefficients are measured in percent, and horizon is 10 years ahead. The horizontal lines in right figures represent the 5% critical values (-1.96, 1.96). The sample is 1973:Q1 to 2018Q3.

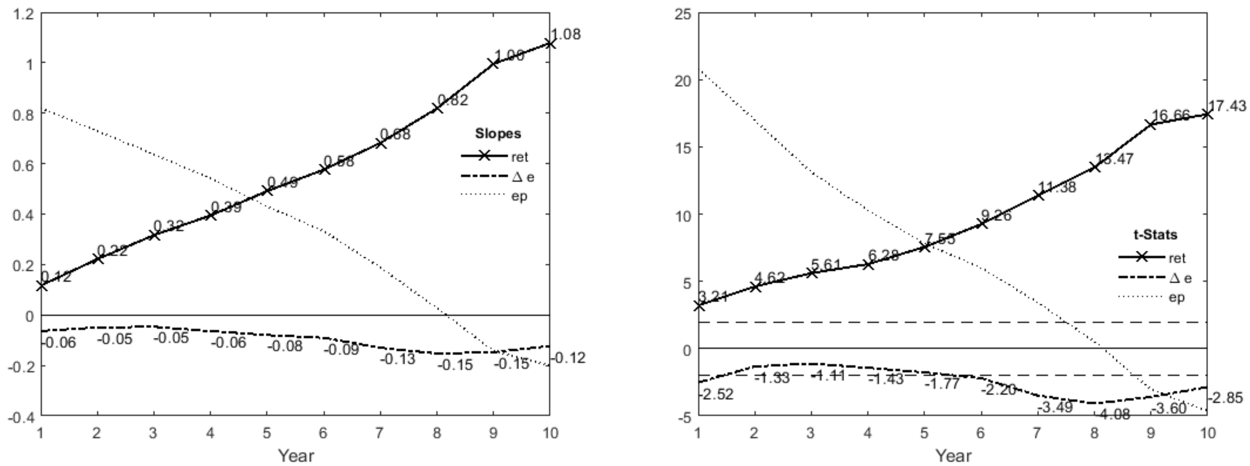


(Nominal-EW: Slopes and t-Stats)

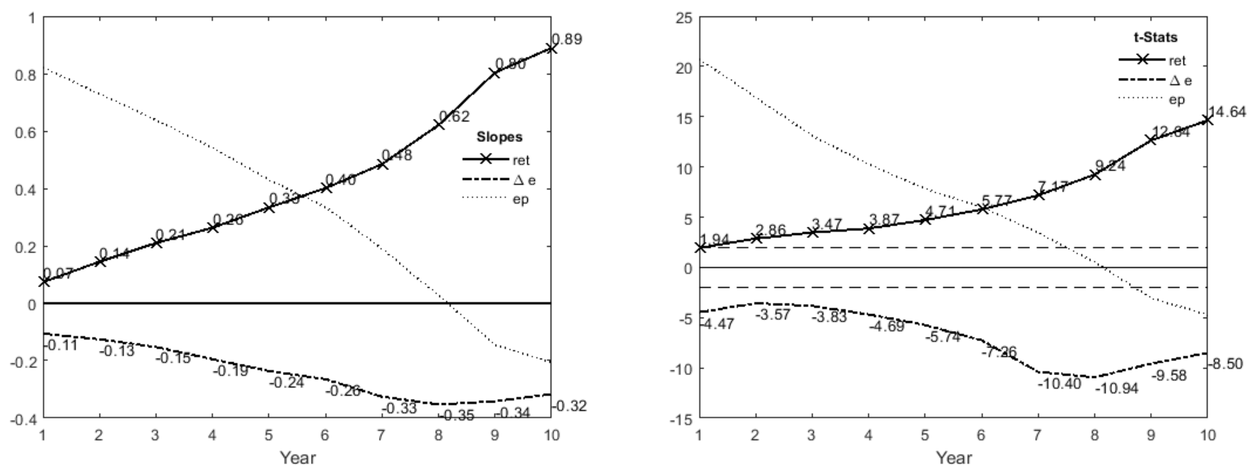


(Real-EW: Slopes and t-Stats)

Fig. 5. Nominal and Real Term Structure of Coefficients of ep: VW. This figure plots the real VAR-based term structure of the long-horizon predictive coefficients and respective t-statistics for the value-weighted case. The predictive slopes are associated with the log return (ret), log earning growth (Δe), and log earnings-to-price ratio (ep). The forecasting variable is the log earnings-to-price ratio in all three equations. The long-run coefficients are measured in percent, and horizon is 10 years ahead. The horizontal lines in right figures represent the 5% critical values (-1.96, 1.96). The sample is 1973:Q1 to 2018Q3.



(Nominal-VW: Slopes and t-Stats)



(Real-VW: Slopes and t-Stats)

In Figure 5 we present both the nominal and real term structure of the value-weighted portfolio. When we use nominal returns and nominal earnings growth, we will document that most of the price variations come from the discount rates. The contribution from cash flows are insignificant from year two to year five. When real terms are applied in the framework, we find both discount rates and cash flows significantly contribute to the price variation across horizons. The contribution ratios from cash flow sources are not negligible within ten year horizons but discount rates variation dominate in longer horizon.

4. Why does the Dividend Yield Predict Inflation?

One puzzle in asset pricing literature is that why does the dividend-price ratio predict future inflation. Since the dividend-price ratio is the ratio of price and dividend which is free from the inflation by theoretical construction. Asness (2000) and Sharpe (2002) find that stock dividend and earnings yields are highly correlated with nominal bond yields. Since stocks are claims to cash flows from real capital and inflation is the main driver of nominal interest rates, this correlation makes little sense, a point made recently by Ritter and Warr (2002), Asness (2003), and Campbell and Vuolteenaho (2004). Engsted and Pedersen (2010) documented mixed inflation predictability results which are not robust across forecasting horizons, sub-periods, and countries. For example, they find that in the US the dividend-price ratio predicts future long-term inflation negatively, i.e. an increase (decrease) in expected inflation leads to an increase (decrease) in stock prices, the opposite of what the Modigliani and Cohn hypothesis implies. Here we document new international evidence different from Engsted and Pedersen (2010) and we find that dividend price ratios can positively predict inflation across countries and across horizons. In this section, our empirical results do not support the hypothesis that the stock market suffers from inflation illusion but provide strong support that high future inflation turns to coincide with periods of worse economic fundamentals and higher risk premia.

Modigliani and Cohn hypothesize that the stock market suffers from money illusion, discounting real cash flows at nominal discount rates. The particular form of money illusion is incorrectly discounting real cash flows with nominal discount rates. An implication of such an mispricing error is that time variation in the level of inflation causes the marketâĂŹs subjective expectation of the future equity premium to deviate systematically from the rational expectation. Thus, when inflation is high (low), the rational equity-premium expectation is higher (lower) than the marketâĂŹs subjective expectation, and the stock market is undervalued (overvalued). If expected long-term growth is constant in real terms, yet the investor expects it to be constant in nominal terms, then in equilibrium stocks will be undervalued when inflation is high and overvalued when inflation is low. Therefore dividend-price ratio positively predicts future inflation. Campbell and Vuolteenaho (2004) find that in the US the dividend-price ratio is positively related to past inflation and they interpret that as evidence of irrational undervaluation of stock prices when inflation is high and irrational overvaluation of stock prices when inflation is low, in accordance with the Modigliani and Cohn (1979) hypothesis.

The other two hypothesis made are Fama (1981)'s proxy hypothesis and Brandt and Wang (2003)'s risk aversion hypothesis. Fama (1981) argues that the strong negative relationship between stock returns and inflation is due to stock returns anticipating future economic activity and inflation acting as a proxy for expected real activity; Brandt and Wang (2003) argues that high inflation makes investors more risk averse, driving up the equity premium and thus the real discount rate (similar argument made by Bekaert and Engstrom (2010)).

