Time Variation of the Equity Term Structure

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ABSTRACT

I study the term structure of one-period expected returns on dividend claims with different maturity. I find that the slope of the term structure is counter cyclical. The counter cyclical variation is consistent with theories of long-run risk and habit, but these theories cannot explain the average downward slope. At the same time, the cyclical variation is inconsistent with recent models constructed to match the average downward slope. More generally, the average and cyclicality of the slope are hard to reconcile with models with a single risk factor. I introduce a model with two priced factors to solve the puzzle.

Keywords: equity term structure, dividend strips, time-varying discount rates.

JEL classification: G10, G12.

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This paper documents cyclical variation in the term structure of equity returns. Understanding this variation is important for understanding which risks drive fluctuations in the equity risk premium. The cyclical variation documented in this paper suggests that fluctuations in the equity risk premium are driven mainly by long-maturity risks such as long-run risk dividend growth or discount rate risk, and less by short-maturity risks such as disaster risk. This finding is, however, a puzzle because it is inconsistent with the set of models that can replicate the average slope of the equity term structure. The cyclical variation is also important for understanding time variation in valuation ratios on equity claims and the extent to which this variation is predictable.

Previous research on the equity term structure focuses on its average slope. Binsbergen, Brandt, and Koijen (2012) and Binsbergen and Koijen (2017) document that the term structure is downward sloping on average, but Bansal, Miller, and Yaron (2017) argue that it could be upward sloping when liquidity is taken into account. The downward slope is inconsistent with traditional models of long-run risk and habit, which have upward sloping term structures. Addressing this challenge to traditional asset pricing models has become one of the most active areas in macro-finance (Cochrane (2017)), leading to the development of new models with average downward sloping term structures.[1]

I contribute to the literature on the equity term structure by studying its time-variation. My main result is that the equity term structure of one-period returns is counter cyclical – it is downward sloping in good times but upward sloping in bad times. As Figure 1 shows, this counter cyclical variation is economically large. In good times, long-maturity equity

[1]The reference model for a downward-sloping term structure is Lettau and Wachter (2007), which precedes the empirical literature on the downward sloping equity term structure. More recent models include Eisenbach and Schmalz (2013), Nakamura et al. (2013), Croce, Lettau, and Ludvigson (2014), Andries, Eisenbach, and Schmalz (2015), Belo, Collin-Dufresne, and Goldstein (2015), Hasler and Marfe (2016), Ai et al. (2018). Binsbergen and Koijen (2017) review the new theoretical models that have been motivated by the downward sloping terms structure.

claims has 4% lower expected annual return than short-maturity equity claims, but in bad times it has 5% higher expected return, meaning that the equity term premium increases by 9 percentage points from good to bad times.

– Figure 1 goes about here –

I document this new stylized fact using several alternative measures of term premia, sample periods, and data sources, as well as by also using futures returns as opposed to spot returns. Using dividend futures with maturities up to seven years, I find a positive relation between the ex ante dividend-price ratio and the ex post one-year return difference between long- and short-maturity dividend futures. The result also holds when using the market portfolio as the long-maturity claim, and it holds in the U.S. for the S&P 500, and internationally for the Nikkei 225, Euro Stoxx 50, and FTSE 100, although international results are weaker. Going beyond dividend futures, the result continues to hold when measuring the equity term structure using option implied dividend prices or the cross-section of stocks.[2]

The counter cyclical equity term premium represents a puzzle for asset pricing theory – none of our canonical asset pricing models are able to produce both the counter cyclical variation documented in this paper and the negative average documented by Binsbergen, Brandt, and Koijen (2012). As shown in the first two columns of Table I, the counter cyclical variation is consistent with the traditional macro-finance models such as Campbell and Cochrane (1999) and Bansal and Yaron (2004), but inconsistent with the new models with negative term premia.

– Table I goes about here –

Why might the term premium represent a puzzle for these models? The puzzle arises because we cannot explain both the average and the cyclicality of the term premium with

[2]I estimate a term premium mimicking portfolio in the cross-section of stocks by sorting stocks into portfolios based on cash flow duration.

a single risk factor. A single risk factor can explain the average downward slope by making near-future dividends riskier than distant-future dividends. But such a risk factor generally becomes more pronounced in bad times, in the sense that it commands a higher premium, which means that the risk factor makes the slope even more negative in bad times. To instead make the slope positive, we need an additional risk factor, in particular one that makes distant-future dividends risky during bad times. But in the standard asset pricing models, risk premia are often driven by a single risk factor. They need one more to explain the stylized facts.

I therefore introduce a new model that has two priced risk factors. In the model, shocks to dividends and discount rates are priced separately. The model is specified such that dividend risk pushes term premia downwards while discount rate risk pushes term premia upwards. On average, the effect of the dividend risk dominates and thus term premia are negative. In bad times, however, the price of discount rate risk goes up while the price of dividend risk remains constant, meaning term premia increase and become positive. Term premia are therefore counter cyclical.

I also study time-variation in the equity yield curve. Equity yields are similar to dividend-price ratios of individual dividends claims and can be thought of as a measure of hold-to-maturity returns. The term structure of hold-to-maturity returns differs substantially from the term structure of one-period returns referred to above. Indeed, the term structure of one-period returns fixes the holding period to, for instance, one year, and compares one-year returns on dividend claims across maturities. Differences in returns along this curve reflect term premia. In contrast, the term structure of hold-to-maturity returns compares returns on claims with different maturities that are held for different holding periods.[3] Differences in returns along this curve reflect both term premia and expectations about future returns, or yields.

[3]For instance, it compares the one-year return on the one-year claim with the annualized seven-year return on the seven-year claim.

Binsbergen et al. (2013) document that the equity yield curve is pro cyclical and steeply downward sloping in bad times.[4] Such a downward-sloping yield curve implies one or both of two things: either yields are expected to fall in the future or term premia are lower than usual. Since term premia are higher during bad times, the downward sloping yield curve observed during bad times cannot arise because of lower term premia.

Instead, the downward sloping yield curve observed during bad times must reflect that investors expect yields to fall in the future. For instance, the high yields observed during the financial crisis returned to pre-crisis levels within a few years. To the extent that investors expected such mean reversion, it would show up in a more downward-sloping equity yield curve. To understand the impact of expected future yields on the slope of the equity yield curve, I decompose the variance of the slope into expectations about yields and term premia. I find that expectations about yields is the main driver of variation in the slope, and thus that the slope is a good predictor of future yields.[5] The variance decomposition also shows that term premia are negatively correlated with the slope of the yield curve, consistent with term premia being counter cyclical and the slope being pro cyclical.

The time-variation in the equity yield curve represents an additional challenge for asset pricing models. If the equity term premium is too counter cyclical relative to the predictable time-variation in equity yields, the slope of the equity yield curve will be counter cyclical as well. For the models to have both a counter cyclical term premium and a pro cyclical slope of the yield curve, the models must feature large, predictable variation in equity yields.

The paper proceeds as follows. Section I defines equity term premia and equity yield spreads and studies these in leading asset pricing models. Section II describes the data.

[4]Binsbergen et al. (2013) also show that the term structure of hold-to-maturity returns is pro cyclical.

[5]This result contrasts the early results from the bond literature. For bonds, the slope mainly predicts term premia and future yields move in the opposite direction of what the yield curve suggests. See Shiller (1979); Shiller, Campbell, and Schoenholtz (1983), and Campbell and Shiller (1991).

Section III studies cyclical variation in equity term premia. Section IV studies time variation in equity yields. Section V studies real investment. Section VI introduces a new model that explains the empirical facts. Section VII concludes.

I. The Equity Term Structure in Leading Asset Pricing Models

To motivate the empirical analysis and generate testable implications, I first study time-variation in the equity term structure in leading asset pricing models. In section A, I define equity term premia and equity yield spreads and discuss general relations. In section B, I study time variation in these objects in leading asset pricing models.

A. *The Equity Term Structure*

A.1. Equity Term Premia

Equity term premia refer to one-period return premia on a long-maturity dividend claim in excess of a short-maturity claim,

$$\theta_t^{n,m} = E_t\left[R_{t+1}^n - R_{t+1}^m\right], \tag{1}$$

where R_{t+1}^n is the future-return between period t and $t+1$ on the claim to the dividends that are paid out in period $t+n$ and $n > m$.

