Subjective Cash Flow and Discount Rate Expectations

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ABSTRACT

Why do stock prices vary? Using survey forecasts, we find that cash flow growth expectations explain most movements in the S&P 500 price-dividend and price-earnings ratios, accounting for at least 93% and 63% of their variation. These expectations comove strongly with price ratios, even when price ratios do not predict future cash flow growth. In comparison, return expectations have low volatility and small comovement with price ratios. Short-term, rather than long-term, expectations account for most price ratio variation. We propose an asset pricing model with beliefs about earnings growth reversal that accurately replicates these cash flow growth expectations and dynamics.

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A central question in finance is what drives stock price movements. Specifically, we want to know what explains the large movements in the aggregate price-dividend ratio, a measure of how cheap or expensive stocks are at a given time. Based on the present value approach, for any investor that prices the stock, the stock’s price should equal her expected discounted value of future dividends. This is true regardless if her expectations match an objective probability distribution or if they come from a subjective distribution. Price changes should therefore be due to changes in her dividend expectations or her return expectations, and changes in the price-dividend ratio should be due to changes in her dividend growth expectations or return expectations.

The challenge is determining the expectations of market participants. If investors have rational expectations, then we can infer the importance of dividend growth and return expectations from the realized data. Regressions using historical price and dividend data for the S&P 500 index have shown that a high price-dividend ratio is typically followed by low future returns, not high future dividend growth (e.g. Campbell and Shiller (1988a); Cochrane (2008, 2010)). This result has motivated many models where price movements are driven by agents’ time-varying expected returns, such as habit formation, stochastic volatility, and time variation in disaster probabilities. Many of these models assign little or no importance to fluctuations in expected dividend growth for explaining price movements.

Rather than assuming rational expectations, this paper uses survey forecasts to measure investors’ subjective expectations of dividend growth and returns for the S&P 500 index. Using these subjective expectations and the Campbell and Shiller (1988b) variance decomposition, we estimate how much of the variation in the price-dividend ratio comes from changes in dividend growth expectations versus return expectations. We then perform the same exercise for the price-earnings ratio using earnings growth expectations from the survey data. We estimate that dividend growth expectations explain at least 93% of the variation in the price-dividend ratio and earnings growth expectations explain at least 63% of the variation in the price-earnings ratio. Based on these results, we construct a model of expectations formation that accurately replicates these subjective expectations and generates price ratios that are primarily explained by movements in cash flow growth expectations, rather than movements in return expectations.

We use data from several surveys to measure subjective cash flow growth and return expectations. For both dividends and earnings, cash flow growth expectations vary substan-
tially over time and positively comove with price ratios, even when price ratios do not predict future cash flow growth. In comparison, return expectations across multiple surveys have relatively low volatility over time and limited comovement with either the price-dividend or price-earnings ratio. We construct quarterly one-year and two-year subjective expectations of S&P 500 dividends and earnings from the Thomson Reuters I/B/E/S Estimates Database by aggregating analyst forecasts for individual firms in the S&P 500. The one-year and two-year dividend forecasts are available from 2003 onwards, and the one-year and two-year earnings forecasts are available from 1976 and 1985 onwards, respectively. We measure one-year and ten-year return expectations for the S&P 500 from the quarterly Graham-Harvey Global Business Outlook Survey, which surveys CFO’s of major US corporations. We also collect additional surveys of return expectations that go back as far as 1952.

The variance decompositions for both price ratios show three key results: a large contribution from cash flow growth expectations, a negligible contribution from return expectations, and a dominance of short-term expectations. Cash flow growth expectations vary significantly over time and are high when the price ratios are high, so most price ratio movements can be explained by investors expecting higher or lower future cash flows. Return expectations have much lower volatility which means price ratio movements are not explained by changes in discount rates. If anything, return expectations slightly rise when price ratios are high, which means discount rates somewhat dampen the movements in the price ratios. Lastly, we find that movements in both price ratios are largely explained by changes in short-term cash flow growth expectations, with one-year dividend growth expectations accounting for 39% of the variation in the price-dividend ratio from 2003 to 2015 and one-year earnings growth expectations accounting for 42% of the variation in the price-earnings ratio for 1976 to 2015.

To quantify the entire contribution of cash flow growth and return expectations, we estimate a simple decay functional form for the long-term expectations. Longer horizon subjective expectations show that investors do not believe that changes in short-term cash flow growth or returns will be persistent. Changes in short-term subjective expectations are only associated with small changes in longer horizon subjective expectations and the comovement between subjective expectations and price ratios is primarily concentrated in short-term expectations.

To provide a theoretical benchmark for the three key results of these decompositions, we
calculate the variance decompositions in four leading models from different branches of the asset pricing literature. We focus on the external habit formation model of Campbell and Cochrane (1999), the long-run risk model of Bansal, Kiku, and Yaron (2012), the parameter learning model of Collin-Dufresne, Johannes, and Lochstoer (2016) and the return extrapolation model of Barberis et al. (2015). Both the external habit formation model and the learning model generate a zero or very small contribution from cash flow growth expectations for explaining price-dividend ratio variation and the return extrapolation model generates a negative contribution. In the long-run risk model, cash flow growth expectations do explain some of the price-dividend ratio variation, however, return expectations still explain the majority of the variation.

These results illustrate the challenges of reconciling the large variation in subjective cash flow growth expectations with standard asset pricing models. We propose a simple asset pricing model that is able to replicate the subjective cash flow growth expectations from the survey data and match relevant moments from the joint dynamics of asset prices and subjective expectations. In the model, agents believe that shocks to earnings will be partially transitory, which means that changes in earnings growth will be partially reversed by future earnings growth, and believe that changes in earnings will be gradually incorporated into dividends. Agents’ discount rates are based on consumption growth, which is only weakly related to dividend growth, resulting in low volatility for agents’ return expectations and allowing for a closed-form solution for price ratios. We refer to this as the Earnings Growth Reversal (EGR) model.

The model is calibrated using three parameters from the joint distribution of the survey expectations. We do not use any information about the observed price ratios. The model succeeds in several dimensions. First, the model matches the variance decompositions documented in the paper. Second, the model is able to closely reproduce both the subjective earnings growth and dividend growth expectations time series. Third, in addition to the covariance between expectations and price ratios measured in the decompositions, the model also matches the comovement between short horizon and longer horizon subjective expectations and the autocorrelations and volatilities for price ratios and realized returns. Fourth, model cash flow growth expectations rise with price ratios, even when price ratios do not predict realized future cash flow growth, meaning that forecast errors may be predictable by price ratios. The predictability of these forecast errors varies over time in the data and the
model accurately replicates this finding. Finally, the model reconciles our findings with two important findings from the return extrapolation literature.\(^1\)

We then perform robustness checks on our main results. First, we generalize our decompositions so that they require no assumptions about dividend growth, earnings growth, or return expectations. This is done by removing the no-bubble condition, allowing for the possibility that investors believe the price-dividend ratio or price-earnings ratio will explode to infinity or collapse to 0. We also estimate an exact decomposition for the price-earnings ratio rather than the simplified decomposition used in earlier sections. These extensions have no effect on our estimates of how much of the price ratio variation is explained by subjective cash flow growth expectations. Second, we show that our results do not depend on our estimated decay functional form for long horizon expectations. We calculate an extended decomposition exclusively using the directly measured cash flow growth and return expectations. The first two years of cash flow growth expectations can account for 65% and 64% of the movements in the price-dividend ratio and price-earnings ratio, respectively. So, we do not need to estimate long horizon expectations in order to conclude that cash flow growth expectations account for the majority of price ratio movements. Third, we show that our results are robust to the alternative decomposition introduced by Campbell (1991) that uses changes in dividend growth expectations and return expectations to explain unexpected returns, rather than price ratios. Changes in dividend growth expectations explain 96% of the variation in unexpected returns while changes in return expectations only explain 2%.

Our paper contributes to a growing literature that uses surveys of expectations, rather than statistical expectations based on regressions, to understand aggregate asset price movements. This literature has typically focused on expectations of aggregate returns for the stock market and other asset classes (Greenwood and Shleifer (2014); Piazzesi, Salomao, and Schneider (2015); Koijen, Schmeling, and Vrugt (2015)) and how these expectations relate to current market conditions and future realized returns. We similarly use expectations of aggregate stock market returns, but importantly, also construct measures of aggregate cash flow growth expectations. Through the three key results from the decompositions and the success of the proposed model, we show that these cash flow growth expectations have

\(^1\)In the model, return expectations are more correlated with current returns than with future returns, as documented by Greenwood and Shleifer (2014), and the ability of the price-dividend ratio to predict future returns is stronger when return expectations are more related to recent returns than earlier returns, as Cassella and Gulen (2018) find.
significant potential for explaining stock market volatility. Because of this, our paper is also connected to the literature challenging the irrelevance of expected cash flow growth and the dominance of expected returns in driving price ratios. Several papers (Ang (2012); Koijen and Van Nieuwerburgh (2011); Larrain and Yogo (2008)) argue that sample selection and changing the definition of cash flows (e.g. reinvesting dividends in a particular way, including payments to bondholders) could lead to results were realized future cash growth has nontrivial significance. Our paper sticks to the standard definitions of dividend growth and earnings growth and shows that expectations of standard cash flow growth, in particular short-term cash flow growth, are the main driver of price ratio movements when expectations are measured from the survey data.

Recent theoretical models (e.g. Barberis et al. (2015); Adam, Marcet, and Beutel (2017)) have been proposed to reconcile survey data on expectations with price volatility. With some exceptions (for example, Bordalo et al. (2017)), these papers have primarily focused on explaining the behavior of subjective return expectations. The main force driving price ratio movements in these models is typically expectations of future price growth. Consistent with these models, high price ratios in our data are not explained by lower discount rates because agents report slightly higher expected returns when price ratios are high. Our paper adds to this literature by creating measures of subjective cash flow growth expectations and showing that expectations of future cash flow growth, rather than expectations of future price growth, account for the vast majority of price ratio movements. Jin and Sui (2018) show how this stylized fact can be accounted for by beliefs that extrapolate returns. In their model, agents form their cash flow growth expectations based on their expectations of future price-dividend ratios and their expectations of future returns, which allows return expectations to play an important role in asset price movements via their effect on cash flow growth expectations. We also contribute to the theoretical literature by proposing a

2Chen, Da, and Zhao (2013) also cast doubt on the importance of return expectations in moving prices using firm-level earnings expectations data. Their objects of study are different from the traditional cash flow growth and return decomposition in the existing literature, as they decompose prices into the implied cost of equity capital, which they treat as a measure of discount rates, and a residual measure of cash flows. They show that the implied cost of equity capital cannot explain the majority of price movements.

3This importance of short-term expectations is consistent with Van Binsbergen, Brandt, and Koijen (2012) who construct dividend strip prices and conclude that excess volatility in the aggregate stock market can be largely explained by excess volatility in short-term dividend strip prices.

4See Barsky and DeLong (1993); Barberis, Shleifer, and Vishny (1998) for examples of models that focus on cash flow expectations.
model of subjective expectation formation focused on earnings growth reversal that is able to replicate this stylized fact and our other main findings on cash flow growth expectations and generates return expectations consistent with the findings of the return extrapolation literature.

Overall, our paper shows three salient patterns in subjective expectations that should be used to compare the predictions of asset pricing models. First, investors report significant time-varying subjective cash flow growth expectations that positively comove with price ratios, or in other words, changes in subjective cash growth expectations must be important for price determination. Second, subjective return expectations have low volatility and consequently have little comovement with price ratios. Relative to subjective cash flow growth expectations, subjective return expectations do not have quantitatively important direct effects on price ratios. If subjective return expectations play a large role in driving prices, it must be through their effect on subjective cash flow growth expectations. Third, changes in short-term subjective cash flow growth expectations are only associated with small changes in long-term subjective cash flow growth expectations, implying that investors believe changes will not be persistent. The first and second patterns will pose a challenge for most rational expectations models since price ratios are generally more informative about realized future returns than realized future cash flow growth in the historical data. The third pattern can guide quantitative models of long-run risk or learning where shocks cause agents to update both their short-term and long-term expectations. We then present a new model based on these three patterns and show its potential in explaining asset price movements.

The sections are organized as follows. Section I introduces the Campbell-Shiller decomposition and discusses our approach in light of its current treatment in the literature. Sections II and III describe the data construction and explore the key characteristics of the short-term subjective expectations. Section IV calculates the role of cash flow growth and return expectations in explaining movements in the price ratios. Section V tests four leading asset pricing models, then presents the EGR model and discusses its results. Section VI

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Further, under rational expectations, cash flow growth expectations cannot be more volatile than return expectations over long samples. This is because the price ratios do not significantly comove with realized future cash flow growth in most periods. Any information that raises cash flow growth expectations must also raise return expectations by an equal amount, otherwise price ratios would rise and there would be comovement between the price ratios and realized future cash flow growth. We thank John Cochrane for making this point.
covers robustness checks on our main findings. Section VII concludes.

I. Decomposing Price Movements

Movements in the S&P 500 index must reflect changes in expected future dividends or changes in discount rates. A stock’s price is the discounted value of future dividends, which means the value of the S&P 500 is the discounted value of future dividends paid by the constituent firms. In this section, we first focus directly on the expected future dividends and discount rates. The majority of S&P 500 firms pay dividends. By market value, the dividend paying firms represent 80-90% of the entire index, and dividends are the main method by which S&P 500 firms make cash distributions to their shareholders.\(^6\) We then use the payout ratio, which is the ratio of dividends to earnings, to express changes in prices as changes in expected future earnings, discount rates, or expected future payout ratios.

A. Theory

This section describes the variance decompositions used for the price-dividend and price-earnings ratios of the S&P 500 index. Throughout the paper, we will use the notation \(O^∗\) to denote when an operator such as expected value, covariance, or variance uses the subjective probability distribution, and will use \(O\) when the operator uses the statistical distribution as measured by an econometrician. For example, \(E^∗[\cdot]\) will represent the subjective expectation of a variable, while \(\text{Cov} (\cdot, \cdot)\) represents the statistical covariance of the variables.

We start with the one-year return identity

\[
R_{t+1} = \frac{P_{t+1} + D_{t+1}}{P_t} = \frac{(\frac{P_{t+1}}{D_{t+1}} + 1)}{\frac{P_t}{D_t}} \frac{D_{t+1}}{D_t},
\]

where \(P_t\) and \(D_t\) represent the current price and dividends of the index. Because we are using the aggregate S&P 500, dividends are always positive even if some individual firms are not paying dividends. Log-linearizing around a long-term average of \(P/D\), we can state the price-dividend ratio \(pd_t\) in terms of future dividend growth, \(\Delta d_{t+1}\), future returns, \(r_{t+1}\), and

\(^6\)Dividends represent 80% of total payouts made by S&P 500 firms over 2003 to 2015, where total payouts are measured as dividends plus share repurchases minus share issuance. In earlier samples, dividends are an even higher portion of total payouts.
the future price-dividend ratio, \( pd_{t+1} \), all in logs:

\[
pd_t = \kappa + \Delta d_{t+1} - r_{t+1} + \rho pd_{t+1},
\]

where \( \kappa \) is a constant, \( \rho = e^{\bar{pd}} / (1 + e^{\bar{pd}}) < 1 \) and \( \bar{pd} \) is the mean value of the log price-dividend ratio. By further imposing a no-bubble condition, \( \lim_{T \to \infty} \rho^T E_t^* [pd_{t+T}] = 0 \), we can iterate this equation and apply subjective expectations to write the price-dividend ratio as the sum of a constant plus two main factors,

\[
pd_t = \frac{1}{1 - \rho} \kappa + \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [\Delta d_{t+j}] - \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [r_{t+j}].
\]

Note that these subjective expectations do not need to be rational. Given any set of dividend growth and return expectations, equation (2) will hold as long as \( \lim_{T \to \infty} \rho^T E_t^* [pd_{t+T}] = 0 \) is satisfied, (i.e. investors’ return and dividend growth expectations don’t imply that the price-dividend ratio is expected to explode to positive or negative infinity). In Section VI.A, we relax this no-bubble condition and explicitly allow for a non-zero limit term.