We construct the framework as Campbell and Vuolteenaho (2004) and test all three hypothesis. Campbell and Vuolteenaho (2004) derive a mispricing component in the dividend yield by relating the classic Gordon growth model (Gordon, 1962) to the log dividend-price ratio developed by Campbell and Shiller (1988), which allows for time-varying discount rates and dividend growth rates. In relating these two models, they introduce objective and subjective discount rates and growth rates, and capture the mispricing component by the difference between the objective and subjective growth rates. The traditional Gordon growth model states that the dividendâĂŞ price ratio is equal to discount rate minus growth rate:

$$\frac{D}{P} = R - G \tag{17}$$

where R is the long-term discount rate and G is the long-term growth rate of dividends. Subtract the riskless interest rate from both the discount rate and the growth rate of dividends, and define the excess discount rate as $R^e = R - R_f$ and the excess dividend growth rate as $G^e = G - R_f$. Taking into account the possibility that some investors are irrational, Gordon growth model can be rewrote as follows:

$$\frac{D}{P} = R^{e,Obj} - G^{e,Obj} = R^{e,Subj} - G^{e,Subj} = -G^{e,Obj} + R^{e,Subj} + (G^{e,Obj} - G^{e,Subj}) \tag{18}$$

Therefore, they decompose the dividend yield into three components: (1) the negative of objective excess dividend growth ($-G^{e,Obj}$), (2) the subjective risk premium ($R^{e,Subj}$), and (3) a mispricing component, which is given by a difference between the objective (i.e., rational) and subjective (i.e., irrational) dividend growth ($G^{e,Obj} - G^{e,Subj}$).

They relate the above Gordon model to the log-linear dynamic valuation model of Campbell and Shiller (1988), which allows for time-varying discount rates and dividend growth rates. The Campbell-Shiller model of the log dividendâĂŞprice ratio is given by:

$$dp_t \simeq -\frac{\kappa}{1-\rho} + E_t \sum_{j=1}^{\infty} \rho^{j-1}(r_{t+j} - r_{f,t+j}) - E_t \sum_{j=1}^{\infty} \rho^{j-1}(\Delta d_{t+j} - r_{f,t+j}) \tag{19}$$

$$= -\frac{\kappa}{1-\rho} + E_t \sum_{j=1}^{\infty} \rho^{j-1} r^e_{t+j} - E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta d^e_{t+j} \tag{20}$$

where Δd^e_{t+j} denotes Δd_{t+j}, log dividend growth, less the log risk-free rate; r^e_{t+j} denotes r_{t+j}, log stock return, less the log risk-free rate.

They note that $E_t \sum_{j=1}^{\infty} \rho^{j-1} r^e_{t+j}$ is analogous to $R^{e,Obj}$ and $R^{e,Subj}$, and $E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta d^e_{t+j}$

is analogous to $G^{e,Obj}$ and $G^{e,Subj}$, depending on whether the expectations taken are objective or subjective. They estimate the term $E_t \sum_{j=1}^{\infty} \rho^{j-1} r^e_{t+j}$ objective expectations and backout the negative objective expected growth $-E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta d^e_{t+j}$ from equation (20).

The subjective risk premium is estimated as the fitted value of a regression of $E_t \sum_{j=1}^{\infty} \rho^{j-1} r^e_{t+j}$ on a subjective risk-premium proxy λ_t.

$$E_t \sum_{j=1}^{\infty} \rho^{j-1} r^e_{t+j} = \gamma \lambda_t + \epsilon_t \tag{21}$$

A mispricing component given by the difference between objective and subjective expected dividend growth is the residual ϵ_t of this regression. In this model, when stocks are subjectively perceived to be very risky, then the fitted value $\gamma\lambda_t$ is high. In contrast, when stocks are underpriced, the residual ϵ_t is high.

Following Campbell (1991), we combine the valuation framework with a vector autoregression (VAR) that predicts stock returns. The first-order VAR includes the excess log stock return over the three-month interest rates (r^e_{t+1}), the excess log dividend growth over the three-month interest rates (Δd^e_{t+1}), the risk premia (λ) constructed as the ratio of standard deviations of stocks returns over ten-year government bond yields as Asness (2000) and Campbell and Vuolteenaho (2004) did, the log dividend-price ratio (dp), and the inflation rates (π) are constructed from Consumer Price Indexes(another inflation measure is constructed from Producer Price Indexes as robust). The expected future discount rates and cash flows are predicted from our VAR model as in literature. A recent paper by Myers et al. (2017) evaluate decomposition using survey data of dividends and earnings. They provide a new perspective in evaluating variation's composition however the survey data is nominal terms rather than real terms which may introduce biases to the estimation. We present the test results in table 5 and compare the three hypothesis respectively.

We start from the Modigliani and Cohn (1979)'s hypothesis. The money illusion hypothesis assumes that there are significant numbers of irrational investors who incorporate

Table 5: Hypothesis Tests-Consumer Price Indexes (CPI)

Regressions of yield's components on inflation constructed from CPI. Panel A shows results of dividend yield's components and Panel B shows results of earnings yield's components. For each case, coefficients are highlighted reported in first row, the t-stat (Newey/West HAC) are reported in second row and the R^2 are reported in the third row.

Panel A: Dividend Yield (dp)

Dep.	dp_t	$-E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta d^e_{t+j}$	$\gamma\lambda_t$	ϵ_t	$\gamma\lambda_t + \epsilon_t$
EW	5.891	7.359	0.258	-1.709	-1.449
	[5.84]	[10.22]	[3.98]	[-3.68]	[-3.05]
	0.36	0.69	0.26	0.18	0.13
EW_{backed}	5.891	4.866	1.470	-0.434	1.044
	[5.84]	[9.31]	[3.98]	[-0.97]	[1.90]
	0.36	0.64	0.26	0.02	0.05
VW	8.961	6.851	2.815	-0.677	2.137
	[5.69]	[9.22]	[6.94]	[-0.69]	[2.18]
	0.32	0.62	0.60	0.01	0.06
VW_{backed}	8.961	3.238	6.608	-0.855	5.750
	[5.69]	[14.85]	[6.94]	[-0.66]	[4.05]
	0.32	0.86	0.60	0.01	0.18

Panel B: Earnings Yield (ep)

Dep.	ep_t	$-E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta e^e_{t+j}$	$\gamma\lambda_t$	ϵ_t	$\gamma\lambda_t + \epsilon_t$
EW	7.015	10.973	-0.825	-3.132	-3.961
	[10.38]	[17.36]	[-4.01]	[-12.04]	[-18.87]
	0.51	0.82	0.26	0.52	0.74
EW_{backed}	7.015	6.994	0.878	-0.864	0.018
	[10.38]	[16.26]	[4.01]	[-4.62]	[0.07]
	0.51	0.75	0.26	0.13	0.00
VW	8.849	10.050	0.303	-1.500	-1.197
	[6.81]	[12.58]	[6.81]	[-2.66]	[-2.08]
	0.36	0.73	0.60	0.06	0.04
VW_{backed}	8.849	6.188	3.761	-1.095	2.665
	[6.81]	[12.57]	[6.81]	[-1.56]	[3.03]
	0.36	0.72	0.60	0.02	0.09