I measure the cyclicality of equity term premia using a predictive regression of the realized return difference between the long-maturity and short-maturity claims on the ex ante dividend-price ratio,

$$R_{t,t+12}^n - R_{t,t+12}^m = \beta_0^{n,m} + \beta_1^{n,m}\left(d_t - p_t\right) + \epsilon_{t,t+12}, \tag{2}$$

where $d_t - p_t$ is the log of the dividend-price ratio of the index at time t. I use rolling regressions implemented at the monthly level.[6]

The motivation for the regression above is as follows. A high dividend-price ratio reflects either low growth rates, high interest rates, or high risk premia. Empirical evidence suggests that a high dividend-price ratio reflects high risk premia that arise due to a high price of risk (Campbell (1999)). If there is only one price of risk, all risk premia should increase (in absolute terms) when the price of risk increases, which means risk premia should increase when the dividend-price ratio increases. It is therefore natural to expect most risk premia, like term premia, to load on the ex ante dividend-price ratio.

Term premia may load either positively or negatively on the dividend-price ratio. Consider the case with only a single price of risk. If term premia are positive on average, they become even more positive when the price of risk increases, which means they load positively on the dividend-price ratio. In contrast, if term premia are negative on average, they become even more negative when the price of risk increases, which means they load negatively on the dividend-price ratio. In Section B, I show that this relation between the average and the cyclicality of term premia holds in leading asset pricing models. Given that term premia are negative on average, a natural null-hypothesis for the empirical analysis is thus that the slope coefficient in the predictive regression in (2) is negative, meaning that term premia are pro cyclical. Importantly, the above relation between the average and the cyclicality of the dividend-price ratio need not hold if there are multiple prices of risk, as explained later in Section VI.

[6] Throughout the paper, t is measured in months whereas maturity n and m are measured in years. When used together, as in $t + m$, then m is years measured in months.

A.2. Equity Yield Spreads

I also study time-variation in equity yields, which are similar to dividend-price ratios on individual dividend strips and defined as

$$e_t^n = \frac{1}{n}\left(d_t - f_t^n\right), \tag{3}$$

where e_t^n is the equity yield on the n-maturity claim, d_t is the log dividends at time t and f_t^n is the log futures price of the $t+n$ dividends at time t. By the definition of returns, equity yields are equal to the hold-to-maturity returns on the strip minus the hold-to-maturity growth rate of dividends,

$$e_t^n = \frac{1}{n}\sum_{i=1}^{n} r_{t+i}^{n+1-i} - \frac{1}{n}\sum_{i=1}^{n} g_{t+i}, \tag{4}$$

where r_{t+1}^n is the log futures return on the n-maturity claim between period t and $t+1$ and g_{t+1} is the log growth rate of dividends. Comparing the yield on a long-maturity and a short-maturity claim gives rise to the equity yield spread, $s_t^{n,m} = e_t^n - e_t^m$, which can be written as

$$s_t^{n,m} = c_1 \underbrace{\left(e_{t+m}^{n-m} - e_t^n\right)}_{\text{Changes in yields}} + c_2 \underbrace{\left(r_{t,t+m}^n - r_{t,t+m}^m\right)}_{\text{Term premium}}, \tag{5}$$

where $c_1 = (n-m)/m$ and $c_2 = 1/m$ are maturity adjustments.

The equity yield spread thus reflects both expected changes in future yields and equity term premia. I quantify the importance of these two factors through the variance decomposition

$$\mathrm{var}(s_t^{n,m}) = c_1 \mathrm{cov}\left(s_t^{n,m}; e_{t+m}^{n-m} - e_t^n\right) + c_2 \mathrm{cov}\left(s_t^{n,m}; r_{t,t+m}^n - r_{t,t+m}^m\right). \tag{6}$$

Further dividing (6) by $\mathrm{var}(s_t^{n,m})$ and defining $\gamma_1^{n,m} = c_1 \mathrm{cov}\left(s_t^{n,m}; e_{t+m}^{n-m} - e_t^n\right)/\mathrm{var}(s_t^{n,m})$

and $\gamma_2^{n,m} = c_2 \text{cov}\left(s_t^{n,m}; r_{t,t+m}^n - r_{t,t+m}^m\right)/\text{var}(s_t^{n,m})$ gives

$$1 = \gamma_1^{n,m} + \gamma_2^{n,m}. \tag{7}$$

A useful benchmark for the decomposition is the expectations hypothesis under which term premia are constant and yield spreads only reflect expectations about future yields. Under this hypothesis, $\gamma_1^{n,m}$ is equal to one.

Finally, I summarize the cyclicality of the equity yield spread using the regression:

$$s_t^{n,m} = \phi_0^{n,m} + \phi_1^{n,m} \left(d_t - p_t\right) + \eta_t. \tag{8}$$

Because the yield spread reflects term premia and future changes in yields, its cyclicality depends on the cyclicality of both of these factors. In general, we expect changes in yields to be pro cyclical because yields mean-revert (in bad times, when yields are high, yields are expected to go down in the future). If equity term premia are also pro cyclical, we should expect the yield spread to be pro cyclical as well. If equity term premia are counter cyclical, the yield spread may be either pro cyclical or counter cyclical, depending on whether the effect of term premia or expected changes in yields dominate.

B. The Equity Term Structure in Leading Asset Pricing Models

I study the models of Campbell and Cochrane (1999), Bansal and Yaron (2004), and Lettau and Wachter (2007) using simulation studies. To do so, I run 10,000 simulations of 100 years of artificial data for each model and calculate median estimates of the key parameters of the previous section. The results are summarized in Table II. As expected, equity term premia are either positive and counter cyclical or negative and pro cyclical.

B.1. The Habit Model by Campbell and Cochrane (1999)

In the habit model of Campbell and Cochrane (1999), distant-future dividends are risky because they are highly exposed to discount rate risk. When consumption drops, discount rates go up, depressing the value of dividends. This effect is stronger for distant-future claims because the increase in discount rates is persistent and accumulates over the horizon, making investors require a premium on distant-future dividends. In bad times, the price of risk increases, which causes investors to require an even higher premium on distant-future dividends. The term premium is thus counter cyclical.

The simulations confirm this economic intuition. As can be seen in Table II, the equity term premium is positive and counter cyclical. The parameter estimate $\beta_1^{Mkt,2}$ is 0.17, which is large in absolute terms: the model is calibrated to have a standard deviation of the dividend-price ratio of 0.26, which means that a one-standard-deviation change in the dividend-price ratio changes the term premium by around four percentage points. The simulations also show that the equity yield spread mainly reflects variation in the equity term premium, and not changes in expected future yields ($\gamma_1^{5,1} < 0$). The equity yield spread thus becomes counter cyclical like the term premium ($\phi_1^{5,1} > 0$), although the effect is quite modest.

– Table II goes about here –

B.2. The Long-Run Risks Model by Bansal and Yaron (2004)

In the long-run risk model of Bansal and Yaron (2004), distant-future dividends are risky because they are highly exposed to shocks to growth rates and to shocks to the volatility of growth rates. Investors are averse to both of these shocks and therefore require a premium on claims to distant-future dividends, which means that the term premium is positive. In bad times, the risk premium on growth rate risk increases, which causes investors to require an even higher premium on distant-future dividends.[7] The term premium is thus counter cyclical.

The simulations in Table II confirm this economic intuition.[8] The parameter estimate $\beta_1^{Mkt,2}$ is 0.03, which is well below the habit model. The estimate is higher if one uses the calibration from Bansal, Kiku, and Yaron (2012). In addition, the simulations show that the equity yield spread mainly reflects variation in the expected future yields ($\gamma_1^{5,1}$ is close to one). The relative importance of the term premium depends on the exact specification of the model and varies between the specification in Bansal and Yaron (2004) and Bansal, Kiku, and Yaron (2012). Finally, the equity yield spread is pro cyclical. The pro cyclical variation is driven by the pro cyclical variation in expected changes in yields.

B.3. The Model by Lettau and Wachter (2007)

In the model of Lettau and Wachter (2007), a negative shock to dividends is associated with a positive shock to dividend growth rates. This long-run insurance makes distant-future dividends less risky than near-future dividends, that is, it makes the term premium negative. In bad times, the price of risk goes up and investors therefore require an even higher premium for holding the risky near-future dividends. The term premium is thus pro cyclical.

The simulations in Table II confirm this economic intuition as $\beta_1^{Mkt,2}$ is equal to -0.12. The simulations further show that the yield spread reflect term premia and expected changes in yields, with $\gamma_1^{5,1} = 0.62$. As both of these are pro cyclical, the equity yield

[7]It is in fact the quantity of growth rate risk, and not the price of growth rate risk, that increases. Unlike the habit model, which essentially has time-varying risk aversion, the long-run risk model has constant risk aversion but the model has time-varying quantity of risk, which behaves like a time-varying price of risk in the stochastic discount factor.

[8]Because the long-run risk model has a non degenerate risk-free bond term structure, I subtract the corresponding bond return in the simulation to get forward returns.

curve is pro cyclical as well ($\phi_1^{5,1} < 0$).