This equation directly shows that an increase in the price-dividend ratio must be due to higher subjective dividend growth expectations or lower subjective return expectations. While equation (2) holds without expectations, applying expectations makes all components known at time \( t \). This allows us to see what drives the change in the price-dividend ratio (i.e. did prices rise because investors are optimistic about future dividends or because they are expecting lower returns).

To measure the relative importance of subjective dividend growth expectations and subjective return expectations for explaining price movements, we separate the variance of the price-dividend ratio into its covariance with subjective expected dividend growth and its covariance with subjective expected returns to get the following decomposition:

\[
1 = \frac{Cov \left( \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [\Delta d_{t+j}], pd_t \right)}{Var(pd_t)} + \frac{Cov \left( -\sum_{j=1}^{\infty} \rho^{j-1} E_t^* [r_{t+j}], pd_t \right)}{Var(pd_t)}.
\]

The two terms represent the fraction of the variance of the price-dividend ratio that is explained by changes in subjective expected dividend growth and the fraction that is explained by changes in subjective expected returns. This is the standard Campbell-Shiller decomposition. These two terms will then tell us whether price changes are primarily explained by
changes in cash flow growth expectations (dividend growth expectations) or changes in discount rates (return expectations). They will be referred to as cash flow news and discount rate news.

Our subjective dividend expectations data starts in 2003Q1, but the subjective earnings expectations go as far back to 1976Q1. Because of this, we also use a separate decomposition for the price-earnings ratio that doesn’t require the use of subjective dividend expectations or assumptions about subjective expectations of future price-dividend ratios. Using the log payout ratio $de_t$, we can insert the identity $pe_t = pd_t + de_t$ into (1) to obtain:

$$pe_t = \kappa + \Delta e_{t+1} - r_{t+1} + (1 - \rho) de_{t+1} + \rho pe_{t+1}.$$  \hspace{0.5cm} (4)

Just as with dividends, we do not need to worry about very small or negative values for earnings because we are using the earnings for the entire S&P 500 index. Since $1 - \rho$ is close to 0, movements in the future payout ratio do not play a large role in explaining movements in the price-earnings ratio. We ignore these movements for the majority of the paper and use the following approximation for $pe_t$:

$$pe_t \approx \tilde{\kappa} + \Delta e_{t+1} - r_{t+1} + \rho pe_{t+1},$$

$$\approx \frac{1}{1 - \rho} \tilde{\kappa} + \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [\Delta e_{t+j}] - \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [r_{t+j}],$$

(6)

where $\tilde{\kappa} = \kappa + (1 - \rho) \bar{de}$ and $\bar{de}$ is the mean log payout ratio. The second equation requires the no-bubble condition $\lim_{T \to \infty} \rho^T E_t^* [pe_{t+T}] = 0$, which is relaxed in Section VI.A. We now have a decomposition of $pe_t$ analogous to (3) that doesn’t require dividend expectations,

$$1 \approx \frac{ Cov \left( \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [\Delta e_{t+j}], pe_t \right) }{ Var(pe_t) } + \frac{ Cov \left( -\sum_{j=1}^{\infty} \rho^{j-1} E_t^* [r_{t+j}], pe_t \right) }{ Var(pe_t) }.$$  \hspace{0.5cm} (7)

Movements in the price-earnings ratio must primarily come from changes in subjective cash flow growth expectations (subjective earnings growth expectations) or changes in discount rates (subjective return expectations). In Section VI.C, we estimate the exact decomposition for $pe_t$ by including subjective expectations of future payout ratios and show that our results

7There is another useful decomposition from Campbell (1991) that measures the importance of cash flow growth expectations and return expectations for explaining unexpected returns, rather than price-dividend ratio movements. We estimate this decomposition in Section VI.C and find that the results are remarkably similar to our results for the price-dividend ratio decomposition.
are virtually unchanged.

**B. Estimation**

It is important to note that when these decompositions are estimated in the data, they do not measure causal relationships. Despite this, these decompositions are still useful for diagnosing the possible sources of price ratio variation. For example, a large estimate for cash flow news means that whatever shock is responsible for price ratio variation must have a larger impact on subjective cash flow growth expectations than subjective return expectations. While direct shocks to investors’ subjective cash flow growth expectations would be the simplest type of shock that meets this criterion, other shocks could also generate large cash flow news so long as they primarily impact subjective cash flow growth expectations.\(^8\)

There are two possible approaches to empirically estimate these decompositions. A common approach in the literature is to assume agents have rational expectations and statistically infer the expectations from historical dividend, earnings, and price data. These *statistical expectations*, \(E[\cdot]\), satisfy the property \(\text{Cov}(\sum_{j=1}^{T} E_t[\Delta d_{t+j}], pd_t) = \text{Cov}(\sum_{j=1}^{T} \Delta d_{t+j}, pd_t)\) for every horizon \(T\) as long as the price-dividend ratio is used in the inference. Consequently, the component of expected dividend growth can be approximated by \(\frac{\text{Cov}(\sum_{j=1}^{T} \rho_t^{j-1} \Delta d_{t+j}, pd_t)}{\text{Var}(pd_t)}\), which under stationarity is just the OLS coefficient of a simple regression of future dividend growth on \(pd_t\). Similarly, we can obtain the contribution of expected returns by regressing future returns on \(pd_t\) and can repeat this procedure for the price-earnings ratio using future earnings growth and returns.

Findings by Campbell and Shiller (1988b); Fama and French (1988); Cochrane (2008) and others suggest that the contribution of future dividend growth is virtually zero and all price-dividend ratio movements must be explained by future returns. Since the price-dividend ratio does not covary with observed future dividend growth, many economic models assume dividend growth expectations are constant or unimportant for stock market volatility and that time-varying risk premia are the primary factor driving prices in the economy.\(^9\)

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\(^8\)For example, Jin and Sui (2018) show how changes in sentiment in a return extrapolation model can have a much larger impact on subjective cash flow growth expectations than subjective return expectations, meaning that cash flow news is large in their model.

\(^9\)Even models that incorporate time-varying cash flow growth, such as Bansal and Yaron (2004), typically focus on how cash flow risk affects the risk premia demanded by investors by making cash flows correlated with investors’ consumption.
bell and Shiller (2001); Lewellen (2004); Maio and Xu (2018) find that a similar result holds for the price-earnings ratio, where changes in the price-earnings ratio are mainly explained by changes in future returns, rather than changes in future earnings growth.

There is a second approach to measure the importance of cash flow growth expectations versus return expectations. Rather than inferring the statistical expectations, we can directly measure the expectations held by investors at each point in time. We use forecast surveys to construct robust measures of dividend growth, earnings growth, and return expectations at different horizons. With these direct measures of subjective expectations, $E^*[\cdot]$, we revisit the relative importance of cash flow growth expectations and return expectations for explaining price ratio movements. This way, we can re-evaluate if the current models of time-varying risk premia and constant cash flow growth expectations align with actual investor expectations or if more focus should be placed on modeling agents with large time-varying cash flow growth expectations.

Table I shows the key features of these subjective expectations. We use subjective expectations of average annual dividend growth, earnings growth, and returns for the S&P 500 for different horizons. In Panels A and B, we see that subjective dividend growth and earnings growth expectations have high standard deviations, meaning there is significant time-variation in investors’ cash flow growth expectations. Importantly, subjective dividend growth expectations and subjective earnings growth expectations also have large comovements with the price-dividend ratio and price-earnings ratio. In fact, just the movement in the one-year subjective dividend growth expectations accounts for 39% of the variation in the price-dividend ratio, and the movement in one-year subjective earnings growth expectations accounts for 42% of the variation in the price-earnings ratio. The two-year annual dividend growth and earnings growth expectations also have large comovements with price ratios, implying that subjective expectations of total dividend growth and earnings growth over the next two years can explain the majority of price-dividend ratio and price-earnings ratio variation.

In contrast, Panel C shows that all five measures of subjective return expectations have low standard deviations compared to the dividend growth and earnings growth expectations. Further, none of the subjective return expectations have large comovements with the price-dividend ratio or the price-earnings ratio. Even the relatively higher standard deviation of the Livingston survey does not translate into a high comovement with the price ratios. This
implies that these subjective return expectations do not account for much of the variation in the price-dividend or price-earnings ratios.

In Section IV, we will formally estimate the portions of price-dividend ratio variation and price-earnings ratio variation that are explained by subjective dividend growth, earnings growth, and return expectations. This will include accounting for the powers of \( \rho \) coefficients in the decompositions and estimating long horizon expectations. However, Table I already indicates that subjective return expectations are unlikely to explain much of the variation in the price ratios, given that none of the subjective return expectations comove substantially with the price-dividend ratio or price-earnings ratio. Instead, the cash flow growth expectations are much more promising candidates for explaining price ratio variation as they have high variation over time and large comovements with the price ratios. This large role for subjective cash flow growth expectations and small role for subjective return expectations is consistent across different samples and forecast horizons. Because the results are similar for all the return surveys, we will primarily focus on the Graham-Harvey survey as it provides subjective return expectations for two different horizons, one-year and ten-year, and aligns well with the sample for the subjective dividend growth expectations.

II. Data and Variable Construction

In this section, we explain the data sources used for our main calculations and the construction process to build expectations for aggregate dividend growth, earnings growth and returns.

A. S&P 500 Index

From Compustat, we create a list of all companies in the S&P 500 at the end of each quarter and record their price, dividends and earnings per share together with their number of outstanding shares. We calculate a quarterly dividend measure for the index by aggregating the total ordinary dividends paid by each company and adjusting them by the S&P 500 index divisor. Similarly, we calculate an aggregate earnings measure by summing over the total earnings reported by each firm and adjusting them by the same S&P 500 divisor. We build the S&P 500 index divisor by taking the total market capitalization of the S&P 500
Table I

Comovement of subjective expectations and price ratios


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<tr>
<th>Panel A: Dividend Growth</th>
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<tbody>
<tr>
<td>Survey</td>
<td>Horizon (years)</td>
<td>Sample</td>
<td>Std. Dev.</td>
<td>$\frac{Cov(-pd_t)}{Var(pd_t)}$</td>
</tr>
<tr>
<td>IBES</td>
<td>1</td>
<td>2003-2015</td>
<td>8.1%</td>
<td>0.39 (0.03)</td>
</tr>
<tr>
<td>IBES</td>
<td>2</td>
<td>2003-2015</td>
<td>7.3%</td>
<td>0.33 (0.06)</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Panel B: Earnings Growth</th>
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<tbody>
<tr>
<td>IBES</td>
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<tr>
<td>IBES</td>
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<th>Panel C: Returns</th>
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<tbody>
<tr>
<td>G-H</td>
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<tr>
<td>Livingston</td>
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<td>Michigan</td>
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<tr>
<td>G-H</td>
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companies and dividing by the S&P 500 index at the end of each quarter.

**B. Subjective Cash Flow Expectations**

We construct cash flow expectations for the S&P 500 using the Summary Statistics of the Thomson Reuters I/B/E/S Estimates Database. I/B/E/S is a comprehensive forecast database containing analyst estimates for more than 20 forecast measures - including DPS (dividends per share) since 2003 and EPS (earnings per share) since 1976. The Summary Statistics contains the median forecasts on different horizons for U.S. publicly traded companies.\(^\text{10}\) We build measures of aggregate dividend and earnings expectations using the constituents of the S&P 500 at each point in time. This procedure is analogous to the process in which the S&P 500 index is calculated and is explicitly derived in Appendix.

It is important to note that Thomson Reuters gathers their forecasts from hundreds of brokerage and independent analysts who track companies as part of their investment research work. Each individual estimate is identified by the name of the analyst or brokerage firm. Because the forecasts are not anonymous, analysts have a strong incentive to accurately report their expectations.\(^\text{11}\) Previous literature has found evidence that accuracy in earnings forecasts is important for tenure and compensation (Mikhail and Willis (1999); Cooper, Day, and Lewis (2001)). Furthermore, research on the I/B/E/S Estimates Database suggests that financial firms’ trades are consistent with their own analysts’ forecasts and recommendations, which adds to the evidence that the reported forecasts genuinely reflect the beliefs of the firms.\(^\text{12}\)

Two features of the data must be dealt with in order to calculate aggregate expectations. To calculate dividend growth expectation, we first note that the I/B/E/S database contains DPS forecasts for up to five Annual Fiscal Periods (FY1-FY5), four Quarter Fiscal Periods (Q1-Q4) and a Long-Term Growth measure. Because not all companies have the same fiscal year end, we interpolate across the different horizons to obtain a precise expectation over the next twelve months following the response of the analyst. For example, if the fiscal year of

\(^{10}\)Using the mean forecasts does not change the results in any noticeable way.

\(^{11}\)In Section III.A we confirm that short-term cash flow expectations indeed have predictive power, and in the Online Appendix we discuss the possibility that the analysts responses reflect risk-neutral expectations.

\(^{12}\)Bradshaw (2004) shows that individual earnings forecasts are correlated to Buy/Sell recommendations, while Chan, Chang, and Wang (2009) show that financial firms’ own stock holding changes are significantly positively related to recommendation changes.
Firm A ends 9 months after the survey date, we may only have available a 9-month dividend expectation and a 21-month dividend expectation for that firm. We interpolate these two measures in order to ensure that every expectation is exactly twelve months ahead. We use an analogous procedure to construct two-year expectations. The second feature of the data is that I/B/E/S estimates are not available for all S&P 500 companies. We calculate the aggregate dividend expectation of those companies in the S&P 500 with available forecasts and multiply it by the ratio of total S&P 500 market value to the market value of the forecasted companies. The assumption behind this normalization is that the forecasted companies are a representative sample of the S&P 500. We follow the same procedure to calculate aggregate earnings expectations. We test the representativeness assumption for both dividends and earnings in Table II and in the Appendix and find that it holds quite well. The Appendix gives more detail on our methodology. I/B/E/S collects dividend forecasts since 2003 and earnings forecasts since 1976. Thus, we are able to construct one-year and two-year dividend expectations for the range 2003Q1 to 2015Q3. Since earnings forecasts for longer horizons were only available after 1985, we construct one-year earnings expectations for 1976Q1 to 2015Q3 and two-year earnings expectations for 1985Q1 to 2015Q3.

Since we cannot know the expected cash flows for those companies that do not report forecasts, we test our methodology using realized cash flows. Table II shows tests of our methodology applied to the construction of one-year dividend expectations. We construct aggregate realized dividends using the same method applied to subjective expected dividends. The first three columns of Table II give the correlation of our aggregate dividend measure with Robert Shiller’s S&P 500 dividend and the dividend for SPY, a popular S&P 500 replicating ETF. The first dividend measure is our aggregate dividend using all companies in the S&P 500. The high correlation of this measure with Shiller and SPY dividends shows that our aggregation technique is accurate. The second measure is identical to the first, except it only uses companies for which we have a one-year subjective dividend expectation and is scaled by the ratio of total S&P 500 market value to total forecasted companies market value. The high correlation between the first two measures shows that the forecasted companies are representative of the entire set of constituents.

The second set of columns in Table II show the correlation of dividend growth for each of the four measures. As before, the high correlation between All Companies dividend growth and Forecasted Companies dividend growth shows that the reporting companies are
Table II.

Correlations of S&P 500 dividend measures
This table shows the correlations for four quarterly time series spanning 2003Q1 to 2015Q3. All Companies contains the aggregate quarterly dividends paid out by all S&P 500 companies. Forecasted contains the aggregate quarterly dividends paid out only by S&P 500 companies for which a one-year subjective dividend expectation exists. Shiller contains the quarterly S&P 500 dividends obtained from Shiller (2015). SPY contains the quarterly dividends paid out by the SPDR S&P 500 ETF. Under the Levels columns, we calculate the correlation of the four series. Under the Growth columns, we calculate the log annual change of each of the four series and then take the correlations.

<table>
<thead>
<tr>
<th></th>
<th>Levels</th>
<th></th>
<th></th>
<th></th>
<th>Growth</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forecasted</td>
<td>0.996</td>
<td>0.995</td>
<td>0.994</td>
<td>0.974</td>
<td>0.937</td>
<td>0.928</td>
<td>0.963</td>
</tr>
<tr>
<td>All Companies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forecasted</td>
<td>0.995</td>
<td>0.993</td>
<td>0.901</td>
<td>0.892</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shiller</td>
<td>0.997</td>
<td>0.997</td>
<td>0.963</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a representative subset. The high correlation of these two measures with Shiller and SPY dividend growth shows that our dividend aggregation procedure is accurate. The Appendix shows the equivalent tests performed on the construction of earnings expectations, which gives similar results.