expected inflation into their nominal discount rate but not into future nominal cash flows, thereby there exist undervaluation when inflation is high and we should observe higher mispricing errors ϵ. The coefficient should be positive but the estimate coefficient is -1.709 in the equally-weighted portfolio and -0.677 in the value-weighted portfolio (Panel A). Both coefficients are negative which do not support the money illusion hypothesis. The second hypothesis is Fama (1981)'s proxy hypothesis. Fama argues from the quantity theory of money that higher anticipated growth rates of real activity are associated with lower current inflation rates and higher expected future economic activities are more likely corresponding to higher expected dividend growth. Therefore if we use the inflation as future economic fundamental's proxy and we expect that higher inflation should correspond to lower expected cash flows(higher negative expected cash flows) which suggest the coefficient of $-E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta d^e_{t+j}$ should be positive. The estimated coefficient is 7.359 in the equally-weighted portfolio and 6.851 in the value-weighted portfolio (Panel A). Both coefficients are significant positive which support the Fama (1981)'s proxy hypothesis. The third hypothesis is risk aversion hypothesis (Brandt and Wang (2003), Bekaert and Engstrom (2010)) that high inflation makes investors more risk averse, driving up the equity premium and thus the real discount rate. We expect the coefficients of subjective discount rates $\gamma\lambda_t$ and objective discount rates $\gamma\lambda_t + \epsilon_t$ to be positive. The estimated coefficient of $\gamma\lambda_t$ is 0.258 in the equally-weighted portfolio and 2.815 in the value-weighted portfolio (Panel A). The coefficients are significantly positive which means high inflation does correspond to high discount rates. The evidence also lends support to the risk aversion hypothesis. In Panel B, we test each components of the earnings yield and documented consistent evidence as in Panel A. The coefficient of mispricing errors ϵ is -3.132 in the equally-weighted portfolio and -1.500 in the value-weighted portfolio. Both coefficients are insignificant which do not support the money illusion hypothesis. The coefficient of $-E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta d^e_{t+j}$ is 10.973 in the equally-weighted portfolio and 10.050 in the value-weighted portfolio. Both coefficients are significantly positive which support the Fama (1981)'s proxy hypothesis.

We also provide 'backed-out' test results in table 5 corresponding to Chen and Zhao (2009)'s criticism on Campbell-Shiller decomposition's approximation error. They argue that the 'backed-out series' will be acting as a catchall for modelling noise and any inaccuracy in Campbell-Shiller decomposition. Engsted, Pedersen, and Tanggaard (2012) have strongly challenged this criticism, arguing that, provided one abstracts from the approximation error in Campbell and Shiller's decomposition and provided the VAR is properly modelled, it should not matter which component is backed out. Therefore we provide the backed-out results and find that the conclusion we made on hypothesis test remain the same. The 'backed-out' results show Chen and Zhao (2009)'s criticism plays little role in choosing the hypothesis. The only concern is that the expected inflation corresponds to lower subjective risk premia which is inconsistent with the backed-out results. We argue that the 'wrong' sign of subjective risk premia coefficient is due to the missing variation in payout ratio. After the payout ratio being considered, the signs will turn into positive and suggest higher risk premia required from investors (see table 13).

Our international results strongly support the growth proxy hypothesis (Fama (1981), Wei (2010)) and the risk aversion hypothesis (Brandt and Wang (2003), Bekaert and Engstrom (2010)) but reject the Modigliani and Cohn (1979)'s money illusion hypothesis. Wei and Joutz (2011) found that the correlation between inflation and the mispricing component is close to zero in the US post-war period and the evidence does not support the inflation illusion hypothesis. The post-war US data demonstrates 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 (2010). We also document consistent evidence that the expected excess dividend growth rate and inflation are negative correlated based on international data which can be interpreted as high inflation implies lower growth prospect. Brandt and Wang (2003) propose the time-varying risk aversion hypothesis, which maintains that inflation makes investors more risk averse, driving up the equity premium and thus the real discount rate. Here the documented factor loadings of subjective risk premium are positive which is consistent with their risk aversion hypothesis. Moreover, our evidence here does lend support to Bekaert and Engstrom (2010)'s argument that high expected inflation has tended to coincide with periods of heightened uncertainty about real economic growth and high risk aversion. They postulate that in recession times economics uncertainty and risk aversion may increase and lead to high equity premia thus in turn increase the equity yields. We find consistent evidence that high inflation leads to higher required subjective risk premium.

Table 6: Hypothesis Robust Tests-Producer Price Indexes (PPI)
Regressions of yield's components on inflation constructed from PPI. Panel A shows results of dividend yield's components and Panel B shows results of earnings yield's components. For each case, coefficients are highlighted reported in first row, the t-stat (Newey/West HAC) are reported in second row and the R^2 are reported in the third row.

Panel A: Dividend Yield (dp)

Dep.	dp_t	$-E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta d_{t+j}^e$	$\gamma\lambda_t$	ϵ_t	$\gamma\lambda_t + \epsilon_t$
EW	17.419	14.018	4.146	-0.745	3.401
	[2.25]	[2.58]	[3.38]	[-0.46]	[1.40]
	0.19	0.24	0.32	0.01	0.07
EW_{backed}	17.419	10.005	8.201	-0.786	7.414
	[2.25]	[2.47]	[3.38]	[-0.40]	[1.98]
	0.19	0.23	0.32	0.00	0.15
VW	19.639	13.218	8.657	-2.207	6.442
	[2.02]	[2.54]	[3.65]	[-0.76]	[1.39]
	0.14	0.22	0.39	0.01	0.06
VW_{backed}	19.639	4.106	18.764	-3.192	15.554
	[2.02]	[2.08]	[3.65]	[-0.85]	[2.00]
	0.14	0.17	0.39	0.01	0.13

Panel B: Earnings Yield (ep)

Dep.	ep_t	$-E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta e_{t+j}^e$	$\gamma\lambda_t$	ϵ_t	$\gamma\lambda_t + \epsilon_t$
EW	21.388	18.345	1.882	1.152	3.035
	[2.73]	[2.68]	[3.46]	[1.59]	[2.97]
	0.29	0.28	0.31	0.07	0.29
EW_{backed}	21.388	12.325	6.784	2.268	9.055
	[2.73]	[2.37]	[3.46]	[1.73]	[3.39]
	0.29	0.23	0.31	0.09	0.39
VW	23.139	16.582	4.650	1.904	6.552
	[2.47]	[2.36]	[3.74]	[1.24]	[2.75]
	0.22	0.21	0.39	0.03	0.22
VW_{backed}	23.139	6.977	13.508	2.655	16.158
	[2.47]	[1.62]	[3.74]	[1.13]	[3.15]
	0.22	0.10	0.39	0.02	0.33

Then we construct the alternative inflation measure from Producer Price Indexes and we find the evidence in table 6 still supports the previous argument that high inflation implies lower future cash flows and higher required risk premia. The differences between the PPI and CPI are consistent with the different uses of the two measures. A primary use of the PPI is to deflate revenue streams in order to measure real growth in output. A primary use of the CPI is to adjust income and expenditure streams for changes in the cost of living. In Panel A, the coefficient of mispricing errors ϵ is -0.745 in the equally-weighted portfolio and -2.207 in the value-weighted portfolio. Both coefficients are insignificant which do not support the money illusion hypothesis. The coefficient of $-E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta d_{t+j}^e$ is 14.018 in the equally-weighted portfolio and 13.218 in the value-weighted portfolio. Both coefficients are significantly positive which support the Fama (1981)'s proxy hypothesis. Moreover, we document that inflation can affect the subjective risk premia since all coefficients of $\gamma\lambda_t$ are significantly positive. The coefficient is 4.416 in the equally-weighted portfolio and 8.657 in the value-weighted portfolio. In Panel B, we test each components of the earnings yield and documented consistent evidence as in Panel A. The coefficient of mispricing errors ϵ is 1.152 in the equally-weighted portfolio and 1.904 in the value-weighted portfolio. Both coefficients are insignificant which do not support the money illusion hypothesis. The coefficient of $-E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta d_{t+j}^e$ is 18.345 in the equally-weighted portfolio and 16.582 in the value-weighted portfolio. Both coefficients are significantly positive which support the Fama (1981)'s proxy hypothesis. Moreover, we document that the coefficient of $\gamma\lambda_t$ is 1.882 in the equally-weighted portfolio and 4.650 in the value-weighted portfolio. Therefore, the source of the positive correlation between the US dividend yield and expected inflation is that high expected inflation has tended to coincide with periods of lower real economic growth and higher discount rates. The conclusion is largely unaffected by the precise definitions of the measures of inflation.