B.4. Additional Models

The new models of Hasler and Marfe (2016) and Ai et al. (2018) behave similar to the Lettau and Wachter (2007) model: they both generate negative and pro cyclical equity term premia (I do not simulate the models here because the authors explicitly state the average and the cyclicality of the equity term premium in their papers). Table I also considers the Gabaix (2012) model. In this model, there is no spot equity term premium because all dividends are equally exposed to disaster risk (see the online appendix of Binsbergen et al. (2012)).

II. Data

Dividend futures: Dividend futures and swaps are claims to the dividends that go ex dividend during a given calendar year. For instance, the 2018 dividend futures for the S&P 500 are claims to the dividends that go ex dividend for the S&P 500 during 2018. I use proprietary data from a major financial institution on dividend swap prices for the S&P 500, Nikkei 225, FTSE 100, and Euro Stoxx 50.[9] The data are from January 2003 to April 2016. The first expiration year is 2007 for all indexes except the Nikkei 225, for which the first expiration year is 2008, meaning prices of one-year claims become available at the end of 2006 and 2007. The last expiration year is 2020. I supplement the data with prices of exchange-traded dividend futures, downloaded from Bloomberg, that become available

[9]The literature uses financial institutions' internal dividend swap prices for the early sample where the exchange-traded dividend futures are not yet available. I follow the literature in referring to these as dividend futures despite the fact that they predate the exchange-traded product (see Binsbergen et al. (2013) and Binsbergen and Koijen (2017)).

over the sample.[10] The last observation in the sample is July 2019. See Binsbergen et al. (2013) for more detail on dividend futures and swaps.

I calculate annual returns as the return to buying a dividend future of a certain maturity and selling it again one year later when the maturity is one year shorter.[11] Because the contracts expire in December, the maturity of the available contracts varies over the calendar year. To get constant-maturity prices, I interpolate across the prices of different contracts each month, following the norm in the literature (see Binsbergen et al., 2013; Binsbergen and Koijen, 2017; Cejnek and Randl, 2016).

Option-implied dividend prices: Binsbergen, Brandt, and Koijen (2012) make their estimated time series of dividend returns available online. These are monthly returns for dividends on the S&P 500 and the sample runs from 1996 to 2009. Binsbergen, Brandt, and Koijen (2012) estimate the return on next year's dividends and the return on the dividend two years ahead. I calculate annual returns by annualizing the monthly returns to the one- and two-year claims. Boguth et al. (2012) argue that there may be noise in the option-implied dividend prices, and I therefore windsorize the monthly return at the 99% level to reduce the effect of potential outliers.

Cross-section of equity: Stock returns are from CRSP and fundamentals are from Compustat. I measure book-to-market following Fama and French (1993). Portfolio breakpoints are calculated each June using the most recent characteristics starting from the end of the previous year. Portfolios are rebalanced at the end of each calendar month. The

[10] I switch to the exchange-traded prices on January 2014 for the Euro Stoxx 50 and Nikkei 225, July 2015 for the FTSE 100, and December 2015 for the S&P 500. For the S&P 500, the six- and the seven-year claim is missing from 2014 to 2016. For the FTSE 100, the seven-year claim is missing from 2014 until the end of the sample and the six-year claim is missing for the first half of 2015. I consider claims with one to seven year maturity following Binsbergen and Koijen (2017).

[11] The one-year claim cannot be resold after a year because it has expired. I therefore calculate one-year returns to the one-year claim as the return to buying the dividend future and one year later receiving the dividends that were paid out over the year. I thank the referee for suggesting this method.

sample excludes stocks without property, plant, and equipment (PPEN) and number of employees in Compustat, as these are required when calculating the capital-to-labor ratio in the analysis of real effects.

Indexes: I obtain the dividends and prices for the S&P 500 from Robert Shiller's webpage. For the international indexes, I obtain dividends from Bloomberg and index prices from Compustat. All index returns come from Bloomberg.

III. Counter Cyclical Term Premia: A New Stylized Fact

In this section, I study cyclical variation in equity term premia through the predictive regressions in (2). I first study regressions of overlapping one-year returns in rolling monthly regressions using the full sample of dividend futures.[12] I then document robustness using other sample periods and other measures of equity term premia.

Panel A in Table III shows the estimates of the slope coefficient $\beta_1^{n,m}$ for the S&P 500. The parameter estimates are positive for all maturity pairs. The positive parameter estimates suggest that term premia increase when the dividend-price ratio increases, which is to say that the term premia are counter cyclical.

The estimates of $\beta_1^{n,m}$ are large in magnitude. Consider, for instance, the premium of the five-year claim in excess of the two-year claim. The loading on the dividend-price ratio is around 0.28, suggesting that the term premium increases by 28 percentage points annually when the log dividend-price ratio increases by one unit. To interpret this number, note that the the log dividend-price ratio is on average -4.0 when below the median and -3.8 when above the median, implying that the term premium is around six percentage

[12] As explained in Section II, the availability of dividend futures varies across maturities. Since the first expiration date for the S&P 500 is 2007, the maturity pairs with $m = 1, 2$, and 3 become available at the end of 2006, 2005, and 2004, respectively. I use the longest samples possible for all regressions.

points higher when the dividend-price ratio is above the median.

– Table III goes around here –

Below the estimates I report p-values for the hypothesis that the estimates are less than or equal to zero. To account for Stambaugh (1999) bias and size distortions, I simulate distributions of parameter estimates under the null of no predictability and calculate p-values based on these distributions. Details on the simulations are reported in the Appendix. Most of the estimates are significant except for term premia measured in excess of the three-year claim. Table AII in the Appendix report standard errors calculated using conventional methods, which lead to higher levels of statistical significance as discussed below in Section III.C.

In the rightmost column, I include the market portfolio as the long-maturity claim. Because the return to the market portfolio is not a futures contract, I must correct for the effect of interest rates. Following Binsbergen and Koijen (2017), I subtract from the market portfolio the return on a 30-year Treasury over the same period. The term premia that have the market as the long-maturity claim are all counter cyclical.

The results in the international sample for Nikkei 225 are largely similar to those in the U.S. The parameter estimates for the term premia in excess of the one- and two-year claim are positive and generally statistically significant. The estimates in excess of the three-year claim are also generally positive but they are statistically insignificant. In Europe, the parameter estimates are positive and significant only when measured in excess of the one-year claim.

Taken together, the results in Table III provide both statistically and economically significant evidence that equity term premia are counter cyclical. Given that equity term premia are negative on average (Binsbergen, Brandt, and Koijen (2012) Binsbergen and Koijen (2017)), the results thus reject a large class of models (see Section I and Table II).

I conduct several robustness checks. First, one possible concern is that the results are driven by a single observation such as the global financial crisis of 2008. One way see that the results are not only driven by the financial crisis is to plot the time series of the term premium and the dividend-price ratio in Figure 2. The figure shows for each date the dividend-price ratio and the realized return difference between long- and short-maturity claims over the subsequent two years. Consider, for instance, the Euro Stoxx 50 and the FTSE 100 in Panels C and D. As can be seen on the dividend-price ratios, the indexes go through two crises: the financial crisis in 2008 and the European sovereign debt crisis in 2011. In both instances, the term premium increases substantially. The results are similar for the Nikkei 225, which goes through the financial crisis and a crisis following the Tohoku earthquake in 2011. Finally, Panel A considers the S&P 500, for which the time series goes all the way back to 1996. The figure shows that the term premium tracked the dividend-price ratio through the tech bubble and financial crisis, again underlining the generality of the counter cyclical term premium. The early sample for the S&P 500 is based on option-implied dividend prices, which I analyze in depth in Section III.A. The Internet Appendix reports further robustness analysis excluding the financial crisis.[13]

– Figure 2 goes about here –

Another concern is that the use of interpolated prices gives misleading returns. I address this concern in end-of-year regressions in Table IV. At the end of each year, I regress future one-year returns on the ex ante dividend-price ratio. By running such end-of-year regressions, I avoid having to interpolate prices across maturities as annual contracts are traded at the end of the year. In addition, I avoid the mechanical autocorrelation in residuals that arises from using overlapping observations.

As shown in Panel A of Table IV, the parameter estimates remain positive for all S&P 500 maturity pairs, suggesting that they are not artifacts of interpolated prices. The

[13]The Internet Appendix is available in the online version of the article on the *Journal of Finance* website.

estimates are almost all statistically significant, except for the premia measured in excess of the three-year claim.

– Table IV goes about here –

I obtain similar results in the international sample as presented in Panel B. For the international sample, I report only three maturity pairs for each index: the five-year in excess of the one-year claim, the market in excess of the one-year claim, and the market in excess of the average dividend futures. The estimates are all positive. When measured in excess of the one-year claim, the estimates are all statistically significant. When measured as the market in excess of the average dividend future return, the estimates remain highly statistically significant for the FTSE 100 and Euro Stoxx 50 but are only marginally statistically significant for Nikkei 225.