C. Subjective Return Expectations

Our main measure of subjective return expectations is taken from a survey conducted by John Graham and Campbell Harvey of Duke University’s Fuqua School of Business. The survey is completed quarterly by 200 to 500 chief financial officers (CFO’s) of major U.S. corporations. Among other things, the survey solicits CFO views about the U.S. economy. In particular, they report their expectations of returns on the S&P 500 index over the next twelve months and their expectations of the average annual returns over the next ten years. The sample includes CFO’s from both public and private companies representing a broad range of industries, geographic areas and sizes. The data is available from the third quarter of 2000 onwards.
We choose the Graham-Harvey survey as our main source for return expectations because it provides both short-term and long-term return forecasts and aligns with our dividend forecast sample. The different sampling periods, methodology and population targets of the other surveys of return expectations shown in Table I makes them excellent measures of external validation for our main results. A more detailed description of the additional surveys is available in the Appendix.

III. Short-Term Subjective Expectations

In this section, we take a first look at the data and the main properties of the short-term subjective expectations. For both dividends and earnings, one-year subjective cash flow growth expectations are volatile and significantly correlated with future realized cash flows. In comparison, one-year subjective return expectations have relatively low volatility and a weak negative correlation with future realized returns. Despite the significant correlation between subjective cash flow growth expectations and future realized cash flow growth, subjective cash flow growth expectations are not fully rational. Investors make predictable forecast errors because their subjective cash flow growth expectations comove positively with price ratios while price ratios generally do not predict future cash flow growth.

A. Characteristics of Subjective Expectations

We know from Section I that the large variation in the observed price ratios means that there must be large time variation in either the cash flow growth expectations or the return expectations. Figure 1 shows that one-year dividend growth expectations, denoted as \( E_t^* [\Delta d_{t+1}] \), have similar volatility to that of realized future one-year dividend growth and track it quite well. Dividend growth expectations have a standard deviation of 8.1% and are strongly correlated with realized future dividend growth (a correlation of 0.74).\(^{13}\) The accuracy of the dividend growth expectations is one more piece of evidence that investors are making an effort in reporting their true expectations through these dividend forecasts.

\(^{13}\)At first sight, one may think that the high correlation between \( E_t^* [\Delta d_{t+1}] \) and \( \Delta d_{t+1} \) may be due to high persistence in the dividend growth process. However, the correlation between \( E_t^* [\Delta d_{t+1}] \) and \( \Delta d_t \), though positive, is noticeably lower (0.29) than corr(\( E_t^* [\Delta d_{t+1}] \), \( \Delta d_{t+1} \)), suggesting there is an important component of the prediction that is unexplained by current dividend growth.
**Figure 1. Expected and realized one-year dividend growth.** The figure compares the one-year subjective dividend growth expectation and the realized future one-year dividend growth of the S&P 500. The solid line is the one-year subjective dividend growth expectation based on survey data. The dotted line is the realized future one-year dividend growth.

Figure 2 shows the one-year earnings growth expectations and the realized future one-year earnings growth. Earnings growth expectations are also highly volatile with a standard deviation of 28%. Although the large recovery after the recent financial crisis is the main episode of volatility, earnings growth expectations are still volatile outside the recession. Earnings growth expectations typically fail to predict the change in earnings during busts, but they do tend to predict recoveries and track future earnings growth reasonably well during normal times. During the recent financial crisis, earnings fell several quarters before dividends fell, which may explain why investors did not foresee the drop in earnings growth but did predict the subsequent drop in dividend growth. Despite their inability to predict busts, the correlation of earnings growth expectations with realized future earnings growth is significant and relatively high at 0.33 for 1976 to 2002, 0.59 for 2003 to 2015, and 0.48 for the full sample 1976 to 2015.

The behavior of subjective one-year return expectations is shown in Figure 3. On the left-hand side, we show the one-year subjective return expectations along with the one-year subjective dividend growth expectations. Compared to subjective cash flow growth expc-
Figure 2. Expected and realized one-year earnings growth. The figure compares the one-year subjective earnings growth expectation and the realized future one-year earnings growth of the S&P 500. The solid line is the one-year subjective earnings growth expectation based on survey data. The dotted line is the realized future one-year earnings growth.

Subjective return expectations $E_t^*[\Delta r_{t+1}]$ look noticeably less volatile with a standard deviation of just 1.3%. Moreover, subjective return expectations have no clear relationship with future realized returns, with an insignificant correlation of $-0.03$. Greenwood and Shleifer (2014) show that the correlation of return expectations with realized future returns is, if anything, negative and that these expectations are more correlated with past returns.

We can conclude thus far that short-term cash flow growth expectations are significantly more volatile than short-term return expectations. The volatility of dividend growth expectations (8.1%) is 6 times larger than the volatility of return expectations (1.3%), and the volatility of earnings growth expectations is $\sim 17$ times larger. In Section IV we will see that changes in return expectation will not be large enough to account for significant movements in the aggregate price ratios. The standard deviations of the price-dividend ratio (18%) and price-earnings ratio (35%) are simply too large.
Figure 3. Expected and realized one-year returns. The left figure compares the one-year subjective return and dividend growth expectations based on the survey data. The solid line is the one-year subjective return expectation. The dashed line is the one-year subjective dividend growth expectation. The right figure compares the one-year subjective return expectation and the realized future one-year return on the S&P 500. The solid line is the one-year subjective return expectation. The dotted line is realized future one-year return.

B. Predictability of Forecast Errors

From Section I we also recall that high price ratios must be followed either by low returns or by high cash flow growth. The conventional wisdom from the literature is that high price ratios predict lower future returns and do not predict future cash flow growth. If investors have full information rational expectations, their forecast errors for cash flow growth and return expectations should be uncorrelated with prices at time $t$, meaning their return expectations should fall with price ratios and cash flow growth expectations should be uncorrelated with the price ratios. We measure the one-year forecast errors as the realized future values minus the expected values.

Table III shows that dividend growth expectations are strongly positively correlated with the price-dividend ratio ($0.86$). When the price-dividend ratio is high, dividend growth expectations are high. However, we can see in the third column that prices are also positively correlated with future realized dividend growth ($0.70$). This goes against the conventional wisdom drawn from previous samples where the price-dividend ratio did not predict dividend growth. The period of 2003 to 2015 was unusual in the sense that prices did predict divi-
Table III

**Correlation of cash flow growth and price ratios**

This table shows the correlation of price ratios with expected and realized one-year cash flow growth. The first row shows the correlation of the price-dividend ratio with expected one-year dividend growth $E_t[\Delta d_{t+1}^*]$, realized future one-year dividend growth $\Delta d_{t+1}$, and the forecast errors $fe_{t+1}^d = \Delta d_{t+1} - E_t[\Delta d_{t+1}]$. The second through fourth rows show the correlation of the price-earnings ratio with expected one-year earnings growth $E_t[\Delta e_{t+1}^*]$, realized future one-year earnings growth $\Delta e_{t+1}$, and the forecast errors $fe_{t+1}^e = \Delta e_{t+1} - E_t[\Delta e_{t+1}]$ for different samples. All four rows use quarterly data. Small-sample adjusted Newey-West standard errors in parenthesis.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Expected</th>
<th>Realized</th>
<th>Forecast Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Corr (\Delta d_{t+1}, pd_t)$ 2003-2015</td>
<td>0.86</td>
<td>0.70</td>
<td>−0.03</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td>(0.23)</td>
<td>(0.34)</td>
</tr>
<tr>
<td>$Corr (\Delta e_{t+1}, pe_t)$ 2003-2015</td>
<td>0.93</td>
<td>0.61</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.11)</td>
<td>(0.07)</td>
</tr>
<tr>
<td>$Corr (\Delta e_{t+1}, pe_t)$ 1976-2002</td>
<td>0.78</td>
<td>0.14</td>
<td>−0.52</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(0.11)</td>
<td>(0.14)</td>
</tr>
<tr>
<td>$Corr (\Delta e_{t+1}, pe_t)$ 1976-2015</td>
<td>0.77</td>
<td>0.27</td>
<td>−0.30</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(0.18)</td>
<td>(0.10)</td>
</tr>
</tbody>
</table>

dividend growth. For this sample, dividend growth forecast errors turn out to be uncorrelated with the price-dividend ratio. There are two possible explanations for the apparent lack of predictability of dividend growth forecast errors. One possibility is that dividend forecast errors are generally not predictable. Investors understand the relationship between dividend growth and prices. They quickly learned the atypical nature of the period of 2003 to 2015 and reported their expectations accordingly. The second possibility is that dividend forecast errors are only unpredictable for this unusual sample. Investors’ dividend growth expectations are generally correlated with prices, despite the lack of a relationship between the two variables in earlier samples. The period of 2003 to 2015 just happened to be a sample where the relationship did hold and errors appeared unpredictable.

The two explanations could be tested by looking at dividend growth expectations at earlier dates, where prices are not correlated with realized dividend growth. Under the first explanation, we should see that dividend growth expectations are not correlated with prices due to the rationality of investors. Under the second explanation, we should see that even
for earlier dates, expectations are still positively correlated with prices. Unfortunately, there is no data on dividend growth expectations at earlier dates. However, the evidence from earnings growth expectations strongly supports the second story. Over 2003 to 2015, both expected and realized earnings growth are highly correlated with the price-earnings ratio, matching what we find for dividend growth. When we look at the 1976 to 2002 sample, the correlation of realized earnings growth with the price-earnings ratio drops substantially, while the correlation of expected earnings growth and the price-earnings ratio remains high. Over this earlier sample, 1976 to 2002, we see that investors’ forecast errors are significantly correlated with current prices. When prices are high, investors overpredict future earnings growth. It is natural to think that for this earlier period of time, dividend growth expectations are also significantly correlated with prices. The fourth row of Table III shows that the significance of their forecasts errors remains even when we extend the sample to 1976 to 2015. Looking at the second column of Table III, the correlation of subjective cash flow growth expectations with price ratios is strikingly similar across the different samples and the two measures of cash flows, indicating that this high correlation is a consistent feature of the subjective expectations.

Return expectations are positively correlated with the price-dividend ratio (0.65) even though the price-dividend ratio is weakly negatively correlated with future realized returns (−0.20). This means that when prices are high, the return survey respondents consistently overestimate one-year future returns and their forecast errors are negatively correlated with the current price-dividend ratio (−0.25). This positive correlation of subjective return expectations with the price-dividend ratio was also documented in Greenwood and Shleifer (2014). In the next section we will show that the comovement not only has the wrong sign for explaining price ratio variation, but is also very small, particularly when compared to the comovement of cash flow growth expectations with prices ratios. Even if the relationship between subjective return expectations and price ratios was reversed so that expectations fell when price ratios were high, it still would only account for a negligible amount of the price ratio variation.

The content of this section already hints that return expectations will have a harder time explaining price movements than cash flow growth expectations. Cash flow growth expectations are volatile and they significantly correlate with prices, implying that high prices can be explained by high expectations for future cash flows. Return expectations
are much less volatile and positively correlate with prices, meaning that high prices cannot come from low discount rates. In the next section we will confirm this by quantifying the contribution of each type of expectation for explaining price ratio movements.

IV. Decomposition of Price Ratio Volatility

In this section, we decompose the variance of the price-dividend and price-earnings ratios into movements in subjective cash flow growth and return expectations. First, we use one-year subjective expectations to estimate the importance of short-term subjective cash flow growth and return expectations relative to the long-term component. Then, using longer horizon subjective expectations, we estimate the importance of the full horizon subjective cash flow growth expectations relative to the full horizon subjective return expectations. The portion of price ratio movements that is explained by changes in subjective cash flow growth expectations is defined as cash flow news, and the portion that is explained by changes in subjective return expectations is defined as discount rate news.

A. One-year Decomposition

Applying expectations to equation (1), we see that changes in the price-dividend ratio must be explained by changes in one-year dividend growth expectations, one-year return expectations, or expectations of the future price-dividend ratio. This gives the following one-year decomposition,

\[
1 = \frac{Cov(E_t^* [\Delta d_{t+1}], pd_t)}{Var(pd_t)} + \frac{-Cov(E_t^* [r_{t+1}], pd_t)}{Var(pd_t)} + \rho \frac{Cov(E_t^* [pd_{t+1}], pd_t)}{Var(pd_t)}. \tag{8}
\]

Our measures \(CF_1\) and \(DR_1\) capture the influence of one-year subjective dividend growth expectations (cash flow news) and one-year subjective return expectations (discount rate news). The influence of subjective dividend growth and return expectations looking more than one year ahead is all captured in our measure of long-term influence \(LT\). We can directly measure one-year subjective dividend growth and return expectations, while the one-year subjective price-dividend ratio expectation \(E_t^* [pd_{t+1}]\) is inferred from the current price-dividend ratio, one-year subjective dividend growth expectations, and one-year subjective
return expectations.

A useful feature of this decomposition is that the one-year cash flow news and one-year discount rate news are estimated completely separately. There is no concern that subjective return expectations are affecting the estimate of cash flow news or that the subjective dividend growth expectations are affecting the estimate of discount rate news. This separation of the two types of subjective expectations means that these estimates will still be accurate even if the investors answering the return surveys and the investors answering the dividend surveys disagree on their beliefs. If the two groups of investors have different subjective expectations, then LT can simply be interpreted as the portion of the price-dividend ratio variation that is not explained by movements in the first group’s subjective return expectations or the second group’s subjective dividend growth expectations.

In Table IV, we see that one-year cash flow news is large and positive, with one-year subjective dividend growth expectations explaining 39% of the variation in the price-dividend ratio. As discussed in Section III, investors tend to report higher subjective dividend growth expectations during market booms. Because these expectations vary significantly over time, they account for a large portion of the volatility of the price-dividend ratio. One-year dividend growth can have a large effect on prices because it affects the levels of both short-term and long-term dividends. Holding dividend growth fixed for all following years, a 10-percentage point drop in one-year dividend growth means that all future dividends fall by 10%, which causes the price to fall by 10%.

Using equation (5), we can create a similar decomposition for the price-earnings ratio. Changes in the price-earnings ratio must be explained by changes in one-year expected earnings growth, one-year expected returns, or the expected future price-earnings ratio. Similar to the decomposition for the price-dividend ratio, the one-year cash flow news will represent the portion of the price-earnings ratio variance that is explained by one-year subjective earnings growth expectations and one-year discount rate news will represent the portion explained by one-year subjective return expectations. All price-earnings ratio movements that are explained by longer horizon earnings growth or return expectations will be captured by the long-term component. The decomposition is

\[
1 \approx \frac{\text{Cov}(E_t^\star [\Delta e_{t+1}], p_{et})}{\text{Var}(p_{et})} + \frac{-\text{Cov}(E_t^\star [r_{t+1}], p_{et})}{\text{Var}(p_{et})} + \frac{\rho \text{Cov}(E_t^\star [p_{et+1}], p_{et})}{\text{Var}(p_{et})}.
\]  (9)
This table shows the importance of one-year cash flow news ($CF_1$) and one-year discount rate news ($DR_1$) in the price-dividend ratio and price-earnings ratio variance decompositions. For the price-dividend ratio, $CF_1$, $DR_1$, and $LT$ are the coefficients obtained by individual regressions of the one-year dividend growth expectations, the one-year returns expectations, and $\rho$ multiplied by the one-year price-dividend ratio expectations on the current price-dividend ratio. For the price-earnings ratio, $CF_1$, $DR_1$, and $LT$ are the coefficients obtained by individual regressions of the one-year earnings growth expectations, the one-year returns expectations, and $\rho$ multiplied by the one-year price-earnings ratio expectations on the current price-earnings ratio. All rows use quarterly data. Only the earnings growth expectations are available for the longer 1976Q1 to 2015Q3 sample, so only $CF_1$ is estimated in the third row. Small-sample adjusted Newey-West standard errors in parenthesis.