5. An Economic Model with Inflation Non-Neutrality

We document that investors do not suffer from the inflation illusion and evidence suggests that high expected inflation has tended to coincide with periods of lower real economic growth and higher discount rates which lead to the drop in today's prices. The hypothesis tests provide a more rational based explanation for the documented facts. To rationalize the inflation predictability and provide further insights, we build a cash flow model with inflation non-neutrality which is high future inflation dampens the economy growth. The estimated model can reproduce both the inflation predictability and the documented asset pricing facts.

A large number studies have explained that high expected inflation has non-neutral and negative effect on future economic growth. Piazzesi et al. (2006) highlight the role of inflation non-neutrality in explaining the nominal bond yields. Bansal and Shaliastovich (2013) extend the long-run risk model (Bansal and Yaron (2004)) including preference for early resolution of uncertainty, time-varying volatilities, and non-neutral effects of inflation on growth and in the new model the risk premia are driven by the volatilities of expected growth and expected inflation. Kung (2015) develops a stochastic endogenous growth model where the firm production and price-setting decisions drive low-frequency negative co-movement of growth and inflation rates in explaining the bond markets. Engsted and Pedersen (2018) extend the Bansal and Shaliastovich (2013)'s framework by considering the money illusion in the pricing kernel to explain the disappearance of money illusion during 1970s in US. Gómez-Cram and Yaron (2019) build on the long-run risk setup of Bansal and Shaliastovich (2013) and Schorfheide et al. (2018) by including the preference shocks to show that the inflation-related factors are not predominant in explaining the term premia component of the nominal yield curves.

5.1. *Model*

We build on the long-run risk setup of Bansal and Shaliastovich (2013) and Schorfheide et al. (2018). We include the dividend growth process in economic dynamics and estimate the model jointly to match the consumption, dividend and inflation process. The economic dynamics are joined by z_t and x_t process.

$$z_{t+1} = \mu + \Phi x_t + S_z \eta_{t+1} \tag{22}$$

$$x_{t+1} = \Pi x_t + S_x \epsilon_{t+1} \tag{23}$$

where $z_t = [\Delta c_t, \Delta d_t, \pi_t]$ are consumption growth, dividend growth and inflation process, $x_t = [x_{c,t}, x_{\pi,t}]$ are the long-run components of expected consumption growth and expected inflation.

$$\Phi = \begin{bmatrix} 1 & 0 \\ \phi & 0 \\ 0 & 1 \end{bmatrix}, \quad \Pi = \begin{bmatrix} \rho_c & \rho_{c\pi} \\ 0 & \rho_\pi \end{bmatrix}$$

In z_t process, ϕ captures the dividend leverage. In x_t process, ρ_c and ρ_π represent the persistence the long-run component process and $\rho_{c\pi}$ measures the non-neutrality of inflation which is negative to dampen the consumption growth.

$$S_z = \begin{bmatrix} \sigma_c & 0 & 0 \\ 0 & \sigma_d & 0 \\ 0 & 0 & \sigma_\pi \end{bmatrix}, \quad S_x = \begin{bmatrix} \sigma_{xc} & 0 \\ 0 & \sigma_{x\pi} \end{bmatrix}$$

η_{t+1} and ϵ_{t+1} represent the normal distributed shocks and S_z and S_x capture the time variation in the uncertainty about expected consumption growth and expected inflation. Both S_z and S_x are diagnol matrix.

In the economy, the representative agent has the Epstein and Zin (1989) preferences defined over the consumption bundle C_t:

$$U_t = [(1-\delta)C_t^{1-\frac{1}{\psi}} + \delta(E_t[U_{t+1}^{1-\gamma}])^{\frac{1-\frac{1}{\psi}}{1-\gamma}}]^{\frac{1}{1-\frac{1}{\psi}}}$$

Therefore the IMRS (Inter-temporal Marginal Rate of Substitution) for this economy is given by

$$m_{t+1} = \theta \cdot log\delta - \frac{\theta}{\psi} \cdot \Delta c_{t+1} + (\theta - 1) \cdot r_{c,t+1}, \quad \theta = \frac{1-\gamma}{1-\frac{1}{\psi}} \tag{24}$$

By solving the model, we have the analytic solutions as

$$pc_t = A_0 + A_1 \cdot x_{c,t} + A_2 \cdot x_{\pi,t}, \quad A_1 = \frac{1-\frac{1}{\psi}}{1-\kappa_1 \cdot \rho_c}, A_2 = \frac{\kappa_1 \cdot (1-\frac{1}{\psi}) \cdot \rho_{c\pi}}{(1-\kappa_1 \cdot \rho_c) \cdot (1-\kappa_1 \cdot \rho_\pi)}; \tag{25}$$

$$pd_t = B_0 + B_1 \cdot x_{c,t} + B_2 \cdot x_{\pi,t}, \quad B_1 = \frac{\phi-\frac{1}{\psi}}{1-\kappa_1^d \cdot \rho_c}, B_2 = \frac{\kappa_1^d \cdot (\phi-\frac{1}{\psi}) \cdot \rho_{c\pi}}{(1-\kappa_1^d \cdot \rho_c) \cdot (1-\kappa_1^d \cdot \rho_\pi)}; \tag{26}$$

$$E_t[r_{d,t+1}] = C_0 + C_1 \cdot x_{c,t} + C_2 \cdot x_{\pi,t}, \quad C_1 = \phi + (\kappa_1^d \rho_c - 1)B_1, C_2 = \kappa_1^d \rho_{c\pi} B_1 + (\kappa_1^d \rho_\pi - 1)B_2; \tag{27}$$

The solution coefficients for the effect of expected consumption growth rate $x_{c,t}$ on the price-dividend ratio, B_1, and the effect of inflation rate $x_{\pi,t}$ on the price-dividend ratio, B_2, respectively

$$B_1 = \frac{\phi-\frac{1}{\psi}}{1-\kappa_1^d \cdot \rho_c} > 0; \quad B_2 = \frac{\kappa_1^d \cdot (\phi-\frac{1}{\psi}) \cdot \rho_{c\pi}}{(1-\kappa_1^d \cdot \rho_c) \cdot (1-\kappa_1^d \cdot \rho_\pi)} < 0$$

The economic mechanism is straightforward. B_1 is positive suggesting the substitution effect dominates the wealth effect. When good news on expected consumption growth comes, agents buy more assets which increase the price-dividend ratio. Since $\phi > \frac{1}{\psi}$, B_2 is negative simply due to the negative and non-neutral effect of inflation, $\rho_{c\pi} < 0$.

5.2. Estimation

We jointly estimate three processes: consumption growth, dividend growth and inflation. In the model, we calibrate preference parameters before estimation: the risk aversion γ is calibrated to 10 (see Bansal and Yaron (2004) among others); the inter-temporal elasticity of substitution ψ is set to 1.5, usual in the long- run risk literature; the household's subjective discount rate δ is set to 0.99 at quarterly frequency. The dividend leverage factor ϕ is calibrated to 3. Here we use the one-year ahead forecast to proxy the expected consumption growth as Bansal and Shaliastovich (2013). The expected inflation data are either the SPF data or the model implied inflation(either choice leads to similar results). We estimate the model using U.S. data for two reasons: one is due to data limitation since U.S. has the longest growth forecast data after 1968Q4 while the other countries' SPF data starts from 1999Q1; the second is that we have better estimated preference parameters based on U.S. data and these parameters are variously applied in many previous studies. We estimate the variable means μ, the transition matrix Π and the variance scale S_z and S_x in the economic dynamics.