I next use quarterly instead of annual returns in the rolling regressions from (2). Panel A in Table V reports the results for the S&P 500. As with the annual returns, the parameter estimates are all positive, but the counter cyclical effect is weaker as the slope coefficients are relatively low and the levels of significance are lower. The weak effect in the quarterly data arises mainly because of timing effects that cause the predictability in quarterly data to look lower when using the dividend-price ratio as the predictor variable. Indeed, predicting quarterly market returns with the dividend-price ratio results in a slope coefficient that is substantially below what is implied by the annual data in this sample.[14] This discrepancy between quarterly and annual results may come from the fact that rolling annual dividends are not an appropriate measure of dividends at the quarterly horizon: when dividends are cut sharply in one quarter, the dividend-price ratio will be too high because the rolling annual dividends do not reflect the actual level of dividends being paid.

[14] Regressing the quarterly log market return on the dividend-price ratio gives a slope coefficient of 0.08 whereas that implied from annual regressions is around 0.15 (this implied value comes from assuming that the log dividend-price ratio follows an AR(1) process and that lags of the dividend-price ratio do not predict residuals in the quarterly regressions).

– Table V goes about here –

To account for such timing issues, one can use expected dividends rather than realized past dividends in the dividend-price ratio. These can be measured using survey expectations or using the price of next year's dividends, the latter of which is natural in the context of this paper. Panel B of Table V thus reports slope coefficients from the predictive regressions with $f_t^1 - p_t$ as the predictor variable in the quarterly data. The slope coefficients are substantially higher and almost all of them are statistically significant.

Finally, the results in the quarterly data are stronger when excluding the financial crisis, suggesting that these timing issues are limited to the financial crisis (see the Internet Appendix).

The analyses above use the dividend-price ratio to capture good and bad times, for multiple reasons. First, much of asset pricing research revolves around understanding the relation between expected returns and the dividend-price ratio (Cochrane (2011)). In addition, the dividend-price ratio is well defined in all of the models studied in Section I.B and it is easy to construct for all of the countries I consider. However, to ensure that term premia are not counter cyclical only when measured using the dividend-price ratio, Table AIII in the Appendix reports results of predictive regressions where I use alternative predictor variables. Specifically, I consider the annual change in consumption, the cay variable from Lettau and Ludvigson (2001), the Chicago Fed National Financial Conditional Index (NFCI), and the output gap, as explained in the table notes. Bad times as measured by these variables are associated with higher term premia. Thus, the counter cyclical term premia are not unique to using the dividend-price ratio as the predictor variable.

I next confirm the results using other measures of equity term premia over different sample periods. In particular, I estimate the equity term premium by using option-implied dividend prices from Binsbergen, Brandt, and Koijen (2012) and by using the cross-section of stock returns. Neither of these measures is as direct as the dividend futures, but using them allows me to consider a sample period that goes as far back as 1963 and to verify that the counter cyclical equity term premium is not an artifact of the dividend futures.

A. *The Equity Term Premium Implied from Options Prices*

Binsbergen, Brandt, and Koijen (2012) use options prices to estimate the present value of future dividends. The intuition behind their method is as follows. When you buy the index you get next year's dividends plus next year's resale price. By going short a call option and buying a put option you can hedge the resale price such that you are certain only to get next year's dividends. The price of buying the stock and hedging the resale price thus reflects the price of the dividends. The option-implied dividend prices are available for the one- and two-year dividends.

To measure the cyclicality of the option-implied equity term premium, I again regress the rolling one-year realized return difference between long- and short-maturity claims onto the ex ante dividend-price ratio. Because the option-implied dividends prices are spot prices, I consider both spot and future returns in the regressions.

The parameter estimates of the predictive regressions are all positive, as shown in Panel A of Table VI, meaning that the equity term premia are counter cyclical. In addition, the estimates are similar in magnitude to those based on the dividend futures in Table 3, suggesting that the counter cyclical equity term premia are stable across both sample period and data source.

– Table VI goes about here –

The statistical significance of the estimates is lower than in the dividend futures data, with the majority of the estimates being significantly positive only at the 10% level. The lower significance partly arises from the shorter sample length and the fact that the option-implied dividends have more volatile returns than the futures. This high volatility may come from measurement error or from high short-maturity discount rate variation in the early sample. Regardless, the results remain marginally significant for spot returns, and the fact that I obtain similar parameter estimates when using option implied dividends and dividend futures suggests that the counter cyclical equity term premia in Table III are neither an artifact of the sample period nor specific to the data source.[15]

To increase statistical power, I next increase the sample length by splicing the option implied data with the dividend futures data. I create a time series from 1996 to 2019 that includes the return to the one- and two-year dividend claim and the market. I use the return from the option-implied dividends from 1996 until the dividend futures become available, and the return on the dividend futures after that.

As can be seen in Panel B of Table VI, the equity term premia are counter cyclical in the spliced data. In addition, the parameter estimates are all statistically significant at either the 5% or 10% level.

B. The Equity Term Premium in the Cross-Section of Stocks

I next study the equity term premium in the cross-section of stocks. I create a mimicking portfolio of the equity term premium in the 1963 to 2015 U.S. sample and find that it has counter cyclical expected returns.

I use the measure of cash flow duration from Dechow, Sloan, and Soliman (2004), who forecasts the cash flows of individual stocks and calculates their duration based on that forecast.[16] The duration measure is highly correlated with the book-to-market characteristic. Because the book-to-market characteristic has its own cyclical properties,[17] this high corre-

[15] A previous version of this paper used annualized returns to a monthly long-minus-short portfolio in this section, rather than the difference between an annualized long-maturity return and an annualized short-maturity return. When measuring the equity term premium this way, the significance is higher for the option-implied dividends.

[16] I use the specifications in Weber (2018) to estimate cash flow duration. I thank Michael Weber for sharing data.

[17] For instance, Asness et al. (2017) argue that the time-variation in the value premium mostly comes

lation is a problem for identifying the cyclical properties of the equity term premium, and I therefore use a double sort to create duration sorted portfolios that are book-to-market neutral.[18]

I first stocks into two groups based on the NYSE median book-to-market. Within each of these groups, I sort stocks unconditionally into five portfolios based on duration. The breakpoints for duration are based on the full time series of NYSE stocks, which means I use the same breakpoints every month. I do that to ensure that the duration of the individual portfolios is as constant as possible over time, which is necessary for estimating the cyclicality of the equity term premium.[19] Finally, I average across the book-to-market sort to get five portfolios sorted on duration. Because the returns are spot and not future returns, I subtract the appropriate U.S. Treasury bond return.

Table VII reports the duration, average return, and cyclicality of the five duration-sorted portfolios as well as the long-short portfolio that is long the long-duration portfolio and short the short-duration portfolio. The long-short portfolio can be interpreted as a mimicking portfolio of the equity term premium. The average return is slowly decreasing in duration, consistent with a downward-sloping term structure, but the effect is not statistically significant, as can be seen by the insignificant excess return of the long-short portfolio in column (6).

– Table VII goes about here –

More importantly, the loading on the dividend-price ratio increases as duration increases, implying that the equity term premium is counter cyclical. The effect is statis-

from potentially behavioral drivers that are unrelated to duration.

[18]If I instead sort only on duration, I find qualitatively similar results, but the statistical significance is lower.

[19]Indeed, if the term structure of returns is not flat and the duration of the mimicking portfolio varies over time, its expected return may vary even if the slope of the term structure is constant because, when its duration varies, the mimicking portfolio moves up or down the term structure.

tically significant, as can be seen in the long-short portfolio in column (6). To ease the comparison with the previous results, I run the analysis using annualized returns in column (7). For the annualized returns, the loading on the dividend-price ratio is 0.13 and the R^2 is 0.08. Considering that the long-short portfolio is long a 22-year claim and short a nine year claim, this parameter estimate appears consistent with the results in the previous sections.

In conclusion, the results suggest that the equity term premium is also counter cyclical when measured in the cross-section of stocks from 1963 to 2015.

C. Statistical Remarks

The predictive regressions in the previous section are subject to a potential Stambaugh bias (Stambaugh (1999)). While the simulated p-values already account for this bias, a comment is in order. The Stambaugh bias in the parameter estimates arises when one predicts returns with a persistent predictor that has innovations that are negatively correlated with realized returns. The bias is of particular concern in small samples, but the biases in this paper are generally small, as reported in the Internet Appendix. The biases are small for two reasons. First, because the left hand side in the predictive regressions is a long-short portfolio that is both long and short an equity claim, the returns are less strongly linked to innovations in the dividend yield. Second, the dividend-price ratio is not as persistent in this sample as in the long sample (the dividend-price ratio always appears less persistent in-sample (Kendall, 1954), but the persistence is low in this sample even after correcting for this bias).