<table>
<thead>
<tr>
<th>Sample</th>
<th>$CF_1$</th>
<th>$DR_1$</th>
<th>$LT$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price-dividend ratio</td>
<td>0.390</td>
<td>-0.049</td>
<td>0.659</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td>(0.013)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>Price-earnings ratio</td>
<td>0.937</td>
<td>-0.004</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>(0.095)</td>
<td>(0.008)</td>
<td>(0.105)</td>
</tr>
<tr>
<td>1976-2015</td>
<td>0.417</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.105)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For the 2003 to 2015 sample, we have subjective earnings growth, dividend growth, and return expectations which allows us to compute all three components. We estimate the cash flow news using the subjective earnings growth expectations and estimate the discount rate news from the subjective return expectations. As with the price-dividend ratio decomposition, this means that cash flow news and discount rate news are estimated completely separately and are still valid even if the investors answering the two surveys have different beliefs. We infer the expected future price-dividend ratio from the current price-dividend ratio, the one-year dividend growth expectations, and the one-year return expectations. Using the expected future price-dividend ratio, the current price-earnings ratio, and the one-year earnings and dividend growth expectations, we then infer the expected future price-earnings ratio and calculate $LT$.

Table IV shows the results of this decomposition. The fact that $CF_1$, $DR_1$, and $LT$ sum almost exactly to one (0.997) shows that our approximation is quite accurate and in Section VI.A we estimate the exact decomposition including expectations of future payout ratios. We
continue to find large, positive cash flow news and small, negative discount rate news. Over the longer 1976 to 2015 sample, one-year subjective earnings growth expectations account for 42% of price-earnings ratio movements, which is similar to the one-year cash flow news for the price-dividend ratio. Just like subjective dividend growth expectations and the price-dividend ratio, subjective earnings growth expectations are high when the price-earnings ratio is high. From Section III, we know that this positive correlation exists even when realized future earnings growth is not correlated with the price-earnings ratio. This high correlation, combined with the high volatility of subjective earnings growth expectations, implies that subjective earnings growth expectations can explain a large portion of price-earnings ratio movements.

In the 2003 to 2015 sample, one-year subjective earnings growth expectations account for virtually all (94%) price-earnings ratio movements. From Table III, we know that the correlation of earnings growth expectations with the price-earnings ratio is quite stable across different samples, so this high value for $CF_1$ is primarily due to higher volatility of earnings growth expectations in this period. Interestingly, the cash flow news for the 2003 to 2015 sample implies that investors believed that changes in the price-earnings ratio would be extremely short-lived over this period, as we can see from the low value of $LT$.

Over the 2003 to 2015 sample, discount rate news only explains $-0.4\%$ of the variation in the price-earnings ratio. While we do not have a return survey that perfectly aligns with the 1976 to 2015 quarterly earnings growth expectations, we can look back to Table I and the Livingston survey, which covers 1952 to 2015 and is reported twice a year. For this measure of subjective one-year return expectations, the covariance of the price-earnings ratio with subjective return expectations is 3% of the total variance of the price-earnings ratio. From equation (9), this means that one-year discount rate news would be $-0.03$. If we only use the Livingston survey for 1976 to 2015, the one-year discount rate news is $-0.02$. Thus, even over long samples, one-year discount rate news remains small and negative.

In Section VI.B, we show that these results for the price-dividend ratio and price-earnings ratio also hold for two-year cash flow news and ten-year discount rate news. Specifically, we show that two-year cash flow news can explain the majority of price-dividend and price-earnings ratio movements, while discount rate news, even out to the ten-year horizon, is small and negative. This can also be seen qualitatively in Table I. Across the different samples and forecast horizons, subjective dividend growth and earnings growth expectations
have large, positive comovement with the price-dividend and price-earnings ratios, while subjective return expectations have small, positive comovement with both price ratios. This produces large, positive cash flow news and small, negative discount rate news.

**B. Full Horizon Decomposition**

This section calculates the full horizon cash flow news and discount rate news for the price-dividend and price-earnings ratios. To start, we focus on the price-dividend ratio. From equation (3), we know that the full horizon cash flow news is

\[ CF = \frac{\text{Cov}(\sum_{j=1}^{\infty} \rho^{j-1} E_t^*[\Delta d_{t+j}], pd_t)}{\text{Var}(pd_t)} \]

and the full horizon discount rate news is

\[ DR = \frac{\text{Cov}(\sum_{j=1}^{\infty} \rho^{j-1} E_t^*[r_{t+j}], pd_t)}{\text{Var}(pd_t)}. \]

In order to calculate this decomposition, we need to estimate the investors’ long horizon subjective dividend growth and return expectations. We use a simple decay model of investor expectations given by

\[ E_t^*[\Delta d_{t+1+j} - \mu_d] = \phi_d^j (E_t^*[\Delta d_{t+1}] - \mu_d) + \varepsilon^d_{t,j} \]

\[ E_t^*[r_{t+1+j} - \mu_r] = \phi_r^j (E_t^*[r_{t+1+j}] - \mu_r) + \varepsilon^r_{t,j}. \]

After the agent forms her one-year expectations, she believes that dividend growth and returns will gradually decay back to their mean values \( \mu_d, \mu_r \) with persistences \( \phi_d, \phi_r \). We choose this form because of its simplicity and the fact that it holds for most standard asset pricing models, due to the fact that stock fundamentals are typically written as AR1 processes. We estimate the persistence of dividend growth using the two-year subjective dividend growth expectations obtained from I/B/E/S. For returns, we use the subjective expected returns for the next 10 years, \( E_t^*[r_{t+1,t+10}] \), and the one-year subjective return expectations to calculate subjective return expectations for years 2 through 10, \( E_t^*[r_{t+2,t+10}] \). We then use this value to estimate the persistence of returns.

With this simple specification, we have a straightforward definition for full horizon cash flow news and discount rate news, \( CF = \frac{1}{1-\rho_d} CF_1 \) and \( DR = \frac{1}{1-\rho_r} DR_1 \). Even if subjective expectations do not follow a simple decay process, this definition of cash flow news and discount rate news will still be correct as long as \( \sum_{j=1}^{\infty} \rho^{j-1} \varepsilon_{t,j}^d \) and \( \sum_{j=1}^{\infty} \rho^{j-1} \varepsilon_{t,j}^r \) are not correlated with the current price-dividend ratio. Using the two-year subjective dividend growth expectations and ten-year subjective return expectations, we do not find any evidence that the error terms are correlated with \( pd_t \). Combining our definitions for \( CF \) and \( DR \) with
(3) gives three equations that determine $\phi_d, \phi_r$:

$$E_t^* [\Delta d_{t+2}] - \mu_d = \phi_d (E_t^* [\Delta d_{t+1}] - \mu_d) + \nu_t^d$$  \hfill (12)

$$E_t^* [r_{t+2,t+10}] - 9\mu_r = \phi_r \frac{1 - \phi_r^0}{1 - \phi_r} (E_t^* [r_{t+1}] - \mu_r) + \nu_t^r$$  \hfill (13)

$$1 = \frac{1}{1 - \rho \phi_d} CF_1 + \frac{1}{1 - \rho \phi_r} DR_1.$$  \hfill (14)

The benefit of having both subjective dividend growth expectations and subjective return expectations is that we have independent methods for measuring the size of cash flow news and discount rate news. There are three possible ways to estimate the decomposition. First, we can estimate $\phi_d$ from the subjective dividend growth expectations, calculate $CF$ and then infer $DR = 1 - CF$. Second, we can estimate $\phi_r$ from the subjective return expectations, calculate $DR$ and infer $CF = 1 - DR$. Third, we can jointly estimate $\phi_d, \phi_r$ such that $CF + DR = 1$ using maximum likelihood. Table V shows the results of these three estimations.

Both the dividend growth and return surveys provide strong evidence that price movements are predominantly explained by investors’ subjective dividend growth expectations. Since the surveys are taken from different groups of investors, it is remarkable that the directly observed $CF$ and the inferred $CF$ are so similar. In the first row of Table V, where the effect of subjective dividend growth expectations is estimated directly, we see that subjective dividend growth expectations explain the majority of price-dividend ratio movements, 93%. While this coefficient only has moderate statistical significance, it fits well with the one-year cash flow news of 0.39 estimated in Table IV and two-year cash flow news of 0.65 estimated in Table IX in Section VI.B, both of which have high statistical significance. This estimation relies only on subjective dividend growth expectations data and is completely separate from the subjective return expectations data.\footnote{Giglio and Kelly (2017) find empirical evidence that risk-neutral expectations of cash flow growth in the equity market decay more slowly than a simple decay function would imply. This result would suggest that our direct estimation of full-horizon subjective dividend growth expectations may be biased down and that the estimated $CF = 0.93$ in the first row is a lower bound. This will not change our result that short-term cash flow growth expectations explain the majority of price ratio movements, since we directly estimate short-term cash flow news in Section VI.B without assuming a functional form for expectations.}

The second row shows the results when the contribution of subjective dividend growth expectations is estimated indirectly using the subjective return expectations. The contribution of full horizon subjective return expectations is $-9\%$. The negative contribution of subjective return expectations means subjective dividend growth expectations must explain
**Table V**

**Variance decomposition of price-dividend ratio into full horizon \( CF \) and \( DR \)**

This table calculates the full horizon variance decomposition using different subsets of data sources. In the first row, we use exclusively the one-year and two-year subjective dividend growth expectations from I/B/E/S and estimate the persistence \( \phi_d \). Then \( CF \) is estimated as \( CF_1/(1-\rho \phi_d) \) and \( DR \) is inferred as \( 1-CF \). In the second row, we use exclusively the one-year and ten-year subjective return expectations from Graham-Harvey and estimate the persistence \( \phi_r \). Then, \( DR \) is estimated as \( DR_1/(1-\rho \phi_r) \) and \( CF \) is inferred as \( 1-DR \). The third row uses both sources of data to perform a ML estimation constrained by the identity \( 1 = CF + DR \) and jointly estimate the persistences \( \phi_d, \phi_r \) which determine \( CF \) and \( DR \). \( CF_1 \) and \( DR_1 \) are estimated by regressing one-year dividend growth expectations and one-year return expectations on the price-dividend ratio. All rows use quarterly data running from 2003Q1 to 2015Q3. Standard errors in parenthesis. For the first and second rows, standard errors for \( \phi_d, \phi_r \) are small-sample adjusted Newey-West. For all rows, standard errors for \( CF \) and \( DR \) are calculated from the standard errors for \( CF_1, DR_1, \phi_d \) and \( \phi_r \) assuming independence of the errors.

<table>
<thead>
<tr>
<th>Subjective Expectations Data</th>
<th>( \phi_d )</th>
<th>( \phi_r )</th>
<th>( CF )</th>
<th>( DR )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dividend growth</td>
<td>0.59</td>
<td>0.93</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.22)</td>
<td>(0.48)</td>
<td>(0.48)</td>
<td></td>
</tr>
<tr>
<td>Returns</td>
<td>0.48</td>
<td>1.09</td>
<td>-0.09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.39)</td>
<td>(0.07)</td>
<td>(0.07)</td>
<td></td>
</tr>
<tr>
<td>Dividend growth and returns</td>
<td>0.66</td>
<td>0.47</td>
<td>1.09</td>
<td>-0.09</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.21)</td>
<td>(0.04)</td>
<td>(0.04)</td>
</tr>
</tbody>
</table>

over 100% of the price-dividend ratio volatility as it must drive the price-dividend ratio movements and make up for the positive comovement of subjective return expectations and \( pd_t \). The \( DR \) measured from the return surveys is not only negative, but also small in magnitude. Even if the sign of \( DR \) was reversed to positive 9%, meaning that subjective return expectations were low when the price-dividend ratio is high, we would still infer that dividend growth expectations must be driving the vast majority of price-dividend ratio movements. There is simply not enough volatility in the return expectations to explain the large observed movements in the price-dividend ratio.

When the persistences of dividend growth and returns are estimated jointly, the result is similar to the case where discount rate news is estimated directly. Because subjective return expectations have low volatility and \( DR_1 < 0 \), it is difficult to noticeably change \( DR \) from a small, negative value. Therefore, in the joint estimation it is far more likely that the direct estimation of \( CF \) slightly understates the role of subjective dividend growth expectations than that the indirect estimation of \( CF \) from the subjective returns data overstates the role.
of subjective dividend growth expectations.

In all three cases, we estimate low persistences \( \phi_d, \phi_r \) for both dividend growth and return expectations. Large increases in one-year expectations are only associated with modest increases in longer horizon expectations. This means that price-dividend ratio variation is not explained by investors expecting long-lived changes to future dividend growth or returns. Instead, it is explained mainly by changes in short-term expectations. Given that return expectations do not account for much of the price-dividend ratio variation, this means that short-term dividend growth expectations explain the majority of price-dividend ratio movements.

For the price-earnings ratio, we use a similar methodology. First, we estimate the long horizon subjective earnings growth expectations using the simple decay functional form,

\[
E_t^* [\Delta e_{t+1+j}] - \mu_e = \phi^e_t (E_t^* [\Delta e_{t+1}] - \mu_e) + \varepsilon^e_{t+j}.
\]

(15)

Just as we did for subjective dividend growth expectations, we estimate the persistence \( \phi_e \) of subjective earnings growth expectations using the one-year and two-year expectations constructed from the I/B/E/S data. Analogous to the price-dividend ratio decomposition, the full horizon cash flow news and discount rate news for the price-earnings ratio are

\[
CF = \frac{\text{Cov}\left(\sum_{j=1}^{\infty} \rho^{j-1} E_t^* [\Delta e_{t+j}]_e, p_e t\right)}{\text{Var}(p_e t)}
\]

and

\[
DR = \frac{\text{Cov}\left(-\sum_{j=1}^{\infty} \rho^{j-1} E_t^* [r_{t+j}]_e, p_e t\right)}{\text{Var}(p_e t)}.
\]

With this simple decay functional form, the full horizon cash flow news and discount rate news can be simplified to

\[
CF = \frac{1}{1 - \rho \phi_e} CF_1 \quad \text{and} \quad DR = \frac{1}{1 - \rho \phi_r} DR_1,
\]

where \( CF_1 \) and \( DR_1 \) are the one-year cash flow and discount rate news for the price-earnings ratio.

Using equation (7), we again have three equations that determine the two persistences, \( \phi_e, \phi_r \). The first equation is (13), which uses the short-term and long-term return expectations to pin down \( \phi_r \). The other two equations are analogous to (12) and (14), except they involve earnings instead of dividends,

\[
E_t^* [\Delta e_{t+2}] - \mu_e = \phi^e_t (E_t^* [\Delta e_{t+1}] - \mu_e) + \nu^e_t
\]

(16)

\[
1 \approx \frac{1}{1 - \rho \phi_e} CF_1 + \frac{1}{1 - \rho \phi_r} DR_1.
\]

(17)

Just like the price-dividend ratio decomposition, the decomposition for the price-earnings ratio can be estimated in three ways. We can estimate \( \phi_e \) using just the one-year and two-year subjective earnings growth expectations, calculate \( CF \) and infer \( DR \approx 1 - CF \). Conversely, we can estimate \( \phi_r \) from the subjective return expectations, calculate \( DR \) and infer \( CF \approx \).
1 − DR. Last, we use the subjective earnings growth and return expectations to jointly estimate \( \phi_e, \phi_r \) with the restriction that the approximation holds exactly \( CF + DR = 1 \). The estimates from these three different methods are show in Table VI. In Section VI.A, we show that estimating the exact decomposition including expectations of future payout ratios, rather than the approximated decomposition, has almost no effect on our results. We can also see in Table VI that our directly measured cash flow news \((CF = 0.99)\) and our directly measured discount rate news \((DR = −0.01)\) sum almost exactly to 1, which means our approximation holds quite well.

Our results for the price-earnings ratio are strikingly similar to the results for the price-dividend ratio. Both the earnings growth expectations and the return expectations indicate that cash flow news accounts for almost all movements in the price-earnings ratio. Using the earnings growth surveys, we directly observe that earnings growth expectations explain 99% of the movements in the price-earnings ratio. This is almost exactly the value that we get from the return surveys. For the return surveys, we estimate that return expectations account for −1% of price-earnings ratio movements, implying that earnings growth expectations must account for 101%.