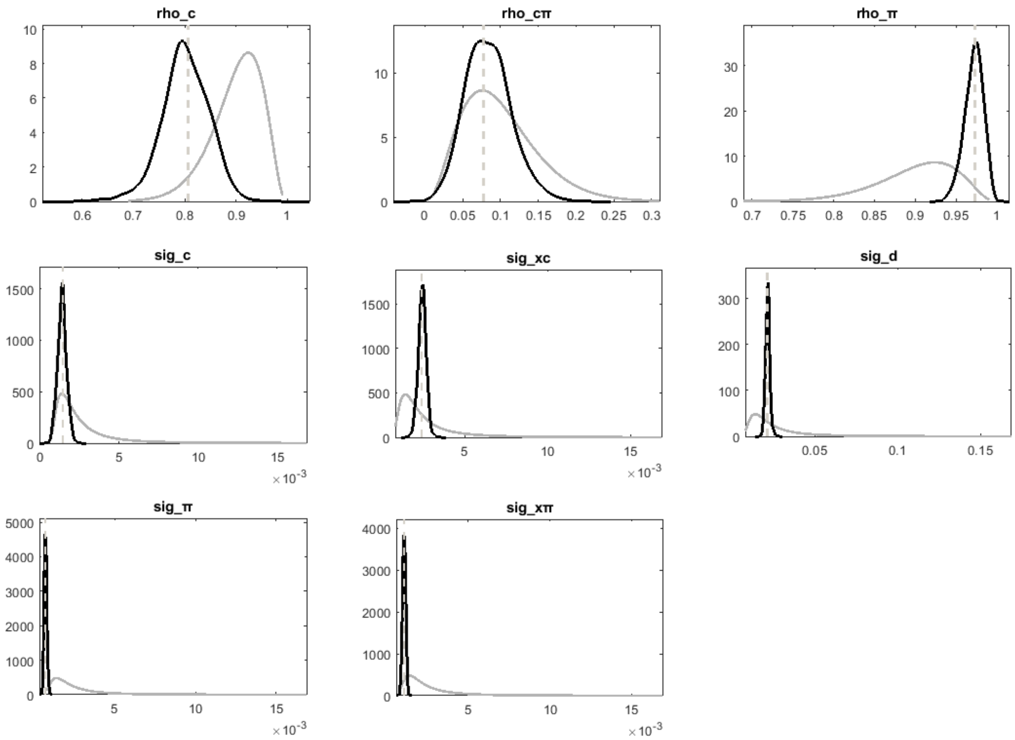
Table 7: Estimated Parameters

This table reports the estimated parameters. All reported numbers are Bayesian estimated using consumption growth, dividend growth and inflation data. Priors mean, standard deviations and distributions are reported in first three columns. Posterior mean and 90% intervals are reported in last three columns.

Parameters	Prior			Posterior		
	mean	*std*	*dist.*	*mean*	5%	95%
ρ_c	0.900	0.0500	*Beta*	0.8010	0.7357	0.8716
ρ_π	0.900	0.0500	*Beta*	0.9719	0.9558	0.9913
$-\rho_{c\pi}$	0.100	0.0500	*Beta*	0.0834	0.0364	0.1289
μ_c	0.005	0.0015	*Uniform*	0.0050	0.0036	0.0065
μ_d	0.010	0.0030	*Uniform*	0.0104	0.0064	0.0151
μ_π	0.010	0.0030	*Uniform*	0.0093	0.0064	0.0129
σ_c	0.003	*Inf.*	*Inv-Gamma*	0.0014	0.0009	0.0019
σ_{xc}	0.003	*Inf.*	*Inv-Gamma*	0.0024	0.0021	0.0028
σ_d	0.030	*Inf.*	*Inv-Gamma*	0.0214	0.0194	0.0234
σ_π	0.003	*Inf.*	*Inv-Gamma*	0.0007	0.0006	0.0008
$\sigma_{x\pi}$	0.003	*Inf.*	*Inv-Gamma*	0.0011	0.0009	0.0012

The ρ_π is equal to 0.9719 and both scales of σ_π and $\sigma_{x\pi}$ are relatively smaller than the consumption related volatility. Results suggest that the expected inflation is very persistent and with lower variations. The estimated $\rho_{c\pi}$ is equal to -0.0834 and 90% intervals also suggest that $\rho_{c\pi}$ is significantly negative. Evidence suggests that the inflation has negative and non-neutral effect on the consumption growth which is consistent with the argument by Bansal and Shaliastovich (2013).

Fig. 6. Priors and Posteriors: The vertical lines represent the posterior means, the dark lines represent posteriors and the gray lines represent priors.



5.3. *Model Implications*

In table 8, we find that the estimated model can match the key features of consumption, asset-pricing related and inflation data. By construction, the model matches the consumption growth, dividend growth and inflation, the model implied price-dividend ratio and implied expected returns can also be matched in the data.

Table 8: Descriptive Statistics and Simulated Moments
Statistics in Data column are calculated based on quarterly sample data from 1973Q1 to 2018Q3. Statistics in LRR Model column are bootstrapped statistics calculated from 2,000 simulations, each with 180 observations. All values are annualized and standard deviations are reported in brackets.

Variable	**Data**	**LRR Model**
Real Consumption Growth (Δc_{t+1})	0.022	0.020
	[0.021]	[0.009]
Real Dividend Growth (Δd_{t+1})	0.043	0.042
	[0.058]	[0.050]
Real Equity Returns (ret_{t+1})	0.066	0.071
	[0.178]	[0.099]
Log Price Dividend Ratio (pd_t)	3.645	3.480
	[0.464]	[0.341]
Inflation Rate (π_{t+1})	0.035	0.037
	[0.023]	[0.009]

With the calibrated preference parameters and the estimated economic dynamics, we generate 2,000 simulation data each with sample length 180 quarter observations. We re-run the return, dividend, inflation and consumption predictability regressions with independent variable the dividend-price ratio dp_t. As shown in table 9, the model can replicate several documented facts. First of all the inflation predictability reinforces the return predictability and reduces the dividend growth predictability. The cash flow predictability decrease if we use the dividend-price ratio to predict the nominal dividend growth. Second, we document that the dividend-price ratio can positively predict future inflation and the predictive significance holds across all horizons. Third, the high expected inflation can dampen the future consumption growth which reflects the inflation non-neutrality by construction.

Table 9: Predictive Regressions

This table reports results for predictive regressions of stock returns (ret), dividend growth (Δd), inflation (π), and consumption growth (Δc) on the log dividend yield. The forecast horizon is from one year to five years. All reported numbers are taken averages across 2,000 simulations with sample length equal 180. Predictive coefficients are highlighted reported in first row, the t-stat are reported in second row and the R^2 are reported in the third row.