Table AII in the Appendix reports results using different heteroscedasticity and autocorrelation robust standard errors, including Newey-West (Newey and West (1987)) errors, Hansen-Hodrick errors (Hansen and Hodrick (1980)), and heteroscedasticity and autocorrelation consistent errors where the long-run variance is estimated using the equal weighted periodogram estimator in Lazarus, Lewis, and Stock (2017). These standard errors imply p-values that are below the p-values from the main analysis, meaning that the p-values from the simulations are more conservative.

IV. Time Variation in the Equity Yield Curve

Figure 3 plots the time series of equity yields on the two-, five-, and seven-year claim. The yield spreads on these yield curves are all pro cyclical. Consider, for instance, the yields for the S&P 500 in the top left corner. Yield spreads are positive from 2005 to 2008, negative during the crisis in 2008 to 2009, and positive from 2010 and forwards.

– Figure 3 goes about here –

To understand this pro cyclical variation in yield spreads, recall from (5) that yield spreads reflect expectations about future changes in yields and term premia. The pro cyclical variation therefore implies that either term premia or changes in yields are pro cyclical. As term premia are counter cyclical, the pro cyclical yield spreads must arise from the fact that expected changes in yields are pro cyclical. That is, in bad times, when yields are high, yields are expected to decrease in the future. As mentioned in Section I.A.2, it is natural that expected changes in yields are pro cyclical: investors expect yields to mean-revert over time. However, what might be surprising is that the effect of these expected changes in yields is strong enough to dominate the counter cyclical effect of the term premia. Indeed, it implies that yield spreads predominantly reflect expected changes in yields, and only to a smaller extent term premia.

I quantify the role of expected changes in yields by running the variance decomposition in (7). I decompose the variance of the yield spread into the part that comes from expected changes in yields, $\gamma_1^{n,m}$, and the part that comes from term premia, $\gamma_2^{n,m}$. The first row of Panel A in Table VIII reports $\gamma_1^{m,m}$ for the spreads in excess of the one-year claim for the S&P 500. The parameter estimate is 1.1 at the short horizon ($n = 2$), suggesting that the yield spread almost only reflects changes in yields (the expectations hypothesis almost holds for this maturity pair). The parameter steadily increases to 1.5 at the long horizon, suggesting that the majority but not all variation in equity yield spreads comes from expected changes in yields.

The fact that $\gamma_1^{n,m}$ is larger than one implies that $\gamma_2^{n,m}$ is negative (the two sum to one). Yield spreads are thus negatively correlated with equity term premia, consistent with the former being pro cyclical and the latter being counter cyclical. It is worth noting that previous research interprets variation in the equity yield spread as a measure of variation in equity term premia, but the negative correlation between the two suggests that this interpretation is inappropriate.

– Table VIII goes about here –

Finally, the positive $\gamma_1^{n,m}$ means that yield spreads reflect expected changes in yields, but one might further be interested in knowing whether these expectations reflect expected changes in growth rates or changes in discount rates. Indeed, recall from (4) that yields are the difference between hold-to-maturity discount rates and hold-to-maturity growth rates. Changes in yields thus reflect changes in one or both of these two. In the Internet Appendix, I separate yields into expectations about growth rates and discount rates using the VAR framework in Binsbergen et al. (2013). I find that yield spreads reflect expected changes in both discount rates and in growth rates.

In conclusion, variation in equity yield spreads reflects both variation in term premia and variation in expectations about future yields. Term premia are counter cyclical and expectations about future yields are pro cyclical. Expectations about future yields dominate the yield spreads, which are thus pro cyclical as well. These findings are inconsistent with some of the models studies earlier, as summarized by Table II.

Finally, the equity yield curve can be used to predict variation in the dividend-price ratio of the market portfolio. Indeed, the expected dividend-price ratio is given by the no-arbitrage condition,

$$E_t[d_{t+n} - p_{t+n}] = p_t^n - p_t^C - E_t[r_{t+n}^C - r_{t+n}^n], \tag{9}$$

where $p_t^n = \ln(P_t^n)$ is the log spot price of the n-period dividend at time t, $p_t^C = \ln\left(\sum_{i=n+1}^{\infty} P_t^i\right)$ is the log price at time t of buying all dividends after period $t+n$ (that is, the price of buying the market portfolio and selling all dividends between period t and $t+n$) and r_{t+n}^n, and r_{t+n}^C are the associated log returns. Abstracting from the term premium in (9), the price ratio $p_t^n - p_t^C$ can be used as a model-free ex ante estimate of expected future dividend-price ratios on the market portfolio. I find that the price ratio predicts one-year changes in the dividend-price ratio of the market portfolio with an R^2 ranging from 44% in Europe to 21% in the U.S. (see the Internet Appendix).

V. Real Effects: Cyclicality in the Relative Investments of Long- and Short-Maturity Firms

The counter cyclical equity term premium influences the cost of capital and therefore may influence firm investment. If there are no frictions, a high equity term premium may decrease the incentive to invest in long-maturity projects relative to short-maturity projects, as these are discounted more heavily over the next period. If so, we should expect long-duration firms (i.e., firms that produce distant future cash-flows) to invest less relative to short-duration firms during bad times, when equity term premia are larger. I formalize this conjecture in a simple model in the Internet Appendix.

I analyze investment in the cross-section of stocks by using the duration-sorted portfolios constructed earlier in Section III.B. I calculate different investment characteristics for the short- and long-duration portfolio and analyze how they covary with the dividend-price ratio in the following monthly regression:

$$X_t^i = b_0 + b_1(d_t - p_t) + \text{controls}_t + e_t \qquad (10)$$

where X_t^i is the investment characteristic at time t, measured in cross-sectional percentiles.

I consider both total capital and capital-to-labor. Capital is the value of property, plant, and equipment (PPEN) from Compustat and capital-to-labor is PPEN divided by the number of employees from Compustat.

Table IX Panel A presents the results on the capital-to-labor ratio. The loading on the dividend-price ratio is lower for the high-duration portfolio than for the short-duration portfolio, suggesting that the long-duration firms decrease their capital-to-labor ratio more in bad times than short-duration firms. The difference is statistically significant, as can be seen for the long-short portfolio. In column (7), I include an NBER dummy variable and the Treasury yield, both of which are statistically insignificant.

– Table IX goes about here –

In the two rightmost columns, I split the sample into pre- and post-1989. The capital-to-labor ratio of the long-short portfolio is pro cyclical in both samples, but the parameter estimates are statistically insignificant and on average slightly lower than the full sample estimate. In addition, R^2 is also lower than the full sample R^2. These results suggest that part of the pro cyclical movement of the capital-to-labor ratio of the long-short portfolio comes from secular movements in the dividend-price ratio and the equity term premium.

Table IX Panel B considers capital instead of the capital-to-labor ratio. As with the capital-to-labor ratio, I find that long-duration firms decrease capital more than short-duration firms in bad times. This difference is both economically and statistically more significant than for the capital-to-labor ratio. Again, the result is robust to controls and to a sample split.

Taken together, the results show that the real activities of short- and long-duration firms have different cyclical properties. These cyclical properties are consistent with the counter cyclical equity term premium.

VI. Reconciling the Facts with Theory: A Model with Negative and counter cyclical Term Premia

The time-variation in the equity term structure is inconsistent with the established asset pricing models studied in Section I.B. Most importantly, none of the models generate term premia that are both negative on average and counter cyclical. To understand what is needed to explain the stylized facts, I introduce a new model based on an exogenous stochastic discount factor.

One can explain the stylized facts by having equity term premia depend on two shocks that have different prices of risk. If these two shocks have opposing effect on the slope of the equity term structure, one shock can generate the average downward slope while the other generates the counter cyclical variation.

I obtain these dynamics by having shocks to dividends and discount rates priced separately. I use dividend risk to generate the negative average and discount rate risk to generate the counter cyclical variation. Dividend risk pushes term premia downwards for reasons similar to Lettau and Wachter (2007). Discount rate risk pushes term premia upwards. On average, the effect of dividend risk dominates and term premia are therefore negative. In bad times, however, the price of discount rate risk goes up while the price of dividend risk remains constant. Term premia therefore increase and become positive, which means they are counter cyclical. Key to model is thus that price of dividend risk is constant while the price of discount rate risk varies. I explain how and why the dividend risk and discount rate risk influence term premia in detail in Section D.[20]

[20] Gonçalves (2020) explicitly links the term structure to cash flow and discount rate risk, finding that

The Internet Appendix presents an alternative model that generates the average downward slope through discount rate risk and the counter cyclical variation through long-run risk in dividends. For this model to reproduce the empirical facts, investors must put a negative price on discount rate risk, which is difficult to reconcile with standard economic models: increases in discount rates lead to decreases in prices, which is usually a bad thing for investors.[21]

A. Model

The economy has an aggregate equity claim with dividends at time t denoted by D_t, where $d_t = \ln(D_t)$ evolves as

$$\Delta d_{t+1} = \mu_g + z_t + \sigma_d \varepsilon_{t+1}. \tag{11}$$

Here, $\mu_g \in \mathbb{R}$ is the unconditional mean dividend growth and z_t drives the conditional mean,

$$z_{t+1} = \varphi_z z_t + \sigma_z \varepsilon_{t+1}, \tag{12}$$

where $0 < \varphi_z < 1$. The 3×1 vector ε_{t+1} contains three independent standard normal shocks. The loadings of the two processes on these shocks are summarized in the row vectors σ_d and σ_z.