When both the earnings growth and return surveys are used, the result is similar to when only the return surveys are used. Again, this is due to the fact that \( DR_1 \) is quite small, which means it takes large changes in \( \phi_r \) to alter the full horizon discount rate news \( DR \). Because this is true for both the price-dividend and price-earnings ratios, changes in \( \phi_r \) do not have a large impact on \( \phi_d \) in Table V or \( \phi_e \) in Table VI, since \( \phi_r \) only affects the other persistences through the \( CF + DR = 1 \) restriction. The result is that \( \phi_r \) is mainly determined by equation (13), which is shared by the price-dividend ratio and price-earnings ratio decompositions and explains why the joint estimate for \( \phi_r \) is similar in both decompositions. Since it only takes a small change in \( \phi_e \) to raise \( CF \) but takes a large change in \( \phi_r \) to increase \( DR \), it is much more likely that the direct estimation of \( CF \) slightly underestimates cash flow news than that the indirect estimate of \( CF \) overstates cash flow news.

Where the results differ from the price-dividend ratio decomposition is in the persistence of cash flow growth expectations. Subjective earnings growth expectations show almost no persistence, \( \phi_e = 0.06 \), compared to the already low persistence of subjective dividend growth expectations, \( \phi_d = 0.59 \). This is consistent with the idea that changes in dividends are smoothed compared to changes in earnings. Instead of immediately altering dividends to
Variance decomposition of price-earnings ratio into full horizon $CF$ and $DR$

This table calculates the full horizon variance decomposition using different subsets of data sources. In the first row, we use exclusively the one-year and two-year subjective earnings growth expectations from I/B/E/S and estimate the persistence $\phi_e$. Then $CF$ is estimated as $CF_1/(1 - \rho \phi_e)$ and $DR$ is inferred as $1 - CF$. In the second row, we use exclusively the one-year and ten-year subjective return expectations from Graham-Harvey and estimate the persistence $\phi_r$. Then, $DR$ is estimated as $DR_1/(1 - \rho \phi_r)$ and $CF$ is inferred as $1 - DR$. The third row uses both sources of data to perform a ML estimation constrained by the identity $1 = CF + DR$ and jointly estimate the persistences $\phi_e, \phi_r$ which determine $CF$ and $DR$. $CF_1$ and $DR_1$ are estimated by regressing one-year earnings growth expectations and one-year return expectations on the price-earnings ratio. All rows use quarterly data running from 2003Q1 to 2015Q3. Standard errors in parenthesis. For the first and second rows, standard errors for $\phi_e, \phi_r$ are small-sample adjusted Newey-West. For all rows, standard errors for $CF$ and $DR$ are calculated from the standard errors for $CF_1, DR_1, \phi_e$ and $\phi_r$ assuming independence of the errors.

<table>
<thead>
<tr>
<th>Subjective Expectations</th>
<th>Data</th>
<th>$\phi_e$</th>
<th>$\phi_r$</th>
<th>$CF$</th>
<th>$DR$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earnings growth</td>
<td></td>
<td>0.06</td>
<td>0.99</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.01)</td>
<td>(0.10)</td>
<td></td>
<td>(0.10)</td>
</tr>
<tr>
<td>Returns</td>
<td></td>
<td>0.48</td>
<td>1.01</td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.39)</td>
<td>(0.02)</td>
<td></td>
<td>(0.02)</td>
</tr>
<tr>
<td>Earnings growth and returns</td>
<td>0.07</td>
<td>0.47</td>
<td>1.01</td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.10)</td>
<td>(0.15)</td>
<td>(0.01)</td>
<td>(0.01)</td>
</tr>
</tbody>
</table>

match changes in earnings, investors may believe that companies will spread these changes over several years. This would explain why two-year dividend growth expectations typically rise when one-year dividend growth expectations rise, but two-year earnings growth expectations do not substantially rise when one-year earnings growth expectations rise. The two-year cash flow news of 0.98 that we estimate in Section VI.B, fits well with this low persistence, given that one-year cash flow news is 0.94.

This low persistence holds in longer samples. We have two-year earnings growth expectations for 1985 to 2015. Over this sample, the estimated persistence of earnings growth expectations is still only 0.06, with a standard deviation of 0.02. This low persistence is still enough for subjective earnings growth expectations to account for the majority of price-earnings ratio movements over the longer sample. For 1985 to 2015, we estimate that full horizon cash flow news accounts for 63% of the movements in the price-earnings ratio, with a standard deviation of 15%.
V. Modeling Subjective Expectations

Summarizing the results of the previous sections, we find three key facts for subjective expectations. First, subjective cash flow growth expectations are time-varying and explain the majority of price movements. Second, subjective return expectations are significantly less volatile and do not play a large role in explaining price movements. Third, subjective cash flow growth expectations have low persistence, which means that changes in short-term cash flow growth expectations account for most price movements. To see how these findings compare to standard asset pricing models in the literature, we select four models and calculate the full horizon cash flow news $CF$, the full horizon discount rate news $DR$, and the short horizon cash flow news $CF_1, CF_2$. We then present the Earnings Growth Reversal model of subjective expectations to match the expectations series and these findings.

A. Existing Asset Pricing Models

To understand how our findings relate to existing asset pricing models, we select four leading models from various branches of the asset pricing literature. We consider the Campbell and Cochrane (1999) external habit formation model, the Bansal, Kiku, and Yaron (2012) long-run risk model, the Collin-Dufresne, Johannes, and Lochstoer (2016) learning model and the Barberis et al. (2015) return extrapolation model. All these consumption-based asset pricing models have theoretical predictions about the facts documented in this paper. Table VII Panel A shows the decomposition of price ratio movements into movements in return expectations and cash flow growth expectations at different horizons using the headline calibrations of each model.

The first model we examine is the habit formation model from Campbell and Cochrane (1999). In this model, agents believe that dividend growth is i.i.d., which means that there is no variation in dividend growth expectations over time. As a result, cash flow news at all horizons are exactly 0 and all variation in the price-dividend ratio is due to changes in expected returns.

Next we examine the long-run risk model from Bansal, Kiku, and Yaron (2012), where cash flow growth has a slow-moving long-run component. Because of this component, cash flow growth expectations do vary over time and explain some of the price-dividend ratio variation. However, due to the recursive preferences, discount rate expectations also depend
heavily on the long-run component and account for 62% of the movements in the price-dividend ratio. As a result, cash flow growth expectations play a secondary role, with one-year, two-year, and full horizon cash flow growth expectations explaining only 11%, 19%, and 38% of price-divided ratio variation respectively.

The third model evaluated is the learning model of Collin-Dufresne, Johannes, and Lochstoer (2016). Here, the agent is uncertain whether there is a long-run component to cash flow growth and this model uncertainty risk is incorporated into asset prices. Both cash flow growth and return expectations vary over time as the agent updates her inferred probability of a long-run component and its value, but the movements in return expectations are significantly larger. This is because her cash flow expectations depend on her inferred probability, while her discount rates depend on the risk-adjusted inferred probability which is much more volatile due to her recursive preferences. Full horizon cash flow news is 0.1 and two-year cash flow news is only 0.02 while full horizon discount rate news is 0.9.

Finally, we evaluate the return extrapolation model of Barberis et al. (2015). In the model, expected price changes depend on a weighted average of previous price changes. This model was designed to better match features of subjective return expectations taken from survey data, in particular the positive correlation of price ratios and short horizon expected returns. Agents believe that dividend changes, rather than dividend growth is i.i.d. Because of this, dividend growth expectations are lower when current dividends are high. In the model, positive shocks to dividends tend to raise the price-dividend ratio, because prices overreact, which generates negative cash flow news.\(^{15}\) Surprisingly, even though the model features negative discount rates news at short horizons, the full horizon discount rate news is large and positive at 1.65. This is because of the countercyclicality of long horizon return expectations.

We now consider the possibility of altering these models to incorporate volatile cash flow growth expectations. In order to match the survey data, the volatility of cash flow growth expectations would need to be similar to the volatility of the price-dividend ratio and these

\(^{15}\)The additive nature of the model implies that the natural quantities to study are the price-dividend difference \(P - \frac{D}{P}\) instead of the price-dividend ratio, and expected dividend changes \(E_t^* [D_{t+1} - D_t]\) instead of dividend growth expectations. As suggested by one of the original authors, we also test the model using an additive decomposition. For this decomposition, we find that expectations of dividend changes explain 0% of the variation in the price-divided difference and expectations of price changes plus expectations of the long-term price-dividend difference explain 100%.
expectations would need to account for virtually all price-dividend ratio movements. We can rearrange equation (2) and take variances to get the following relationship

$$
\text{Var} \left( \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [r_{t+j}] \right) = \text{Var} (pd_t) + \text{Var} \left( \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [\Delta d_{t+j}] \right) - 2 \cdot \text{Cov} \left( \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [\Delta d_{t+j}] , pd_t \right).
$$

Dividing by $\text{Var} (pd_t)$ and using the definition of $CF$ gives

$$
\frac{\text{Var} \left( \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [r_{t+j}] \right)}{\text{Var} (pd_t)} = 1 + \frac{\text{Var} \left( \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [\Delta d_{t+j}] \right)}{\text{Var} (pd_t)} - 2CF.
$$

Thus, altering these models to push $\text{Var} \left( \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [\Delta d_{t+j}] \right)$ towards $\text{Var} (pd_t)$ and $CF$ towards 1 implies that we would also need to push $\text{Var} \left( \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [r_{t+j}] \right)/\text{Var} (pd_t)$ towards 0.

In other words, we cannot alter these models to match our findings on cash flow growth expectations without also altering the models so that there is little variation in return expectations. This is true not just for these four models, but for any model where agents’ expectations satisfy the no-bubble condition, $\lim_{j \to \infty} \rho^{j-1} E_t^* [pd_{t+j}] = 0$. It is important to reiterate that these models were designed to match a different set of facts than those presented here. In particular, they were focused on how asset price behavior can be explained by the effect of preferences, consumption risk, learning or extrapolation on marginal utility and expected returns. The restriction in equation (19) shows that models intended to generate large time-variation in expected returns, such as the four models above, cannot match the survey data on cash flow growth expectations without substantially dampening the key features that make these models different from simple models of constant discount rates.

**B. Model of Subjective Cash Flow Expectations**

Given the difficulty for standard asset pricing models to replicate our results, we construct a simple model of subjective cash flow expectations and asset prices that is able to closely match the survey expectations series and our decompositions. In this model, agents believe that shocks to current earnings will be partly transitory and that changes in dividends will
Table VII

Variance decomposition in different asset pricing models

This table calculates the implied full-horizon cash flow news ($CF$), full-horizon discount rate news ($DR$), as well as one-year and two-year cash flow news ($CF_1, CF_2$) in the variance decomposition of different asset pricing models. **Panel A** shows the decomposition of the price-dividend ratios derived in Campbell and Cochrane (1999) (habit formation), in Bansal, Kiku, and Yaron (2012) (long-run risk), in Collin-Dufresne, Johannes, and Lochstoer (2016) (learning), in Barberis et al. (2015) (return extrapolation), in Section V.B of this paper (earnings growth reversal) and the empirical decomposition measured in the 2003 to 2015 sample. **Panel B** shows the decomposition of the price-earnings ratio derived in the EGR model in Section V.B and the empirical counterpart measured in the 2003 to 2015 sample. All models are solved and estimated using the original author calibrations and simulated over the sample lengths proposed in each paper. The coefficients for the first four models are estimated by directly solving for the relationship between the price-dividend ratio and cash flow growth expectations ($CF_1, CF_2, CF$) and then inferring discount rate news ($DR$) as $1 - CF$. The coefficients of the EGR model for the price-divided ratio decomposition are obtained with the closed form solution derived in Section V.B. The coefficients for the EGR model for the price-earnings ratio decomposition are estimated using the model price ratios and subjective expectations series for 2003 to 2015 calculated in Section V.B. Standard errors are n/a when decomposition terms are functions of fixed parameters.

<table>
<thead>
<tr>
<th>Panel A: Price-dividend Ratio</th>
<th>$CF$</th>
<th>$DR$</th>
<th>$CF_1$</th>
<th>$CF_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data 2003-2015</td>
<td>1.09</td>
<td>-0.09</td>
<td>0.39</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>Habit formation</td>
<td>0.00</td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Long-run risk</td>
<td>0.38</td>
<td>0.62</td>
<td>0.11</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(0.19)</td>
<td>(0.06)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>Learning</td>
<td>0.10</td>
<td>0.90</td>
<td>0.00</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.09)</td>
<td>(0.09)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>Return extrapolation</td>
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<td>-0.02</td>
<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(0.29)</td>
<td>(0.29)</td>
<td>(0.01)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>Earnings growth reversal</td>
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<td>0.39</td>
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<tr>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Price-earnings Ratio</th>
<th>$CF$</th>
<th>$DR$</th>
<th>$CF_1$</th>
<th>$CF_2$</th>
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<td>0.98</td>
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<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.10)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>Earnings growth reversal</td>
<td>0.95</td>
<td>0.05</td>
<td>0.95</td>
<td>0.95</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
</tr>
</tbody>
</table>
be more gradual than changes in earnings. Because changes in earnings are believed to be partly transitory, agents expect that changes in earnings growth will be partially reversed by future earnings growth.

B.1. Earnings Growth Reversal Model

Specifically, agents believe that earnings and dividends evolve according to

\[
\begin{align*}
\varepsilon_{t+1} &= x_t + \varepsilon_{t+1} \\
x_{t+1} &= \mu + x_t + (1 - \theta) \varepsilon_{t+1} \\
d_{t+1} &= (1 - w) e_{t+1} + wd_t + \varepsilon^d_{t+1}
\end{align*}
\]

(20) 
(21) 
(22)

where all variables are in logs. Earnings are the sum of a permanent component \(x_t\) and a shock \(\varepsilon_{t+1}\). Portion \(1 - \theta\) of the shock is permanent, as it shows up in \(x_{t+1}\), while portion \(\theta\) is transitory. Agents believe dividends will be a weighted sum of current earnings and previous dividends, plus a shock \(\varepsilon^d_{t+1}\). The two shocks are believed to be i.i.d. and independent of one another. This belief that shocks to earnings will be partially transitory and partially permanent means that agents expect earnings growth to follow an MA(1) process of the \(\varepsilon_t\) shocks:

\[
\Delta e_{t+1} = \mu - \theta e_t + \varepsilon_{t+1}.
\]

(23)

Shocks to earnings growth at time \(t\) are expected to be partially reversed by earnings growth in \(t + 1\) and the magnitude of this reversal is controlled by how much the shock to earnings is expected to be transitory \(\theta\).\(^{16}\)

This structure is meant to capture several of the key features we find in the survey forecasts data. First, investors believe that shocks to earnings will be largely transitory. Even during the financial crisis, investors believed that the massive drop in earnings would be mostly offset by higher next year earnings growth. Second, survey earnings growth expectations have virtually no persistence, which we show is consistent with believing in an MA(1) process. Third, investors believe that changes in dividends will be smoother than changes in earnings. While investors report large short-lived expected changes in earnings, they re-

\(^{16}\)Equivalently, agents view earnings growth as following an AR(\(\infty\)) process \(\Delta e_{t+1} - \mu = -\sum_{j=0}^\infty \theta^j (\Delta e_{t-j} - \mu) + \varepsilon_t.\) Future earnings growth is believed to be lower when recent earnings growth has been high.
port smaller but more persistent expected changes in dividends, implying that they believe companies will spread the change in earnings over multiple periods rather than immediately adjusting dividends. The parameters $\theta$ and $w$ control how much shocks to earnings will be reversed in the future and how quickly they expect dividends will be adjusted when earnings change. Since this structure is motivated by low persistence in earnings growth expectations, we focus on the 1985 to 2015 sample where we are able to measure the persistence of survey earnings growth expectations.