Dep. Var\ Horizon	1	2	3	4	5
$ret_{nom,t+1}$	0.108	0.110	0.110	0.111	0.108
	[1.76]	[2.44]	[2.96]	[3.41]	[3.78]
	0.00	0.00	0.00	0.00	0.01
$ret_{real,t+1}$	0.016	0.025	0.038	0.043	0.051
	[0.49]	[0.75]	[1.06]	[1.48]	[1.74]
	0.00	0.00	0.00	0.00	0.00
$\Delta d_{nom,t+1}$	-0.091	-0.077	-0.063	-0.054	-0.046
	[-2.37]	[-2.41]	[-2.27]	[-2.09]	[-1.88]
	0.00	0.00	0.00	0.00	0.00
$\Delta d_{real,t+1}$	-0.185	-0.159	-0.137	-0.121	-0.106
	[-4.78]	[-5.01]	[-4.82]	[-4.57]	[-4.25]
	0.16	0.19	0.19	0.14	0.09
π_{t+1}	0.092	0.083	0.075	0.067	0.059
	[20.45]	[15.39]	[12.46]	[10.32]	[8.67]
	0.82	0.72	0.62	0.53	0.44
Δc_{t+1}	-0.061	-0.053	-0.047	-0.041	-0.035
	[-7.06]	[-6.62]	[-6.17]	[-5.68]	[-5.30]
	0.34	0.31	0.28	0.24	0.19

6. Additional Results

6.1. *Dividend Predictability in VW Portfolio*

Why dividend price ratio cannot predict cash flows in the value-weighted portfolio? We documented that the dividend yield can negatively predict the dividend growth in the equal-weighted portfolio but not in the value-weighted portfolio. Rangvid et al. (2014) argue that dividend growth is significantly more predictable in countries with medium-sized or smaller equity markets and the equally-weighted portfolio puts more weight on smaller markets than the value-weighted portfolio therefore the dividend price ratio can only predict the EW dividend growth. Previous research attribute dividend predictability to dividend smoothing by firms. Chen et al. (2012) first investigate the relationship among dividend predictability using U.S. data. They documented in the post-war period, dividends are much more smoothed and respond much more to their past levels rather than to the outlook of future cash flows. They argue the dividend smoothing can kill the predictability and reach the conclusion that cash flow news plays a more important role than discount rate news in price variations in the postwar. Rangvid et al. (2014) documented that dividends are more predictable in countries with smaller equity markets and find that in countries where dividends are smoothed less, dividend predictability by the dividend yield is stronger using international data. They estimate a version of the Lintner (1956) partial-adjustment model and find that the estimated smoothing parameter is significantly higher in the value-weighted portfolio and even insignificant in the equal-weighted portfolio.

Here we estimate the Lintner (1956)'s model using both nominal and real terms and find the results are similar. Here we measure how the earnings growth are disconnected from the dividend growth and how persistent the dividend growth are. δ_1 is slightly higher in equally-weighted setting than the value in value-weighted setting. It suggest that dividends react less to changes in earnings in the value-weighted portfolio compared to the equally-weighted portfolio. δ_2 measures the dividend smoothness and we find the all estimated δ_2

are significant which suggests that firms in those countries do smooth their dividend which may dampens the dividend predictability by the dividend-price ratio.

Table 10: Dividend Smoothing

This table shows results for regressions of dividend growth on the earnings growth and lagged dividend growth for EW and VW where growth are measured in nominal or real term.

$$\Delta D_t = \delta_1 \Delta E_t + \delta_2 \Delta D_{t-1} + \epsilon_t \tag{28}$$

δ_1 and δ_2 are coefficients of the earnings growth and lagged dividend growth, respectively. The t-stat (Newey/West HAC) and the R^2 are reported for each cases.

	δ_1	t	δ_2	t	R^2
$EW_{nominal}$	0.37	[7.05]	0.33	[3.63]	0.44
EW_{real}	0.36	[6.98]	0.31	[3.65]	0.42
$VW_{nominal}$	0.28	[3.18]	0.29	[3.67]	0.38
VW_{real}	0.26	[3.24]	0.26	[3.30]	0.34

To measure the smoothness, we construct the smoothing parameter S as Chen et al. (2012) and Rangvid et al. (2014) where S is the volatility ratio of dividend and earning growth.

$$S_i = \frac{\sigma(\Delta d_i)}{\sigma(\Delta e_i)} \tag{29}$$

Lower value of S means higher degree of the dividend smoothing. For example, the S is equal to zero when there is perfect dividend smoothing $\Delta D_{t-1} = \Delta D_t$. We find that $S = 0.769$ in the EW portfolio and $S = 0.641$ in the VW portfolio, which is consistent with our expectation.

We explore what determines the firms' dividend smoothing pattern as Rangvid et al. (2014) by regressing the smoothing parameter S on potential determinants. Leary and Michaely (2011) find that young and small firms and firms with volatile cash flows are less likely to smooth dividend payment. Therefore we construct two factors: $FirmSize$ factor to reflect the effect of average firm capitalization across different countries and $ReturnVolatility$ factor to reflect the effect of firm's fundamentals. We obtain consistent results with the Rangvid et al. (2014)'s finding that both factors determine the firms dividend smoothing and cash flow predictability. In table 11, we find that firm size are negatively correlated with

Table 11: Dividend Smoothing, Firm Size, and Volatility

This table shows results for cross-sectional regressions of a country's dividend smoothing parameter S_i on firm size and/or each return volatility. The smoothing parameter is defined as the standard deviation of dividend growth of a country divided by the standard deviation of earnings growth. Numbers in brackets are t-statistics based on White-Hinkley heteroskedasticity consistent standard errors.

	(1)	(2)	(3)
Firm Size	-0.165		-0.068
	[-3.64]		[-1.62]
Return Volatility		2.939	2.529
		[4.03]	[3.11]
constant	0.744	0.059	0.154
	[12.50]	[0.32]	[0.31]
R^2	0.36	0.73	0.78

the smoothing parameter which means small firms are less likely to smooth the dividend payment and return volatility are positively correlated with the smoothing parameter which suggests firms with volatile cash flows are less likely to smooth the dividend. We also find the explanatory power of $FirmSize$ become weak when we control for the return volatility factor. Since the sample size is very small, we do not draw conclusion on this.

6.2. Time-Varying Payout Ratio in Earnings Yield Test

Here we consider the payout ratio movement in equation (2) and the new estimation framework will be

$$\sum_{j=1}^{H} \rho^{j-1} r_{t+j} = \alpha_R^H + \beta_r^H ep_t + \epsilon_{t,t+H}^r \tag{30}$$

$$\sum_{j=1}^{H} \rho^{j-1} \Delta e_{t+j} = \alpha_{\Delta e}^H + \beta_{\Delta e}^H ep_t + \epsilon_{t,t+H}^{\Delta e} \tag{31}$$

$$(1-\rho)\sum_{j=1}^{H} \rho^{j-1} de_{t+j} = \alpha_{de}^H + \beta_{de}^H ep_t + \epsilon_{t,t+H}^{de} \tag{32}$$

$$\rho^{H-1} ep_{t+H} = \alpha_{ep}^{H} + \beta_{ep}^{H} ep_t + \epsilon_{t,t+H}^{ep} \tag{33}$$

Similarly to Cochrane (2011), by combining the present-value relation with the predictive regressions above, we obtain an identity involving the predictability coefficients associated with *ep*, at each horizon H.

$$\beta_{r}^{H} - \beta_{\Delta e}^{H} - \beta_{de}^{H} + \rho \beta_{ep}^{H} = 1 \tag{34}$$

Table 12: VAR-Based Results

This table reports the one-period VAR estimation results for EW and VW cases of real(nominal) returns and real(nominal) earnings growth. The variables in the VAR are the log stock return (*ret*), log earnings growth (Δe), log payout ratio (*de*), and log earnings-to-price ratio (*ep*). β denotes the VAR slopes associated with lagged *ep*, while t denotes the respective Newey and West (1987) t-statistics. β^{Delta} denotes the slope estimates implied from the variance decomposition constraint, and t denotes the respective asymptotic t-statistics computed under the delta method. R^2 are the coefficient of determination for each equation in the VAR. β^{LR} denotes the long-run coefficients (infinite horizon). The sample corresponds to quarterly data from 1973:Q1 to 2018:Q3.