The risk-free rate r^f is constant and the stochastic discount factor is denoted by M_{t+1},

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the variation in the term structure can be explained by these constructs.

[21]In Campbell (1993), Campbell and Vuolteenaho (2004), and Bansal and Yaron (2004), for instance, discount rate risk has a lower price than cash flow risk, but it nonetheless has a positive price.

where $m_{t+1} = \ln(M_{t+1})$ is given by

$$m_{t+1} = -r^f - \frac{1}{2}(x_d^2 + x_t^2) - x_d \frac{\sigma_d}{|\sigma_d|}\varepsilon_{t+1} + x_t \frac{\sigma_x}{|\sigma_x|}\varepsilon_{t+1}. \tag{13}$$

Here $x_d \in \mathbb{R}^+$ is the price of risk on the shock to dividends and x_t is the price of risk on the shock to the process x_t itself, which evolves as

$$x_{t+1} = (1 - \varphi_x)\bar{x} + \varphi_x x_t + \sigma_x \varepsilon_{t+1}. \tag{14}$$

The parameter $\bar{x} \in \mathbb{R}^+$ is the long-run mean and the row vector σ_x summarizes the loadings of the process on the three shocks. I assume that $\sigma_d \sigma_x' = 0$ and that $0 < \varphi_x < 1 - |\sigma_x|$. As shown in the next section, the process x_t drives time-variation in discount rates on equity claims. I therefore refer to the term $\sigma_x \varepsilon_{t+1}$ as the discount rate shock and I refer to x_t as the price of discount rate risk.

The stochastic discount factor has two priced shocks, namely, the dividend shock, $\sigma_d \varepsilon_{t+1}$, and the discount rate shock, $\sigma_x \varepsilon_{t+1}$. The dividend shock enters the stochastic discount factor negatively, reflecting that an increase in dividends is a good state of the world ceteris paribus. The discount rate shock, in contrast, enters the stochastic discount factor positively, reflecting that an increase in discount rates is a bad state of the world.

The remaining term in the stochastic discount factor is an adjustment that ensures that the risk-free rate is constant at r^f. Indeed, the conditional log-normality of M_{t+1} implies that

$$\ln(E[M_{t+1}]) = -\, r^f - \frac{1}{2}(x_d^2 + x_t^2) + \frac{1}{2}x_d^2 \sigma_d \sigma_d{}' / (|\sigma_d|^2) + \frac{1}{2}x_t^2 \sigma_x \sigma_x{}' / (|\sigma_x|^2) \tag{15}$$

$$= -\, r^f. \tag{16}$$

B. Prices and Risk Premia

The analysis is centered around the prices and returns on n-maturity dividend claims. The price of an n-maturity claim at time t is denoted by P_t^n and the log price is denoted by $p_t^n = \ln(P_t^n)$. Since an n-maturity claim becomes an $n-1$ maturity claim next period, we have the following relation for prices:

$$P_t^n = E_t\left[M_{t+1}P_{t+1}^{n-1}\right], \tag{17}$$

with boundary condition $P_t^0 = D_t$ because the dividend is paid out at maturity. To solve the model, I conjecture and verify that the price dividend ratio is log-linear in the state variables z_t and x_t,

$$\frac{P_t^n}{D_t} = \exp\left(A^n + B_z^n z_t + B_x^n x_t\right). \tag{18}$$

The price-dividend ratio can then be written as

$$\frac{P_t^n}{D_t} = E_t\left[M_{t+1}\frac{D_{t+1}}{D_t}\frac{P_{t+1}^{n-1}}{D_{t+1}}\right] = E_t\left[M_{t+1}\frac{D_{t+1}}{D_t}\exp\left(A^{n-1} + B_z^{n-1}z_{t+1} + B_x^{n-1}x_{t+1}\right)\right]. \tag{19}$$

Matching coefficients of (18) and (19) using (11) and (14) gives

$$A^n = A^{n-1} - r^f + \mu_g - x_d V^{n-1}\frac{\sigma_d{}'}{|\sigma_d|} + B_x^{n-1}(1-\varphi_x)\bar{x} + \frac{1}{2}V^{n-1}(V^{n-1})' \tag{20}$$

$$B_x^n = B_x^{n-1}\varphi_x + V^{n-1}\frac{\sigma_x{}'}{|\sigma_x|} \tag{21}$$

$$B_z^n = \frac{1-(\varphi)_z^n}{1-\varphi_z}, \tag{22}$$

where $B_x^0 = 0$, $A^0 = 0$, and

$$V^{n-1} = \sigma_d + B_z^{n-1}\sigma_z + B_x^{n-1}\sigma_x,$$

which provides the solution to the model and verifies the conjecture.

The term A^n governs the level of price-dividend ratios of the dividend claims. The level is determined by the average growth rate, the risk-free rate, the price of dividend risk, and the average price of discount rate risk, $\bar{x}$. Further, B_z^n governs the exposure of prices to the conditional growth rate z_t and B_x^n governs the exposure of prices to x_t. Given that $0 < \varphi_z < 1$, B_z^n is positive for all values of $n > 0$, but the signs of A^n and B_x^n depend on the model parameters. I study the three in more detail later after estimating the model.

The simple return on the n-maturity claim is denoted by $R_{t+1}^n = P_{t+1}^{n-1}/P_t^n - 1$ and the log return is $r_{t+1}^n = \ln\left(1 + R_{t+1}^n\right)$. The expected excess return is

$$E_t\left[r_{t+1}^n - r^f\right] + \frac{1}{2}\mathrm{var}_t(r_{t+1}^n) = -\,\mathrm{cov}_t(r_{t+1}^n; m_{t+1}) \tag{23}$$

$$= x_d V^{n-1}\frac{\sigma_d{}'}{|\sigma_d|} - x_t V^{n-1}\frac{\sigma_x{}'}{|\sigma_x|} \tag{24}$$

$$\equiv \lambda_d + \lambda_{x,t}. \tag{25}$$

The risk premium in (25) is a function of two terms that both depend on the maturity of the claim through V^{n-1}. The first, λ_d, is a premium for dividend risk, which is constant over time. The second, $\lambda_{x,t}$, is a premium for discount rate risk, which varies over time with the process x_t. The sign of these premia depend on the specification of the different parameters, which I turn to next.

C. Estimation

I estimate the model by maximum likelihood using the Kalman filter. The state equations are given by

$$\begin{bmatrix} z_{t+1} \\ x_{t+1} - \bar{x} \end{bmatrix} = \begin{bmatrix} \varphi_z & 0 \\ 0 & \varphi_x \end{bmatrix} \times \begin{bmatrix} z_t \\ x_t - \bar{x} \end{bmatrix} + \begin{bmatrix} \sigma_z \\ \sigma_x \end{bmatrix} \times \varepsilon_{t+1} \tag{26}$$

and the measurement equations are given by

$$e_t^n = \frac{1}{n}(A^n + B_z^n z_t + B_x^n x_t) - r^f + v_t^n, \tag{27}$$

where v_t^n is measurement error.

I estimate the model on monthly data on a global average of the four country-specific yield curves of one- to seven-year strips. For parsimony, I assume that

$$\begin{bmatrix} \sigma_d \\ \sigma_z \\ \sigma_x \end{bmatrix} = \begin{bmatrix} \sigma_{d,1} & 0 & 0 \\ \sigma_{z,1} & \sigma_{z,2} & 0 \\ 0 & \sigma_{x,2} & \sigma_{x,3} \end{bmatrix} \tag{28}$$

I estimate all of the loadings except $\sigma_{d,1}$, the standard deviation on dividend growth. I instead follow Lettau and Wachter (2007) and set $\sigma_{d,1}$ equal to the unconditional volatility of dividends of 10% annually.[22] I also specify x_d directly to help the model distinguish between the average growth rate g and the dividend risk premium on the short end of the curve. I set $x_d = 0.1$, which ensures an annualized premium on the one-period claim of around 3.5%, as is observed empirically.[23] In addition, since I only include the first seven years of dividend yields, there is a risk that the pricing of long-maturity claims is inappropriate for the estimated model. I therefore apply the restriction that the long-run futures return on the market portfolio is 3% per year (Suzuki (2014) similarly imposes constraints on the pricing of the market portfolio in estimating a reduced-form model for dividends).[24] I assume a risk-free rate of 4.5%, which is the average realized return to U.S.