Since this paper is focused on comovements, we demean all variables for the sake of simplicity. Given these beliefs, the model subjective expectations, denoted as $E^m_t \cdot$, for earnings growth and dividend growth are

$$E^m_t [\Delta e_{t+j}] = \begin{cases} -\theta \varepsilon_t & \text{if } j = 1 \\ 0 & \text{if } j \geq 2 \end{cases} \quad (24)$$

$$E^m_t [\Delta d_{t+j}] = w^{j-1} (1-w) (-\theta \varepsilon_t - de_t) \quad (25)$$

where $de_t$ is the payout ratio. After observing the shock to earnings growth, $\varepsilon_t$, agents change their one-year earnings growth expectations but expectations for all other horizons remain constant because of the MA(1) functional form. One-year earnings growth expectations will rise after a bad current shock because agents believe the shock will be partly reversed. Since agents believe that changes to dividends will be smoothed, only $1-w$ portion of the one-year earnings growth expectations shows up in one-year dividend growth expectations. The one-year expected earnings growth $-\theta \varepsilon_t$ is then adjusted by the current payout ratio $de_t$ so that the change is relative to current dividends instead of current earnings. Dividend growth expectations then gradually decay back to 0 with persistence $w$, ensuring that changes in earnings growth are eventually fully incorporated into dividend growth but in a smoothed manner. From equations (22) and (23), the agent believes that the payout ratio evolves according to

$$de_{t+1} = wde_t - w\Delta e_{t+1} + \varepsilon^e_{t+1}. \quad (26)$$

In order to calculate the discount rates of the agents, we assume they have power utility with risk aversion $\gamma$ and discount factor $\delta$ and believe that consumption growth follows

$$\Delta c_{t+1} = \eta \Delta d_{t+1} + \varepsilon^c_{t+1}. \quad (27)$$

The price-dividend ratio is determined by the agents’ first order condition for holding the
stock market, namely \( E_t^m \left[ \delta \exp \left( -\gamma \left[ \eta \Delta d_{t+1} + \varepsilon_{t+1} + r_{t+1} \right] \right) \right] = 1 \). In this framework, the variation in return expectations comes from variation in the risk-free rate rather than variation in expected excess returns. This is consistent with our survey data. For our estimated \( DR_1 = -0.05 \), less than 0.001 comes from comovement of expected excess returns with the price-dividend ratio. Using the log-linearized return approximation (1), this gives the demeaned price-dividend ratio as

\[
pd_t^m = \frac{1 - \chi}{1 - \rho w} E_t^m [\Delta d_{t+1}] \tag{28}
\]

where \( \chi = \gamma \eta \). All terms related to the variance of the shocks are captured in the mean value of the price-dividend ratio, which is why they do not appear in the demeaned equation (28).

Similarly, her return expectations are

\[
E_t^m [r_{t+j}] = w^{j-1} \chi E_t^m [\Delta d_{t+1}] \tag{29}
\]

For positive values of \( \chi \), the agent’s discount rates will rise with her dividend growth expectations because she expects that consumption will be higher in the future. The price-earnings ratio reduces to the following weighted sum of the one-year earnings growth expectations and the payout ratio,

\[
pe_t^m = \frac{1 - w}{1 - \rho w} (1 - \chi) E_t^m [\Delta \varepsilon_{t+1}] + \left[ 1 - \frac{1 - w}{1 - \rho w} (1 - \chi) \right] d\varepsilon_t. \tag{30}
\]

We use a small value for \( \chi \) and \( \rho \) is close to 1, so the price-earnings ratio will primarily depend on earnings growth expectations and the payout ratio will play a secondary role.

For the parameter values, we estimate \( w = 0.66 \) from the persistence of survey dividend growth expectations and \( \chi = 0.08 \) from regressing one-year survey return expectations on one-year survey dividend growth expectations. Since the MA(1) functional form is equivalent to an AR(\( \infty \)), we estimate \( \theta = 0.6 \) from the relative correlation of survey earnings growth expectations with current and prior year earnings growth. The low value of \( \chi \) implies that the agent either has low risk aversion or believes that consumption growth is only weakly related to dividend growth. This means that the agent’s discount factor for the stock market will not fluctuate much over time, which matches the low volatility of return expectations that we find in the survey data.
B.2. Results

Though relatively simple, this model is able to replicate the main findings of the previous sections. First, the decompositions for the model price ratios are remarkably similar to the decompositions using the survey data. Second, the time-series for model cash flow growth expectations match the volatility and movements in the survey cash flow growth expectations. Third, the model persistence of expectations and the model autocorrelation for the price ratios are both relatively low and the volatility of the price ratios, changes in the price ratios, and returns are quite high, in line with what we find in the data. Fourth, the model generates predictable forecast errors for cash flow growth expectations in the pre-2003 sample but not in the 2003 to 2015 sample, matching what we find in Section III.B and offering a potential explanation for why this occurs. Interestingly, the model also generates two of the findings of the return extrapolation literature, namely that return expectations are more correlated with current returns than future returns (Greenwood and Shleifer (2014)) and that the ability of the price-dividend ratio to predict next-year returns is stronger when return expectations are more related to recent returns than earlier returns (Cassella and Gulen (2018)).

Table VII shows that this model accurately captures the key results from our decompositions for both the price ratios. For the price-dividend ratio, we have closed-form solutions for the decomposition. One-year cash flow news is exactly \( \frac{1-\rho_w}{1-\chi} = 0.39 \) from equation (28) and two-year cash flow news is \((1+\rho_w)\frac{1-\rho_w}{1-\chi} = 0.64\), which almost perfectly match the measured one-year and two-year cash flow news in the survey data of 0.39 and 0.65 respectively. Similarly, the full horizon cash flow news of \( \frac{1}{1-\chi} = 1.09 \) and the full horizon discount rate news of \(-\frac{\chi}{1-\chi} = -0.09 \) are virtually identical to the values measured from the survey data despite the fact that none of these decomposition values were directly targeted. In addition, the model generates one-year discount rate news of \(-0.03\) which is quite close to the \(-0.05\) value from Table IV.

For the price-earnings ratio, the decomposition does not have a closed-form solution, so we estimate the model using the realized series of earnings and dividends. Setting the initial shock to 0 for 1985, we measure the value of \( \epsilon_t \) that agents would infer after observing the realized earnings growth \( \Delta e_t \). Using just this sequence of inferred \( \epsilon_t \) and the realized payout ratio \( de_t \), we calculate the model earnings growth expectations and price-earnings ratio. Importantly, no information from the realized data other than \( \epsilon_t, de_t \) is used to calculate the
model variables. We estimate the decompositions over the 2003 to 2015 sample to match the sample for the survey estimation, but the results are virtually identical if we estimate the decomposition over the 1985 to 2015 sample. Because earnings growth expectations are constant for all horizons beyond one year, the one-year, two-year and full horizon cash flow news are all equal at 0.95. While the model values for $CF_2$ and $CF$ are slightly lower than the values from the data, the model accurately captures the fact that virtually all movements in the price-earnings ratio are explained by earnings growth expectations and that cash flow news is more heavily concentrated at short horizons for the price-earnings ratio than for the price-dividend ratio. In the survey data, the full horizon discount rate news $DR = -0.01$ (0.01) is not significantly positive or negative, but we can confidently say that it is small in magnitude. This is matched by the model where full horizon discount rate news accounts for only 5% of the price-earnings ratio variation.

The model is also able to match the large fluctuations in survey cash flow growth expectations, despite the fact that $w$ and $\theta$ do not target these volatilities. Figure 4 shows the one-year cash flow growth expectations from the survey data $(E_t^s [\Delta e_{t+1}], E_t^s [\Delta d_{t+1}])$ and the model subjective cash flow growth expectations $(E_t^m [\Delta e_{t+1}], E_t^m [\Delta d_{t+1}])$ constructed from $\varepsilon_t, \delta e_t$. The model expectations for one-year earnings growth match the survey expectations well, capturing virtually all the movements in the survey earnings growth expectations over this 30-year period including the massive spikes in expected earnings growth during the dot-com bust and the financial crisis. Earnings growth expectations spiked during those periods because there were large negative shocks to earnings growth and investors believed these would be primarily reversed by next year earnings growth. Similarly, while the model dividend growth expectations miss the slight decline in dividend growth expectations in the early 2000’s, they accurately replicate the timing and magnitude of the drop and quick recovery in survey expectations during the financial crisis and the leveling off of dividend growth expectations from 2010 to 2015.

Beyond the decompositions and the time-series for cash flow growth expectations, the model is able to match the dynamics of subjective expectations and price ratios measured in the data, as shown in Table VIII. For variables related to earnings growth and the price-earnings ratio, we use the full 1985 to 2015 sample. For variables related to dividend growth and the price-dividend ratio, we use the 2003 to 2015 sample where we have data on subjective dividend expectations. Panel A shows that the persistences of the model cash
flow growth and return expectations align with the values measured in the survey data. These persistences measure how much the two-year expectations increase when one-year expectations increase by 1. We will use the term autocorrelation to refer to the actual relationship between realized values in $t + 1$ and $t + 2$.

The persistence of model earnings growth expectations $\phi_e$ is 0, since agents believe current shocks will only affect one-year earnings growth. This is very close to the empirical estimate of 0.06. In contrast, agents do expect changes in dividend growth to be persistent, because the shocks to earnings are expected to be spread out over multiple years. In other words, the model is able to generate an accurate persistence in dividend growth expectations without generating persistence in earnings growth expectations. The model persistence of dividend growth expectations $\phi_d$ is exactly the weight $w = 0.66$ which determines how quickly dividends are expected to react to changes in earnings. Lastly, the model persistence of return expectations is also $w$, since return expectations only depend on the agent’s dividend growth expectations. While higher than the estimated value of $\phi_r = 0.47$, this low persistence of $w$ still captures the fact that movements in returns are not expected to be persistent.

Because model agents do not expect changes in cash flow growth or returns will be persistent, they believe that movements in both price ratios will be short-lived. The fourth
and fifth rows of Panel A show that the autocorrelations for both price ratios are indeed quite low. The model autocorrelations for the price-dividend ratio and price-earnings ratio are 0.23 and 0.17 respectively. Though the autocorrelation of the price ratios is slightly higher in the data at 0.44 and 0.43 respectively, the model captures the main result that most price ratio movements are reversed after only one year.

In Panel B, we see that the model matches the volatility of the price ratios, price ratios changes, and realized returns. For both the price-dividend ratio and price-earnings ratio, the substantial time-variation in model cash flow growth expectations generates large price ratio variation. Since the price ratios have low autocorrelations, these movements are relatively short-lived, implying that one-year changes in the price ratios $\Delta pd_t, \Delta pe_t$ and realized one-year returns $r_t$ also have high volatilities both in the model and in the data.

Lastly, the model also explains why we find predictable forecast errors for the early parts of the sample, but not in the more recent years. Panel C shows the correlation of earnings growth expectations, realized earnings growth, and forecast errors with the price-earnings ratio in the data and in the model for 1985 to 2002 and 2003 to 2015. In both samples, model earnings growth expectations are almost perfectly correlated with the model price-earnings ratio, matching the high correlations we find in the data. In the model, agents price the stock market based primarily on their belief that shocks to earnings growth will be reversed by future earnings growth. As a result, the correlation of the model price-earnings ratio with realized future earnings growth depends on the accuracy of this belief.

In the 1985 to 2002 sample, this belief was largely incorrect, as movements in earnings growth were only partly reversed. This results in a low insignificant correlation between the model price-earnings ratio and future realized earnings growth of 0.29 and a significant negative correlation between agents’ forecast errors and the price-earnings ratio of −0.31. This matches the data quite well, where the correlations are an insignificant 0.22 and a significant −0.37. In the 2003 to 2015 sample, however, this belief was more accurate, as movements in earnings growth were largely reversed, particularly during the financial crisis. This means that the model price-earnings ratio is more highly correlated with future earnings growth over this sample and agents’ forecast errors are not significantly correlated with the model price-earnings ratio. The model correlations of a 0.50 (0.13) and a −0.03 (0.14) are once again quite close to the values from the data, 0.61 (0.11) and 0.07 (0.07) respectively.

To summarize, in both samples agents believe that shocks to earnings growth will be
Table VIII
Dynamics of Expectations and Price Ratios
This table compares moments in the data and the model. Panel A shows the persistence of subjective expectations across the forecast horizon as well as the annual autocorrelation of the price-dividend and price-earnings ratios. The expressions $AC(\cdot)$ and $\sigma(\cdot)$ refer to the annual autocorrelation and the standard deviation. Panel B shows the standard deviations for the price ratios, annual change in the price ratios, and realized returns. Panel C shows the correlation of the price-earnings ratio with subjective one-year earnings growth expectations, realized one-year earnings growth, and the forecast error. All rows use quarterly data. Small-sample adjusted Newey-West standard errors in parenthesis. Standard errors are n/a when variables are functions of fixed parameters.

<table>
<thead>
<tr>
<th>Panel A: Persistence and Autocorrelation</th>
<th>Data</th>
<th>Estimate</th>
<th>SE</th>
<th>Model</th>
<th>Estimate</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi_d$</td>
<td>2003-2015</td>
<td>0.66</td>
<td>(0.07)</td>
<td>0.66</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>$\phi_r$</td>
<td>2003-2015</td>
<td>0.47</td>
<td>(0.21)</td>
<td>0.66</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>$\phi_e$</td>
<td>1985-2015</td>
<td>0.06</td>
<td>(0.02)</td>
<td>0.00</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>$AC(pd_t)$</td>
<td>2003-2015</td>
<td>0.44</td>
<td>(0.18)</td>
<td>0.23</td>
<td>(0.07)</td>
<td></td>
</tr>
<tr>
<td>$AC(pe_t)$</td>
<td>1985-2015</td>
<td>0.43</td>
<td>(0.17)</td>
<td>0.17</td>
<td>(0.16)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Volatility</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma(pd_t)$</td>
<td>2003-2015</td>
<td>0.18</td>
<td>(0.02)</td>
<td>0.14</td>
<td>(0.03)</td>
<td></td>
</tr>
<tr>
<td>$\sigma(\Delta pd_t)$</td>
<td>2003-2015</td>
<td>0.19</td>
<td>(0.03)</td>
<td>0.18</td>
<td>(0.03)</td>
<td></td>
</tr>
<tr>
<td>$\sigma(pe_t)$</td>
<td>1985-2015</td>
<td>0.38</td>
<td>(0.03)</td>
<td>0.26</td>
<td>(0.03)</td>
<td></td>
</tr>
<tr>
<td>$\sigma(\Delta pe_t)$</td>
<td>1985-2015</td>
<td>0.40</td>
<td>(0.05)</td>
<td>0.34</td>
<td>(0.05)</td>
<td></td>
</tr>
<tr>
<td>$\sigma(r_t)$</td>
<td>1985-2015</td>
<td>0.16</td>
<td>(0.01)</td>
<td>0.15</td>
<td>(0.02)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel C: Forecast Error Predictability</th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Corr}(pe_t, E_t^* [\Delta e_{t+1}])$</td>
<td>1985-2002</td>
<td>0.74</td>
<td>(0.18)</td>
<td>1.00</td>
<td>(0.02)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2003-2015</td>
<td>0.93</td>
<td>(0.09)</td>
<td>1.00</td>
<td>(0.01)</td>
<td></td>
</tr>
<tr>
<td>$\text{Corr}(pe_t, \Delta e_{t+1})$</td>
<td>1985-2002</td>
<td>0.22</td>
<td>(0.12)</td>
<td>0.29</td>
<td>(0.15)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2003-2015</td>
<td>0.61</td>
<td>(0.11)</td>
<td>0.50</td>
<td>(0.13)</td>
<td></td>
</tr>
<tr>
<td>$\text{Corr}(pe_t, fe_{t+1})$</td>
<td>1985-2002</td>
<td>−0.37</td>
<td>(0.12)</td>
<td>−0.31</td>
<td>(0.13)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2003-2015</td>
<td>0.07</td>
<td>(0.07)</td>
<td>−0.03</td>
<td>(0.14)</td>
<td></td>
</tr>
</tbody>
</table>
chiefly reversed the next year. In samples where this does not turn out to be true, the price-earnings ratio will mostly predict agents’ forecast errors. In samples where this does turn out to be true, the price-earnings ratio will mainly predict future earnings growth.