		β	t	R^2	β^{Delta}	t	R^2	β^{LR}
$EW_{nominal}$	ret	0.14	[3.01]	0.05	0.15	[3.39]	0.05	0.53
	Δe	-0.14	[-3.90]	0.08	-0.14	[-3.89]	0.08	-0.50
	de	0.01	[3.72]	0.07	0.01	[3.56]	0.07	0.03
	ep	0.72	[15.53]	0.58	0.73	[16.06]	0.58	-
EW_{real}	ret	0.06	[1.24]	0.01	0.08	[1.73]	0.01	0.28
	Δe	-0.21	[-6.13]	0.18	-0.21	[-6.09]	0.18	-0.75
	de	0.01	[3.73]	0.07	0.01	[3.42]	0.07	0.03
	ep	0.73	[15.53]	0.58	0.74	[16.08]	0.58	-
$VW_{nominal}$	ret	0.12	[3.47]	0.06	0.12	[3.43]	0.06	0.66
	Δe	-0.06	[-2.46]	0.03	-0.07	[-2.71]	0.03	-0.38
	de	0.01	[4.16]	0.08	0.01	[4.08]	0.09	0.05
	dp	0.83	[22.53]	0.74	0.84	[23.34]	0.74	-
VW_{real}	ret	0.08	[2.18]	0.03	0.08	[2.15]	0.03	0.43
	Δe	-0.10	[-4.28]	0.10	-0.11	[-4.57]	0.10	-0.62
	de	0.01	[4.17]	0.09	0.01	[4.09]	0.09	0.05
	ep	0.83	[22.46]	0.74	0.84	[23.28]	0.74	-

The new estimated results are similar as shown in table 4 where the inflation predictability can reinforce the return predictability and decrease the cash flow predictability. We find that the payout ratio can be positively predicted by the dividend (earnings) yield in both global portfolios. The long run variation contribution from payout ratios is limited at 3% in the equally-weighted portfolio and 5% in the value-weighted portfolio. After inflation being considered, the cash flow plays a dominant role in determining today's financial ratios.

Table 13: Hypothesis Tests: Time-Varying Payout Ratio Case

Regressions of earnings yield's components on inflation constructed from both CPI and PPI. Panel A shows results of CPI constructed inflation and Panel B shows results of PPI constructed inflation. For each case, coefficients are highlighted reported in first row, the t-stat (Newey/West HAC) are reported in second row and the R^2 are reported in the third row.

Panel A: CPI Case

Dep.	ep_t	$-E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta e^e_{t+j}$	$\gamma\lambda_t$	ϵ_t	$\gamma\lambda_t + \epsilon_t$
EW	7.034	8.201	0.567	-1.332	-0.761
	[10.48]	[13.38]	[3.98]	[-2.58]	[-1.46]
	0.52	0.74	0.26	0.13	0.04
EW_{backed}	7.034	4.074	2.527	0.823	3.365
	[10.48]	[9.65]	[3.98]	[1.41]	[4.98]
	0.52	0.55	0.26	0.05	0.29
VW	8.841	7.130	3.155	-0.738	2.416
	[6.76]	[11.74]	[6.92]	[-0.72]	[2.33]
	0.36	0.61	0.60	0.01	0.07
VW_{backed}	8.841	3.040	6.924	-0.416	6.506
	[6.76]	[10.52]	[6.92]	[-0.34]	[4.83]
	0.36	0.35	0.60	0.00	0.25

Panel B: PPI Case

Dep.	ep_t	$-E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta e^e_{t+j}$	$\gamma\lambda_t$	ϵ_t	$\gamma\lambda_t + \epsilon_t$
EW	21.460	16.911	5.476	0.299	5.780
	[2.74]	[2.88]	[3.47]	[0.17]	[2.19]
	0.30	0.31	0.32	0.00	0.16
EW_{backed}	21.460	9.435	12.302	0.944	13.256
	[2.74]	[2.63]	[3.47]	[0.36]	[2.67]
	0.30	0.23	0.32	0.00	0.24
VW	22.518	16.747	9.617	-2.955	6.651
	[2.54]	[3.31]	[3.81]	[-0.96]	[1.40]
	0.22	0.35	0.38	0.02	0.05
VW_{backed}	22.518	6.641	19.154	-2.375	16.757
	[2.54]	[2.61]	[3.81]	[-0.62]	[2.23]
	0.22	0.17	0.38	0.02	0.15

The inflation illusion test provide consistent evidence as before. We find the coefficients of $-E_t \sum_{j=1}^{\infty} \rho^{j-1} \Delta e^e_{t+j}$ and $\gamma\lambda_t$ are all significantly positive and the coefficients of ϵ_t are insignificant. It suggest higher inflation implies lower cash flows and high discount rates in the economy.

6.3. Monte-Carlo Simulation

A part of the return predictability literature has focused on the poor small-sample properties of long-horizon predictability (e.g.Valkanov (2003), Boudoukh, Richardson, and Whitelaw (2006)). To address this issue, we conduct a Monte-Carlo simulation of the VAR model associated with both dividend yields and earnings yields.

Following Cochrane (2007), the first Monte Carlo simulation is based on the null hypothesis of no return predictability; the data-generating process is simulated under the hypothesis that what drives the variation in the dividend yield is only dividend growth predictability:

$$\begin{aligned} ret_{t+1} &= 0 \cdot dp_t + (\epsilon^{\Delta d}_{t+1} - \rho\epsilon^{dp}_{t+1}) \\ \Delta d_{t+1} &= (\rho\beta_{dp} - 1) \cdot dp_t + \epsilon^{\Delta d}_{t+1} \\ dp_{t+1} &= \beta_{dp} \cdot dp_t + \epsilon^{dp}_{t+1} \end{aligned} \tag{35}$$

The second Monte Carlo simulation is based on the null hypothesis of no dividend predictability; the data-generating process is simulated under the hypothesis that what drives the variation in the dividend yield is only discount rates:

$$\begin{aligned} ret_{t+1} &= (-\rho\beta_{dp} + 1) \cdot dp_t + \epsilon^{r}_{t+1} \\ \Delta d_{t+1} &= 0 \cdot dp_t + (\epsilon^{r}_{t+1} + \rho\epsilon^{dp}_{t+1}) \\ dp_{t+1} &= \beta_{dp} \cdot dp_t + \epsilon^{dp}_{t+1} \end{aligned} \tag{36}$$

We estimate the coefficients using two simulated datasets and compare them to the original ones. In no return predictability case, if the coefficient β_{ret} is greater than the original one, we count it as one rejection observation. In no cash flow predictability case, if the coefficient $\beta_{\Delta d}$ is less than the original one, we count it as one rejection observation. We simulate each data-generating process for 50,000 times and the documented rejection ratios are less than 1% in the two global portfolios when inflation is considered. By using the Monte Carlo simulations presented above, we are able to gauge the statistical significance of the VAR-based return and dividend growth coefficients at multiple horizons. The results suggest that we reject the absence of returns and dividend growth predictability for both two global portfolios.

7. Conclusion

In this paper, we explore the fundamental asset pricing question from a new perspective -inflation- using international data. We start from the fact that high inflation corresponds to high dividend yield and high earnings yield across countries and documented the current dividend (earnings) yield can predict future inflation. The inflation predictability brings new implication in assessing the role of discounts rates and cash flows in today's stock prices.

The main finding in this paper is that the inflation predictability reinforces the return predictability but reduces- even changes the direction of- the cash flow predictability. This pattern holds across advanced economies. We also provide fresh evidence to help us understand price movements. We find that the result based on post-War U.S. data pointed out by Cochrane (2011) that asset prices move mainly due to variation in expected returns does not uniformly extend to other countries. The new international data allows us to reassess the variance decomposition analysis and find that both discount rates and cash flows play important roles in determining today's equity price.