[22]I could include dividends as an additional state variable and estimate $\sigma_{d,1}$ using the Kalman filter. This would make the model less parsimonious but allow me to account for the fact that some of the unconditional volatility of dividends comes from z_t.

[23] The return on the one-period claim is given by the product of x_d and $\sigma_{d,1}$. Combining (25) and (28), we have that $E_t[r_{t+1}^1 - r^f] + \frac{1}{2}\text{var}_t(r_{t+1}^1) = x_d\sigma_{d,1}$.

[24]The average negative term premium is thus enforced by assumption, but, importantly for this paper,

Treasuries of two- to 30-year maturity over the same period. Finally, I apply the constraint that the unconditional growth rate is at least half the realized growth rate and I apply the conceptual constraint that the dividend risk premium $x_d V^{n-1} \sigma_d' / |\sigma_d|$ is positive for all n.

The results of the estimation are presented in Panel A of Table X. Most importantly, $\sigma_{z,1}$ is negative, which means there is mean-reversion in the shocks to dividend growth rates (when today's dividends receive a negative shock, future growth rates go up). In addition, the two state variables z_t and x_t are negatively correlated as $\sigma_{z,2}$ is positive and $\sigma_{x,2}$ is negative. Both of these state variables mean-revert fairly quickly, with monthly AR(1) parameters of 0.94 and 0.86.

The model fits the time variation in dividend yields well. The mean absolute error in the measurement equation is 0.005, which means that the mean absolute error in the yields is around 0.5%. By multiplying the yields by the maturity of the claim, one obtains the log dividend-price ratio, with the mean absolute error of these around 1.7%. These pricing errors are economically small and compares well to Kragt, De Jong, and Driessen (2019) who also use the Kalman filter to fit an affine model to dividend prices and find pricing errors of around 1.5% in a one-factor model and 0.05% in a two-factor model.[25]

– Table X goes about here –

I next study the behavior of prices and term premia in the estimated model.

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the counter cyclical variation is not.

[25] In comparing the fit between the model in this paper and the models in Kragt, De Jong, and Driessen (2019), it is worth noting that the pricing errors in Kragt, De Jong, and Driessen are for the Euro Stoxx 50 from 2008 to 2015, which represents a subset of the sample considered here. Also, while the two-factor model of Kragt, De Jong, and Driessen fits the data well, it generally does not explain the stylized facts of the equity term premium, as it does not model risk premia.

D. Prices and Term Premia in the Estimated Model

Prices and expected returns on n-maturity claims are governed by A^n, B_z^n, and B_x^n, which are plotted in Figure 4. As shown in the left-most plot, A^n is negative and decreases in maturity. This is a natural relation that helps ensure that prices decrease in maturity. Further, B_z^n is positive and increases in maturity, which means that prices on all dividend claims increase when growth rates increase. Finally, B_x^n is negative and decreases in maturity, which means that prices on all dividend claims decrease when the price of discount rate risk goes up.

– Figure 4 goes about here –

The model has term premia that are both negative and counter cyclical. To understand how these arise, recall that the expected return in (25) is the sum of the dividend risk premium and the discount rate risk premium. Figure 5 Panel A plots the dividend risk premium as a function of maturity. The risk premium is strictly decreasing in maturity. The downward slope arises because of mean-reversion in shocks to dividend growth rates. When dividends drop today, the long-run growth rates increase. Expected distant-future dividends therefore drop by less than near-future dividends. Accordingly, the prices of distant-future dividends drop by less. Distant-future dividends are therefore less exposed to dividend risk, which makes the dividend risk premium lower for distant-future claims.

Figure 5 Panel B plots the discount rate risk premium as a function of maturity. The solid line shows the premium when the price of discount rate risk is at its long-run mean, $\bar{x}$. The premium is positive for all claims because investors are averse to increases in discount rates, and prices on all claims drop when discount rates go up (B_x^n is negative for all claims). In addition, the premium is upward sloping in maturity because the prices of distant-future dividends drop by more when discount rates increase (B_x^n is strictly decreasing in maturity).

– Figure 5 goes about here –

The slope of the discount rate risk premium varies over time with the price of discount rate risk, x_t. In bad times, when x_t is higher, the discount rate risk premium becomes more upward sloping, making the equity term premium larger. Equity term premia are thus counter cyclical. The next section studies the magnitude of this counter cyclical behavior in simulation studies.

E. Simulation Studies

To further examine the ability of the model to match the empirical facts on the equity term structure, I conduct simulation studies. I run 10,000 simulations of 100 years of artificial data and calculate median estimates. The results are summarized in Panel B of Table X. The model matches the parameters related to time-variation in the equity term structure well, although it generates slightly less pro cyclical variation in the yield spread than observed empirically. The term premium in excess of the two-year claim is close to zero but the term premium is lower if one considers the premium in excess of the one-year claim, as illustrated below in Figure 6. Finally, the model matches the average return and standard deviation of the market returns well. The ability to match the standard deviation of the market might be surprising given that the model is estimated only on the dividend strips and not mechanically required to match this standard deviation.

Figure 6 plots the term structure in good and bad times. For each simulation, I divide periods into good and bad times based on the median ex ante dividend-price ratio of the market portfolio. I then calculate the term structure of realized one-period returns in both good and bad times and take the median across the simulations. The figure illustrates that the term structure is counter cyclical: it is upward sloping when the divided-price ratio is high and downward sloping when the dividend-price ratio is low.

– Figure 6 goes about here –

The model also matches the empirical time-variation in equity yields. As is observed empirically, the estimate of $\gamma_1^{n,m}$ is slightly above one. The fact that the estimate is close to one means that yield spreads predominantly reflect expectations about future yields (the expectations hypothesis almost holds). The fact that the estimate is greater than one means that yields spreads and term premia are negatively correlated. In addition, the slope of the equity yield curve is pro cyclical. These results are qualitatively consistent with the empirical facts about the equity yield curve.

F. Remarks

The model and the empirical analysis together highlight the importance of the pricing of distant-future dividends for the equity risk premium. Indeed, cyclical variation in the equity risk premium is driven by discount rate risk, which can thought of as a long-maturity risk – a risk that long-maturity claims are more exposed to than short-maturity claims. As such, the cyclical variation in the equity risk premium in the model arises predominantly from cyclical variation in the premium on distant-future dividends.

The analysis in the paper compares both the yield spread and the term premium to the dividend-price ratio of the market portfolio. In the model, variation in all three are driven by z_t and x_t. The conditional growth rate, z_t, influences both the dividend-price ratio the yield spread. Indeed, a high growth rate generates low yields on all dividends and thus a low dividend-price ratio. In addition, because the growth rate is expected to mean-revert, future yields are expected to be higher, which generates a high yield spread. Similarly, the price of discount rate risk, x_t, also influence yields and yields spreads, but it also influences term premia – term premia increase when x_t increases. If growth rates were constant, and the model only had time-varying price of discount rate risk, the yield spreads, dividend-price ratios, and term premia would always move together. A high dividend-price ratio would thus always translate into a high term premium. With time-varying growth rates, however, this need not be the case – a high dividend-price ratio might arise because of high growth rates, leaving term premia unchanged. Nonetheless, the dividend-price ratio and the term premia are correlated on average, and the model fits the empirical data well in simulations.

To match the variation in the yield curve, the estimated model has a dividend-price ratio that mean-reverts fairly quickly and it has a fairly high degree of predictability in dividend growth rates. In particular, 10-year dividends are predictable with an R^2 of 12%. This high degree of predictability is broadly consistent with the findings in Binsbergen et al. (2013) for this sample period, but it is hard to reconcile with the long U.S. sample that has little predictability in dividend growth rates (Campbell (1999)). Accordingly, the model's ability to match the variation in the yield curve, and in particular to match the result that yield spreads predominantly reflect expectations about future yields, should be interpreted with caution, as it comes at the cost of a data-generating process that is hard to reconcile with the longer U.S. sample.

VII. Conclusion

I document that the equity term premium is counter cyclical and emphasize a series of implications. First, the counter cyclical equity term premium suggests that long-maturity dividends, and thus long-maturity risks, are the main driver of variation in the expected return on the market portfolio. Second, when considered together with the fact that the equity premium is negative on average, the counter cyclical variation represents a puzzle: none of the standard asset pricing models that I study can generate a term premium that is negative on average and counter cyclical. The recent downward-sloping models have pro cyclical term premia, whereas the traditional upward-sloping models have counter cyclical term premia. More generally, the notion of a negative and counter cyclical term premium is hard to reconcile with models with only one risk factor.