Combining these results, we find that this model is able to replicate the large movements in cash flow growth expectations of Section III.A, the forecast error predictability results of Section III.B, the short horizon cash flow news and discount rate news of Section IV.A, and the persistences and full horizon decompositions of Section IV.B. Interestingly, in addition to matching the findings of this paper, this model is also able to match two of the findings on return expectations from the return extrapolation literature. A core finding from this literature is that survey expectations of returns are more correlated with current and past returns than future returns, as shown by Greenwood and Shleifer (2014). We know from equations (28) and (29) that model return expectations are simply $\chi \frac{1-\rho w}{1-\chi} > 0$ multiplied by the price-dividend ratio.\(^{17}\) Since the price-dividend ratio is stationary, a high value for the price-dividend ratio means recent returns must be high since returns are primarily related to changes in the price-dividend ratio. As a result, return expectations will be high when recent returns are high. We find that the model correlation between return expectations and current realized returns is 0.57 (0.11). In comparison, the correlation between model return expectations and model next year realized returns is an insignificant $-0.14 (0.12)$.

Second, our model is consistent with the finding from Cassella and Gulen (2018) that the price-dividend ratio predicts future returns more strongly when the degree of extrapolative weighting in return expectations is high. They define the term degree of extrapolative weighting ($DOX_t$) to refer to the relative weight placed on recent returns compared to earlier returns when regressing survey return expectations on the past five years of returns. A higher value of $DOX_t$ means that return expectations are more related to recent returns than earlier returns. We take their methodology for measuring $DOX_t$ using survey return expectations and realized returns and apply it to our model return expectations and model realized returns.\(^{18}\)

We then regress the realized next year return from the model $r_{t+1}^m$ on the current model price-dividend ratio $pd_t^m$, the degree of extrapolative weighting $DOX_t$, and the interaction

\(^{17}\)Further, the positive relationship between the price-dividend ratio and return expectations is not solely from the dividend component of returns. Model capital gains expectations are also positively related to the model price-dividend ratio.

\(^{18}\)The Online Appendix contains the details of this estimation.
of these two terms $pd_t^m \cdot DOX_t$. The coefficient on the interaction term is significant and negative $-1.06$ (0.43) while the coefficient on $pd_t$ is insignificant at $0.02$ (0.12). This means that the ability of the price-dividend ratio to predict next year returns is stronger when the measured value of $DOX_t$ is high. The intuition for this result is the following. During periods of high measured $DOX$, current return expectations are mainly related to recent realized returns rather than earlier returns. Since earlier return expectations are mostly related to those earlier returns, this means that current return expectations are not strongly related to earlier return expectations. In the model, return expectations are $\chi \frac{1-\rho_w}{1-\chi}pd_t^m$, so the measured value of $DOX$ will be high during periods where the autocorrelation of the price-dividend ratio is low. Low autocorrelation means one-year return predictability will be larger. This is because lower autocorrelation in the price-dividend ratio strengthens the negative relationship between the current price-dividend ratio and next year returns, following equation (1). Thus, the model is able to simultaneously replicate the findings on return expectations from Greenwood and Shleifer (2014) and Cassella and Gulen (2018) on top of our findings on cash flow growth expectations.

VI. Robustness Checks

A. Relating Assumptions

In Section I, we made three assumptions in order to establish our two decompositions, equations (3) and (7). In this section, we will remove these assumptions and show that our results do not noticeably change. These three assumptions were the two no-bubble conditions, $E_t \left[ \lim_{T \to \infty} \rho^T pd_{t+T} \right] = 0$ and $E_t \left[ \lim_{T \to \infty} \rho^T pe_{t+T} \right] = 0$, and the approximation in equation (5) that we could ignore expectations of the future payout ratio.

We start by using the exact decomposition for the price-earnings ratio. When we include expectations of the future payout ratio, the definitions for $CF_1$, $DR_1$, and $LT$ remain unchanged from equation (9) and the exact one-year decomposition becomes

$$1 = CF_1 + DR_1 + LT + (1 - \rho) \frac{Cov \left( E_t^* [de_{t+1}], pe_t \right)}{Var \left( pe_t \right)} ,$$

(31)

where the fourth term is the one-year payout news. We calculate expectations of the future payout ratio using the current payout ratio, the one-year dividend growth expectations, and
the one-year earnings growth expectations. Because we estimated $CF_1$ and $DR_1$ directly from the earnings growth expectations and return expectations in Section IV.A, including this payout term will not change these values. Thus, earnings growth expectations will still account for 93.7% of the variation in the price-earnings ratio over 2003 to 2015 and return expectations will still account for −0.4%. Over the 2003 to 2015 sample, we find that one-year payout news accounts for only 0.3% of the variation in the price-earnings ratio.

We find similar results for the full horizon decomposition. Including the payout ratio terms, the full horizon decomposition for the price-earnings ratio is

$$1 = CF + DR + (1 - \rho) \frac{Cov \left( \sum_{j=1}^{\infty} \rho^{j-1} E_t^* [de_{t+j}], pd_t \right)}{Var(pd_t)} + PO,$$

where the definitions of $CF$ and $DR$ come from equation (7). The third term is the full horizon payout news. As with the one-year decomposition, including this term will not alter our direct estimate of the full horizon cash flow news, $CF = 0.99$, or our direct estimate of the full horizon discount rate news, $DR = -0.01$, because these were estimated solely from the earnings growth expectations and return expectations. Using our simple decay functional form for earnings growth and dividend growth expectations from Section IV.B, we estimate the full horizon payout ratio expectations and find that they account for −1% of the variation in the price-earnings ratio. So, for both the one-year and full horizon decompositions, including expectations of the future payout ratio does not change our result that price-earnings ratio variation is primarily explained by earnings growth expectations. Expectations of the future payout ratios simply do not play a large role in explaining price movements, which is not surprising given that $1 - \rho$ is close to 0.

Next, we remove our no bubble-conditions, $E_t^* \left[ \lim_{T \to \infty} \rho^T pd_{t+T} \right] = 0$ and $E_t^* \left[ \lim_{T \to \infty} \rho^T pr_{t+T} \right] = 0$. This means that we will allow for the possibility that investors believe the price-dividend ratio or price-earnings ratio will be non-stationary and will grow faster than $1/\rho$. For the price-dividend ratio, this means there would be a third element in our full horizon decomposition. A high price-dividend ratio could be explained by high expected dividend growth,
low expected returns or a high value of the “bubble” term. The new decomposition is

\[ 1 = CF + DR + \frac{Cov\left(E_t^* \left[ \lim_{T \to \infty} \rho^T pd_{t+T} \right], pd_t \right)}{Var(pd_t)}, \]  

(33)

where the definitions of \(CF\) and \(DR\) come from equation (3).

To estimate the three terms in the decomposition, we can use the value of \(CF\) derived from the dividend survey data and the value of \(DR\) derived from the return survey data in Section IV.B. We estimated \(CF = 0.93\) and \(DR = -0.09\), which means that under this specification, 16% of the variation of the price-dividend ratio could be attributed to movements in the bubble term. This is a non-trivial contribution, but it does not change our main result that cash flow news accounts for most price movements, explaining 93% of the volatility of the price-dividend ratio.

For the price-earnings ratio, removing the no-bubble condition means that our decomposition now has four terms,

\[ 1 = CF + DR + PO + \frac{Cov\left(E_t^* \left[ \lim_{T \to \infty} \rho^T pe_{t+T} \right], pe_t \right)}{Var(pe_t)}, \]  

(34)

where \(CF\), \(DR\), and \(PO\) definitions are the same as in equation (32). Analogous to the price-dividend ratio decomposition, we can use the value of \(CF\) measured directly from the earnings survey data and the value of \(DR\) measured directly from the return survey data in Section IV.B. In addition, we directly measured the payout news \(PO\) earlier in this section using the earnings and dividend survey data. This gives \(CF = 0.99\), \(DR = -0.01\), and \(PO = -0.01\), which implies that 3% of the variation in the price-earnings ratio could be attributed to movements in the bubble term. This clearly does not change the result that earnings growth expectations account for the vast majority of price-earnings ratio variation.

To summarize, removing our assumptions about the limit terms or expectations of future payout ratios does not change our result that cash flow growth expectations explain virtually all price movements and that return expectations play a negligible role. Including additional terms in the decompositions for potential bubbles or future payout ratios does not change the fact that we can directly observe a large comovement between cash flow growth expectations and price ratios and can also directly observe a lack of comovement between return expectations and price ratios.
Table IX
Extended variance decomposition of price ratios

This table shows the importance of two-year cash flow news ($\text{CF}_2$) and ten-year discount rate news ($\text{DR}_{10}$) in price ratio variance decompositions. For the price-dividend ratio, $\text{CF}_2$ and $\text{DR}_{10}$ are the coefficients obtained by individual regressions of $\sum_{j=1}^{2} \rho^{j-1} E_t^* \Delta d_{t+j}$ and $\sum_{j=1}^{10} \rho^{j-1} E_t^* [r_{t+j}]$ on the price-dividend ratio. For the price-earnings ratio, $\text{CF}_2$ and $\text{DR}_{10}$ are the coefficients obtained by individual regressions of $\sum_{j=1}^{2} \rho^{j-1} E_t^* \Delta e_{t+j}$ and $\sum_{j=1}^{10} \rho^{j-1} E_t^* [r_{t+j}]$ on the price-earnings ratio. The sum of one-year and two-year dividend growth and earnings growth expectations are calculated from the I/B/E/S forecasts. The sum of one-year to ten-year return expectations is calculated from the one-year and ten-year return forecasts from Graham-Harvey. The first two rows use quarterly data from 2003Q1 to 2015Q3. The third row uses quarterly data from 1985Q1 to 2015Q3. Only earnings growth expectations are available for this longer sample, which is why only the cash flow news is estimated. Small-sample adjusted Newey-West standard errors in parenthesis.

<table>
<thead>
<tr>
<th>Sample</th>
<th>$\text{CF}_2$</th>
<th>$\text{DR}_{10}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price-dividend ratio 2003-2015</td>
<td>0.65</td>
<td>-0.07</td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td>(0.11)</td>
</tr>
<tr>
<td></td>
<td>Price-earnings ratio 2003-2015</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td>(0.03)</td>
</tr>
<tr>
<td></td>
<td>1985-2015</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td></td>
</tr>
</tbody>
</table>

B. Long Horizon Estimation

In Section IV we used a simple decay function to estimate the missing horizons of the cash flow and return expectations. In this subsection we show that even this functional form is not crucial to understand the importance of cash flow news in explaining price movements. The one-year and two-year cash flow expectations constructed directly from the survey data can already account for a significant portion of the price volatility.

To see this, we perform a Campbell-Shiller decomposition similar to Section IV.A, but extend it with two extra pieces of data, the average ten-year expected return obtained in the Graham-Harvey CFO survey and the two-year expected dividend growth we obtained from
We can rewrite (2) as

\[
p_{d,t} = \sum_{j=1}^{2} \rho^{j-1} E^*_t [\Delta d_{t+j}] - \sum_{j=1}^{10} \rho^{j-1} E^*_t [r_{t+j}] + \left( \sum_{j=3}^{\infty} \rho^{j-1} E^*_t [\Delta d_{t+j}] - \sum_{j=11}^{\infty} \rho^{j-1} E^*_t [r_{t+j}] + E^*_t \left[ \lim_{T \to \infty} \rho^T p_{e,t+T} \right] \right)
\]

and use the following decomposition:

\[
1 = \frac{Cov\left(\sum_{j=1}^{2} \rho^{j-1} E^*_t [\Delta d_{t+j}], p_{d,t}\right)}{Var\left(p_{d,t}\right)} + \frac{Cov\left(-\sum_{j=1}^{10} \rho^{j-1} E^*_t [r_{t+j}], p_{d,t}\right)}{Var\left(p_{d,t}\right)} + \frac{Cov\left(\sum_{j=3}^{\infty} \rho^{j-1} E^*_t [\Delta d_{t+j}] - \sum_{j=11}^{\infty} \rho^{j-1} E^*_t [r_{t+j}] + E^*_t \left[ \lim_{T \to \infty} \rho^T p_{e,t+T} \right], p_{d,t}\right)}{Var\left(p_{d,t}\right)}.
\]

The final variables \(\tilde{LT}\) captures all cash flow news beyond the two-year horizon and all discount rate news beyond the ten-year horizon.

As Table IX shows, one-year and two-year subjective dividend growth expectations account for 65% of the volatility of the price-dividend ratio. This means that subjective dividend growth expectations can explain the majority of price movements, even without making assumptions about the limit term or the functional form of long horizon expectations. Extending the scope of the discount rate news from one to ten years also produces similar results to Section IV. Ten-year subjective return expectations rise slightly with the price-dividend ratio, producing small, negative ten-year discount rate news. The equivalent decomposition for earning growth expectations tells us that without any extra assumptions the first two horizons of earning growth expectations already account for 64% of the price-earnings ratio movements in the 1985 to 2015 period, and 98% in the 2003 to 2015 period.

C. Return Decomposition

This paper primarily focuses on determining how much of the variation in the price ratios is due to changes in cash flow growth expectations or return expectations. There is another popular decomposition in the literature from Campbell (1991) that measures the importance of revisions in cash flow growth expectations and return expectations for
explaining unexpected returns. This decomposition splits unexpected returns into revisions in dividend growth expectations and revisions in return expectations. We find that revisions in cash flow growth expectations also explain the vast majority of unexpected returns.

We start with the log-linearized return identity (1), and plug in equation (2) for \(pd_t\) and \(pd_{t+1}\) to derive the unexpected return as

\[
r_{t+1} - E^*_t [r_{t+1}] = \sum_{j=1}^{\infty} \rho^j (E^*_{t+1} [\Delta d_{t+j}] - E^*_t [\Delta d_{t+j}])
- \sum_{j=2}^{\infty} \rho^{j-1} (E^*_{t+1} [r_{t+j}] - E^*_t [r_{t+j}]).
\]  

(37)

For the sake of simplifying the equation, we simply express \(\Delta d_{t+1}\) as \(E^*_{t+1} [\Delta d_{t+1}]\). In words, this equation says that a positive unexpected return must be explained by an upward revision in expected current and future dividend growth or a downward revision in expected future returns. Because equation (2) did not require that these expectations are rational, this relationship can be applied to our subjective expectations.

The variance of the unexpected returns is then split into three terms, (i) the variance of the dividend growth revisions, (ii) the variance of the return revisions, and (iii) the covariance of the dividend growth and return revisions multiplied by negative two. Using the simple decay functional form from Section IV.B, we estimate the full horizon dividend growth and return expectations for 2003 to 2015 and then calculate the one-year revisions. We find that revisions to dividend growth expectations account for 96% of the variation in unexpected returns, revisions to return expectations account for 2%, and the covariance of dividend growth and return revisions accounts for 2%. Given that dividend growth revisions and return revisions are taken from completely independent surveys, it is remarkable that this decomposition sums almost exactly to 1. Just as in the other decompositions, the low volatility of the return expectations implies that their revisions are not a major source of variation, while the large movements in dividend growth expectations implies their revisions account for a substantial amount of the variation. Combining this result with our decomposition in Section IV.B, we conclude that changes in dividend growth expectations account for more than 90% of the variation in both the price-dividend ratio and unexpected returns.
VII. Conclusion

Stock price movements must be explained by changes in expected cash flows or changes in expected returns. Using subjective expectations based on survey data, we find that changes in subjective cash flow growth expectations account for the vast majority of movements in both the price-dividend ratio and the price-earnings ratio for the S&P 500. Subjective cash flow growth expectations vary significantly over time and rise with price ratios, even when price ratios do not predict future cash flows. Subjective return expectations are less volatile and do not move substantially with price ratios. Both subjective cash flow growth and return expectations show low persistence and the price ratio movements are primarily explained by changes to short-term cash flow growth expectations.

To explain these findings, we propose an asset pricing model with subjective beliefs about earnings growth reversal. Agents’ cash flow growth expectations are driven by their belief that shocks to earnings growth will be reversed by future earnings growth and that changes in earnings will be gradually integrated into dividends. This model accurately replicates the measured time-series for subjective cash flow growth expectations and the joint dynamics of subjective cash flow growth expectations and price ratios, as well as findings from the return extrapolation literature. These results highlight the importance of time-varying subjective cash flow growth expectations in determining aggregate stock prices.
References


Appendix

A. Data Aggregation for Dividend and Earnings Expectations

This section describes the process for the dividend expectations calculation. Earnings expectations are constructed analogously. Let the following variables be defined for each period $t$:

$D_{i,t}$ = ordinary dividend per share paid by company $i$ at time $t$

$P_{i,t}$ = price per share of company $i$ at time $t$

$S_{i,t}$ = shares of company $i$ at time $t$

$x_t$ = set of companies in S&P 500 at time $t$.