The consistent inflation predictability evidence across advanced economies allows us to re-evaluate the relationship among dividend price ratio and inflation to see whether the relation is indeed due to inflation illusion. We test three potential hypothesis related to growth prospect, risk aversion and behavior bias and conclude the positive relationship among inflation and dividend (earnings) yields are consistent with Fama (1981), Brandt and Wang (2003), and Bekaert and Engstrom (2010). It suggests that high inflation implies lower future economic prospects thus lower cash flows and higher discount rates. The prices today will drop and higher yields will be documented. Therefore the inflation and dividend (earnings) yields are positively correlated.

To rationalize the inflation predictability and provide further insights, we build on the long-run risk setup of Bansal and Yaron (2004), Bansal and Shaliastovich (2013) and Schorfheide et al. (2018) with inflation non-neutrality which is high future inflation dampens the economy growth. The estimated model can reproduce both the inflation predictability and the documented asset pricing facts.

Our findings have potentially important policy implication. We documented that though investors are not suffering from the money illusion, high inflation does imply lower future cash flows and higher required risk premia. The Federal Reserve's inflation policy does have bearing on the equity market premia and the implications on future economic growth matters. To conclude, we note that the inflation predictability changes the big picture of return and cash flow predictability a lot. Ignorance of inflation will leads us to biased results.

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Appendix A. Model Solutions

Economic Dynamics:

$$z_{t+1} = \mu + \Phi x_t + S_z \eta_{t+1}$$

$$x_{t+1} = \Pi x_t + S_x \epsilon_{t+1}$$

where

$$z_t = [\Delta c_t, \Delta d_t, \pi_t], \quad x_t = [x_{c,t}, x_{\pi,t}]$$

$x_{c,t}$ and $x_{\pi,t}$ are the long-run components of expected consumption growth and expected inflation.

$$\Phi = \begin{bmatrix} 1 & 0 \\ \phi & 0 \\ 0 & 1 \end{bmatrix}, \quad \Pi = \begin{bmatrix} \rho_c & \rho_{c\pi} \\ 0 & \rho_\pi \end{bmatrix}$$

ϕ captures the dividend leverage and ρ_c, ρ_π represents the persistence the expected process. $\rho_{c\pi}$ measures the non-neutrality of inflation which is negative to dampen the consumption growth.

$$S_z = \begin{bmatrix} \sigma_c & 0 & 0 \\ 0 & \sigma_d & 0 \\ 0 & 0 & \sigma_\pi \end{bmatrix}, \quad S_x = \begin{bmatrix} \sigma_{xc} & 0 \\ 0 & \sigma_{x\pi} \end{bmatrix}$$

η_{t+1} and ϵ_{t+1} represent the normal distributed shocks and S_z and S_x capture the time variation in the uncertainty about expected consumption growth and expected inflation. Both S_z and S_x are diagnol matrix.

In the economy, the representative agent has the Epstein and Zin (1989) preferences defined over the consumption bundle C_t:

$$U_t = [(1-\delta) C_t^{1-\frac{1}{\psi}} + \delta (E_t[U_{t+1}^{1-\gamma}])^{\frac{1-\frac{1}{\psi}}{1-\gamma}}]^{\frac{1}{1-\frac{1}{\psi}}}$$

Therefore the IMRS (Inter-temporal Marginal Rate of Substitution) for this economy is given by

$$m_{t+1} = \theta \cdot log\delta - \frac{\theta}{\psi} \cdot \Delta c_{t+1} + (\theta - 1) \cdot r_{c,t+1}$$

where $\theta = \frac{1-\gamma}{1-\frac{1}{\psi}}$

A.1. Price-Consumption Ratio: pc

$$pc_t = A_0 + A_1 \cdot x_{c,t} + A_2 \cdot x_{\pi,t}$$

Proof:

$$1 = E_t[M_{t+1} R_{c,t+1}] = E_t[exp(\theta \cdot log\delta - \frac{\theta}{\psi} \cdot \Delta c_{t+1} + \theta \cdot r_{c,t+1})]$$

where

$$r_{c,t+1} = \kappa_0 + \kappa_1 \cdot pc_{t+1} + \Delta c_{t+1} - pc_t$$

Let $A(\cdot) = \theta \cdot log\delta - \frac{\theta}{\psi} \cdot \Delta c_{t+1} + \theta \cdot r_{c,t+1}$, we have

$$E[A(\cdot)] + \frac{1}{2} Var(A(\cdot)) = 0$$

By the educated guess,

$$pc_t = A_0 + A_1 \cdot x_{c,t} + A_2 \cdot x_{\pi,t}$$

Substitute the guess into $A(\cdot)$ and solve the equation:

$$A_1 = \frac{1 - \frac{1}{\psi}}{1 - \kappa_1 \cdot \rho_c}, \quad A_2 = \frac{\kappa_1 \cdot (1 - \frac{1}{\psi}) \cdot \rho_{c\pi}}{(1 - \kappa_1 \cdot \rho_c) \cdot (1 - \kappa_1 \cdot \rho_\pi)},$$

Q.E.D.

A.2. Price-Dividend Ratio: pd

$$pd_t = B_0 + B_1 \cdot x_{c,t} + B_2 \cdot x_{\pi,t}$$

Proof:

$$1 = E_t[M_{t+1}R_{d,t+1}] = E_t[exp(\theta \cdot log\delta - \frac{\theta}{\psi} \cdot \Delta c_{t+1} + (\theta - 1) \cdot r_{c,t+1} + r_{d,t+1})]$$

where

$$r_{d,t+1} = \kappa_0^d + \kappa_1^d \cdot pd_{t+1} + \Delta d_{t+1} - pd_t$$

Let $B(\cdot) = \theta \cdot log\delta - \frac{\theta}{\psi} \cdot \Delta c_{t+1} + (\theta - 1) \cdot r_{c,t+1} + r_{d,t+1}$, we have

$$E[B(\cdot)] + \frac{1}{2}Var(B(\cdot)) = 0$$

By the educated guess,

$$pd_t = B_0 + B_1 \cdot x_{c,t} + B_2 \cdot x_{\pi,t}$$

Substitute the guess into $B(\cdot)$ and solve the equation:

$$B_1 = \frac{\phi - \frac{1}{\psi}}{1 - \kappa_1^d \cdot \rho_c}, \quad B_2 = \frac{\kappa_1^d \cdot (\phi - \frac{1}{\psi}) \cdot \rho_{c\pi}}{(1 - \kappa_1^d \cdot \rho_c) \cdot (1 - \kappa_1^d \cdot \rho_\pi)},$$

Q.E.D.

A.3. Returns: $r_{d,t+1}$

$$r_{d,t+1} = E_t[r_{d,t+1}] + \kappa_1^d B_1 \sigma_{xc} \cdot \epsilon_{c,t+1} + \kappa_1^d B_2 \sigma_{x\pi} \cdot \epsilon_{\pi,t+1} + \sigma_d \cdot \eta_{d,t+1}$$

$$E_t[r_{d,t+1}] = C_0 + C_1 \cdot x_{c,t} + C_2 \cdot x_{\pi,t}$$

Proof:

$$r_{d,t+1} = \kappa_0^d + \kappa_1^d \cdot pd_{t+1} + \Delta d_{t+1} - pd_t$$

By previous proposition,

$$pd_t = B_0 + B_1 \cdot x_{c,t} + B_2 \cdot x_{\pi,t}$$

Submit it and we have

$$C_1 = \phi + (\kappa_1^d \rho_c - 1)B_1, \quad C_2 = \kappa_1^d \rho_{c\pi} B_1 + (\kappa_1^d \rho_\pi - 1)B_2$$

Q.E.D.