The total market value $M_t$ and dividends $D_t$ paid by S&P 500 constituents are defined as:

$$M_t = \sum_{i \in x_t} P_{i,t} S_{i,t}$$

$$D_t = \sum_{i \in x_t} D_{i,t} S_{i,t}.$$

Standard & Poor’s define the S&P 500 index ($SP500_t$) as the total market capitalization of the constituents $M_t$, adjusted by a divisor. The divisor is defined by Standard & Poor’s at every period to satisfy the following identity

$$\sum_{i \in x_t} P_{i,t} S_{i,t} / Divisor_t = SP500_t = \sum_{i \in x_{t-1}} P_{i,t} S_{i,t-1} / Divisor_{t-1}$$

(A1)

or,

$$Divisor_t / Divisor_{t-1} = \sum_{i \in x_t} P_{i,t} S_{i,t} / \sum_{i \in x_{t-1}} P_{i,t} S_{i,t-1}.$$  

(A2)

In other words, the divisor moves so that the value of the S&P 500 index is not affected by changes in the S&P 500 constituents or the number of outstanding shares issued. One result of this is that the index is not affected by share repurchases. In addition, the divisor is also adjusted whenever a special dividend is issued. Standard and Poor’s assume that the share price drops by the amount of the special dividend and adjust the divisor to offset this change in share price. Since the S&P 500 index is not affected by share repurchases or special dividends, we can think of the index as the value of a portfolio that automatically reinvests any special dividends or payments from share repurchases back into the portfolio.
Therefore, the only cash flow from this portfolio is the ordinary dividends paid by S&P 500 constituents. This is why we do not include special dividends or share repurchases in our measure of dividends.

The divisor is not publicly available, but we can back out the value of the divisor by using (A1) to obtain the simple ratio:

\[ \hat{\text{Divisor}}_t = \frac{M_t}{\text{SP}500_t}. \]

Once an estimate of \( \text{Divisor}_t \) is obtained for every quarter, we construct an aggregate dividend index for the S&P 500, expressed as:

\[ \text{Div}_t = \frac{D_t}{\hat{\text{Divisor}}_t}. \]

This dividend measure has been constructed ‘bottom-up’ from the individual ordinary dividend payments of each company. We can see in Figure A1 the performance of our dividend measure compared to the S&P 500 dividend reported by Robert Shiller and the dividends paid by the Exchange Traded Fund “SPY”, the largest replicating ETF of the S&P 500. The correlation of \( \text{Div}_t \) and the other dividend estimates in levels is very high (> 0.99).

If, instead of an aggregate dividend measure, we want to build an aggregate expected dividend measure, we can use a similar logic. The one-year subjective expected dividend for the S&P 500 can be described as:

\[ E_t^*[\text{Div}_{t+1}] = E_t^* \left[ \sum_{i \in x_{t+1}} D_{i,t+1} S_{i,t+1} / \hat{\text{Divisor}}_{t+1} \right]. \quad (A3) \]

Because dividend forecasts are made in levels, rather than in logs, we approximate subjective expected dividend growth as \( E_t^* [\Delta d_{t+1}] \approx \log (E_t^* [\text{Div}_{t+1}]) - \log (\text{Div}_t) \). As long as volatility is countercyclical, accounting for the Jensen terms from this approximation would only increase the procyclicality of \( E_t^* [\Delta d_{t+1}] \) and strengthen our result that subjective cash flow news is large.

In order to build our aggregate estimator \( E_t^*[\text{Div}_{t+1}] \), we need to make an assumption about how people form expectations about the future constituents and shares outstanding of the S&P 500. We assume that people expect that any changes in constituents or shares outstanding that may affect total dividends will be offset by changes in the divisor. Since the divisor adjusts to offset changes in total market value due to changes in constituents or shares outstanding, this simply means that people expect that changes in constituents or
Figure A1. Comparison of aggregate dividend measures. The figure compares four measures of the aggregate dividend for the S&P 500. The solid line Shiller contains the quarterly S&P 500 dividends obtained from Shiller (2015). The dashed line All Companies contains the aggregate quarterly dividends paid out by all S&P 500 companies. The dash-dotted line Forecasted contains the aggregate quarterly dividends paid out only by S&P 500 companies for which a one-year subjective dividend expectation exists. This value is then scaled by the ratio of the market value of all S&P 500 companies to the market value of S&P 500 companies for which a one-year subjective dividend expectation exists. The dotted line SPY contains the quarterly dividends paid out by the SPDR S&P 500 ETF.

Shares outstanding will have the same proportional effect on total dividends as total market value. In other words, we assume that people do not expect changes in constituents or shares outstanding to affect the price-dividend ratio of the S&P 500. A stronger assumption that would also be consistent with our methodology is to simply assume that people do not expect the constituents or shares outstanding to change over the next year. Assumption 1 implies that $E_t^* \left[ \sum_{x_{t+1}} D_{i,t+1} S_{i,t+1} / \text{Divisor}_{t+1} \right] = E_t^* \left[ \sum_{x_{t}} D_{i,t+1} S_{i,t} / \text{Divisor}_t \right] = \sum_{x_{t}} E_t^* [D_{i,t+1}] S_{i,t} / \text{Divisor}_t$.

Assumption 1. $E_t^* \left[ \sum_{x_{t+1}} \frac{D_{i,t+1} S_{i,t+1}}{D_{i,t+1} S_{i,t}} \right] = E_t^* \left[ \sum_{x_{t}} \frac{D_{i,t+1} S_{i,t}}{P_{i,t+1} S_{i,t}} \right].$

Given that we sometimes do not have expectations data for all firms in the S&P 500, we make a second assumption to construct $E_t^*[\text{Div}_{t+1}]$. Denote as $x_{t}^t \subset x_{t}$ the set of companies...
that have an expected value for horizon \( j \). We normalize by the ratio of total market value, \( M_t \), to the market value of the firms that have an expected dividend for horizon \( j \), \( M^j_t \). To do this, we assume that the firms that have an expected dividend are a representative sample of the S&P 500. Then \( E^*_t[Div_{t+1}] = (M_t/M^1_t) \sum_{i \in x^1_t} E^*_t[D_{i,t+1}] S_{i,t}/Divisor_t \).

**Assumption 2.**
\[
\sum_{i \in x^1_t} E^*_t[D_{i,t+1}] S_{i,t} = M_t \sum_{i \in x^j_t} E^*_t[D_{i,t+1}] S_{i,t}
\]
where \( M^j_t \) is the market value of firms in \( x^j_t \).

Assumption 2 becomes easier to satisfy the higher the coverage of firms with valid forecasts we have. To see that the firms included in the forecast are representative of the S&P 500 index, a fourth measure is shown in Figure A1. The behavior of the measure \( \hat{Div}_t = (M_t/M^1_t) \sum_{i \in x^1_t} D_{i,t} S_{i,t}/Divisor_t \) is very similar to \( Div_t \). This means that aggregate dividend constructions using only those companies with forecast for a certain horizon look very similar to the main aggregate dividend \( Div_t \). Furthermore, the correlation of all the measures both in growth and levels is very close to one, as shown in Table II.

The process to construct earnings expectations is identical to the dividend expectation construction. The time series for earnings span a longer time period and we have more firms with earnings forecasts than dividend forecasts in every quarter. The correlation tests for our earnings measure is shown in Table A1 and in Figure A2.

**B. Horizon Interpolation**

All firms in the I/B/E/S estimates database do not share the same fiscal year end date. In order to match a proper one-year forecast, different forecasts were used depending on the fiscal period of each firm’s estimation.

For instance, if the estimates are taken on April 15, 2004 for a firm with fiscal year ending in January, the \( FY_1 \) variable will show a forecast for January 31, 2005, \( FY_2 \) will present a forecast for January 31, 2006, \( Q_1 \) for May 30th, 2004 and so on. Given that we want an estimate for March 31th, 2005, we will interpolate \( FY_1 \) and \( FY_2 \) accordingly to obtain that firm’s 12-month estimate. When possible, we make use of \( Q_1 \) through \( Q_4 \) estimates to improve the interpolation procedure. The exclusion of the quarterly estimates does not affect the results.


Table AI

**Correlations of S&P 500 earnings measures**

The table shows the correlations for three quarterly time series spanning 1976Q1 to 2015Q3. **All Companies** contains the aggregate quarterly earnings reported by all S&P 500 companies. **Forecasted** contains the aggregate quarterly earnings reported only by S&P 500 companies for which a one-year subjective earnings expectation exists. **Shiller** contains the quarterly S&P 500 earnings obtained from Shiller (2015). Under the **Levels** columns, we calculate the correlation of the three series. Under the **Growth** columns, we calculate the log annual change of each of the three series and then take the correlations.

<table>
<thead>
<tr>
<th></th>
<th>Levels</th>
<th>Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forecasted</td>
<td>Shiller</td>
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<tr>
<td>All Companies</td>
<td>0.999</td>
<td>0.994</td>
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<td>Forecasted</td>
<td>0.990</td>
<td>0.946</td>
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</table>

Figure A2. Comparison of aggregate earnings measures. The figure compares three measures of the aggregate earnings for the S&P 500. The solid line **Shiller** contains the quarterly S&P 500 earnings obtained from Shiller (2015). The dashed line **All Companies** contains the aggregate quarterly earnings reported by all S&P 500 companies. The dash-dotted line **Forecasted** contains the aggregate quarterly reported only by S&P 500 companies for which a one-year subjective earnings expectation exists. This value is then scaled by the ratio of the market value of all S&P 500 companies to the market value of S&P 500 companies for which a one-year subjective earnings expectation exists.
Online Appendix

OAI. Additional Surveys

In addition to the one-year and ten-year return expectations obtained from the Graham-Harvey survey of Duke University (G-H), we use the Federal Reserve Bank of Philadelphia’s Livingston Survey (Livingston), the University of Michigan Survey of U.S. consumers (Michigan) and the Survey of Professional Forecasters (SPF) as additional measures of S&P 500 return expectations at different horizons. All surveys are annualized returns.

The Livingston Survey is conducted twice a year by The Federal Reserve Bank of Philadelphia and spans 1952 to 2016. The survey elicits forecasts of 18 different variables describing national output, prices, unemployment, and other macroeconomic data from 50-60 experts. Our variable of interest is the one-year expectation of stock market prices. Because it is prices and not returns that are forecasted, we can only build capital gains expectations $E_t^s \left[ \frac{P_{t+1}}{P_t} \right]$ and not return expectations $E_t^s \left[ \frac{P_{t+1} + D_{t+1}}{P_t} \right]$. Since dividends are very small compared to prices, we expect capital gains movements to be a reasonable proxy for the qualitative behavior of the expected returns. During the first years of the Livingston Survey, the S&P 400 industrial index was used as the forecasted index. Starting in 1990, the S&P 500 was forecasted instead. We use this survey due to the generous sampling period, obtaining similar results to the rest of the surveys.

The Michigan Survey of Consumers is conducted every month by the Survey Research Center, under the direction of the University of Michigan. The focus of the survey is on three areas: how consumers view prospects for their own financial situation, how they view prospects for the general economy over the near term, and their view of prospects for the economy over the long term. In 22 of the survey months between 2000 and 2005, the expected average return on the S&P 500 over the next 2 to 3 years was included in the questionnaire.

The Survey of Professional Forecasters is conducted quarterly by the Federal Reserve Bank of Philadelphia. One of the variables in the questionnaire is the forecast for the annualized average rate of return on the S&P 500 over the next 10 years. This variable is available annually from 1992 to 2015 and the respondents are professional forecasters, which is defined as those who produce regular forecasts of economic variables as part of their jobs in the business world or on Wall Street.
OAI. Risk-neutral Probabilities

One possible concern regarding the cash flow forecast analysis is that respondents may be using risk-neutral probabilities in their expectation process. This would imply that their return expectations are implicitly embedded in their responses. There are two possible reasons why the cash flow forecasts may be using risk-neutral probabilities. The first is that respondents may be intentionally using risk-neutral probabilities, that is, respondents may choose to report an adjusted expectation that overweight bad states. For example, forecasters may receive a greater punishment when they fail to predict cash flow drops than when they fail to predict cash flow increases. This type of asymmetric reward/punishment would cause respondents to knowingly make conservative forecasts that incorporate risk. The second reason is that respondents may be unintentionally using risk-neutral probabilities. It is possible that even when trying to report their expectations under the actual probabilities, respondents subconsciously put too much emphasis on the negative potential outcomes.

In both cases, we would see that respondents consistently underpredict future cash flows, either because they are knowingly reporting conservative forecasts or because they are subconsciously overweighting bad outcomes. In other words, if respondents are giving their expectations under risk-neutral probabilities then these expectations should be pessimistic. That is not what we observe in the cash flow growth expectations. Both dividend growth and earnings growth forecast errors have negative means, significantly different from zero. The expectations are slightly optimistic, the opposite of what we would expect if they were risk-neutral.

OAIII. Measuring Degree of Extrapolative Weighting

We apply the methodology of Cassella and Gulen (2018) to measure the degree of extrapolative weighting \((DOX_t)\) in the model return expectations. A higher \(DOX_t\) means that agents’ return expectations are more closely related to recent realized returns than previous realized returns. Specifically, we want to estimate the coefficient \(\lambda\) from the following equation

\[
E_t^m [r_{t+1}] = a + b \sum_{i=0}^{59} w_i R_{t-i}^Q + \varepsilon_t^{Exp} \tag{OAIII.1}
\]

where the weights \(w_i\) decay geometrically based on \(\lambda\).
The degree of extrapolative weighting is then defined as \( DOX \equiv 1 - \lambda \). A lower value of \( \lambda \) will indicate a higher degree of extrapolative weighting, since agents’ expectations will place a higher weight on recent returns relative to older returns.

Using a monthly series for earnings and dividends, we calculate the model one-year return expectations \( E^m_t [r_{t+1}] \) and the model price-dividend ratio \( pd^m_t \). Using the model prices, we calculate the quarterly model return in levels \( R^Q_t \) for each month. For any given month \( M \), a value of \( \lambda \) can be estimated using nonlinear least squares over the last \( \ell \) observations. Rather than use a single value for \( \ell \), the final estimate of \( DOX_M \) is based on a weighted sum of the \( \lambda \) estimates from multiple different window sizes \( \ell \). These four windows are the past 24, 36, and 48 months as well as an expanding window which uses all prior observations back to March 1976.

To determine the weights, we first calculate parameter estimates for months \( M - 12 \) to \( M - 1 \). For each of these twelve months, we estimate equation (OAI1.1) over each of the four windows. Then, for each window length and each of the 12 months, we calculate the 1-step-ahead forecast error. For example, for month \( M - 12 \) and window length \( \ell = 24 \), we estimate equation (OAI1.1) for \( t \in [M - 36 + 1, M - 12] \) and use these coefficients to calculate the forecast for month \( M - 11 \). The difference between this forecast and the expectation in \( M - 11 \) obtained from the model is stored as \( \varepsilon^{24}_{M-11} \). Repeating this for all 12 months, \( M - 12 \) to \( M - 1 \), gives a set of 12 forecast errors for each window length \( \ell \). We use these twelve values to calculate the mean squared forecast error (MSFE) for each window length \( \ell \). The weights are then the inverse of the MSFE, normalized so that the weights sum to 1. In other words, window lengths that produce high MSFE over the last 12 months will be given lower weights than window lengths with low MSFE.

Given these weights, we calculate a value for \( \lambda \) in month \( M \) by estimating equation (OAI1.1) over each of the different window lengths \( \ell \) and taking a weighted average. The value of \( DOX \) in month \( M \) is then \( 1 - \lambda \).

\[
    w_i = \frac{\lambda^i}{\sum_{k=0}^{59} \lambda^k}. \tag{OAIIII.2}
\]