I suggest a new model that can explain the stylized facts. The model has two priced shocks that influence term premia. A cash flow shock generates the downward slope and a discount rate shock generates the counter cyclical variation. The model also explains the pro cyclical variation in equity yield spreads and generally provides a good fit to the yield curve when estimated using maximum likelihood.

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Appendix

Simulation Procedure

To obtain p-values in the predictive regressions in equation (2), I simulate the distribution of parameter estimates using Monte Carlo simulations. For each regression, I estimate the AR(1) properties of the dividend-price ratio and the variance-covariance matrix of the unexpected returns and the contemporaneous innovations in the dividend-price ratio (see Stambaugh (1999) page 378). Based on these, I run 100,000 simulations of artificial samples under the null of $\beta_1^{n,m} = 0$, assuming normally distributed residuals, and estimate the distribution of the observed $\beta_1^{n,m}$. I correct the observed AR(1) coefficient and variance-covariance matrix for in-sample bias (see Kendall (1954) and Mentz, Morettin, and Toloi (1998)), such that the observed values in the repeated artificial samples center on the observed values in the true sample.

Table I
The Equity Term Structure: Stylized Facts Versus Theory

The equity term premium $E_t[TP_t] = E_t[r_{t+1}^{long} - r_{t+1}^{short}]$ is the conditional expected annual return to long-maturity equity minus the annual return to short maturity equity. The cyclicality of the equity term premia is measured by linear projections of the realized term premium on the ex ante dividend-price ratio of the market portfolio. The cyclicality of yield spreads is similarly measured as the linear projection of yield spreads on the contemporaneous dividend-price ratio. The habit model refers to the Campbell and Cochrane (1999) model. The long-run risk model refers to the Bansal and Yaron (2004) model.

	Average	Cyclicality of Term Premia	Cyclicality of Yield Spread
Paper	van Binsbergen, Brandt, Koijen (2012)	this paper	van Binsbergen, Hueskes, Koijen, and Vrugt (2013)
Data			
Measured as	$E[TP] = E[r_{t+1}^{long} - r_{t+1}^{short}]$	$TP_t = \beta_0 + \beta_1 D_t/P_t + e_t$	$YS_t = \theta_0 + \theta_1 D_t/P_t + e_t$
Result	Downward sloping $E[TP] < 0$	Counter cyclical $\beta_1 > 0$	Pro cyclical $\theta_1 < 0$
Theories			
Habit	Upward	Counter cyclical	Counter cyclical
Long-run risk	Upward	Counter cyclical	Pro cyclical
Lettau Wacther (2007)	Downward	Pro cyclical	Pro cyclical
Gabaix (2012)	Flat	Constant	Pro cyclical
Hasler Marfe (2016)	Downward	Pro cyclical	Pro cyclical
Ai, Croce, Diercks, and Li (2018)	Downward	Pro cyclical	Pro cyclical
This paper	Downward	Counter cyclical	Pro cyclical

Table II
Time Variation of the Equity Term Structure in Leading Asset Pricing Models

This table shows the result of simulations of different asset pricing models. I simulate the models and estimate the following regressions:

$$R^n_{t;t+12} - R^m_{t;t+12} = \beta_0^{n,m} + \beta_1^{n,m}(d_t - p_t) + \epsilon_{t,t+12}$$

$$e^{n-m}_{t+m} - e^n_t = \gamma_0^{n,m} + \gamma_1^{n,m} s_t^{n,m} \frac{m}{n-m} + e_{t+m}$$

$$s_t^{n,m} = \phi_o^{n,m} + \phi_1^{n,m}(d_t - p_t) + \eta_{t+n},$$

where R^n_{t+12} is the futures return on the *n*-maturity claim between month *t* and *t+12*, $d_t - p_t$ is the log dividend price ratio of the market portfolio at time *t*, e^n_t is the yield on the *n*-maturity dividend at time *t*, and $s_t^{n,m}$ is the yield spread between the *n* and the *m*-maturity dividend at time *t*. Maturities *n* and *m* are measured in years. The habit model is the Campbell and Cochrane (1999) model. The model is simulated using the series method of Wachter (2005). The long-run risk model is the model of Bansal and Yaron (2004) that features stochastic volatility. The table reports the median estimate of 10,000 simulations of 100 years of data along with the 95% confidence interval based on the distribution of simulated parameters.

Theories	$E[R^{mkt}_{t+12} - R^2_{t+12}]$	$\beta_1^{mkt,2}$	$\gamma_1^{5,1}$	$\phi_1^{5,1}$
Habit	0.04 [0.04;0.05]	0.17 [0.08;0.31]	-3.02 [-10.0;0.40]	0.002 [0.00; 0.004]
Long-run risk	0.05 [0.03;0.07]	0.03 [-0.06;0.16]	1.05 [0.02;2.34]	-0.08 [-0.10 ; -0.06]
Lettau-Wacther (2007)	-0.09 [-0.16;-0.03]	-0.12 [-0.19;-0.02]	0.62 [-0.14;2.02]	-0.09 [-0.12 ; -0.06]

Table III
Counter Cyclical Equity Term Premia

This table shows the relation between term premia and the dividend price ratio of the market portfolio. The table reports the slope coefficients from the regression

$$R^{n}_{t;t+12} - R^{m}_{t;t+12} = \beta_0^{n,m} + \beta_1^{n,m}(d_t - p_t) + \epsilon_{t,t+12},$$

where $d_t - p_t$ is the dividend-price ratio of the market portfolio and $R^{n}_{t,t+12}$ is the 12-month forward return to the dividend claim with *n* year maturity. The regression is based on rolling observations. Below the estimates I report *p*-values for the null hypothesis that $\beta_1^{n,m}$ is less than or equal to zero. The *p*-values are based on a simulated distribution of parameter estimates and accounts for Stambaugh (1999) bias in the parameter estimates. Maturities *n* and *m* are both measured in years. "*m=mean(1-7)*" refers to the average return to the available dividend claims with one- through seven-year maturity. The sample period for each regression is the longest possible sample using data from 2003 to 2019.

	Maturity of long-maturity claim (*n*)						
	2	3	4	5	6	7	Mkt
Panel A: S&P 500							
m=1	0.30	0.40	0.48	0.58	0.63	0.69	0.88
	0.003	0.004	0.001	0.000	0.002	0.002	0.001
m=2		0.08	0.18	0.28	0.32	0.36	0.50
		0.114	0.017	0.004	0.008	0.011	0.032
m=3			0.06	0.10	0.12	0.15	0.41
			0.088	0.173	0.247	0.246	0.050
m=mean(1-7)							0.54
							0.025
Panel B: Nikkei 225							
m=1	0.65	0.92	1.03	1.09	1.14	1.19	0.78
	0.000	0.000	0.000	0.000	0.000	0.000	0.000
m=2		0.22	0.33	0.39	0.44	0.47	0.17
		0.010	0.017	0.022	0.030	0.038	0.292
m=3			0.08	0.11	0.12	0.11	-0.04
			0.226	0.258	0.316	0.401	0.548
m=mean(1-7)							0.25
							0.085

continued...

Panel C: Euro Stoxx 50							
m=1	0.55 0.001	0.61 0.010	0.59 0.021	0.58 0.029	0.57 0.035	0.57 0.038	0.65 0.048
m=2		0.03 0.583	0.00 0.583	-0.02 0.583	-0.04 0.583	-0.04 0.583	0.02 0.583
m=3			-0.05 0.942	-0.08 0.942	-0.10 0.942	-0.12 0.942	0.00 0.942
m=mean(1-7)							0.27 0.144
Panel D: FTSE 100							
m=1	0.90 0.000	1.07 0.000	1.09 0.000	1.05 0.000	0.98 0.000	0.96 0.002	1.04 0.000
m=2		0.11 0.285	0.12 0.336	0.07 0.454	0.00 0.607	-0.03 0.694	-0.03 0.598
m=3			-0.01 0.633	-0.07 0.828	-0.14 0.912	-0.16 0.903	-0.18 0.777
m=mean(1-7)							0.10 0.385

Table IV
Counter Cyclical Equity Term Premia: End-of-Year Regressions

This table shows the relation between term premia and the dividend price ratio of the market portfolio. The table reports the slope coefficients from the regression

$$R^n_{t;t+12} - R^m_{t;t+12} = \beta^{n,m}_0 + \beta^{n,m}_1(d_t - p_t) + \epsilon_{t,t+12},$$

where $d_t - p_t$ is the dividend-price ratio of the market portfolio and $R^n_{t,t+12}$ is the 12-month forward return to the dividend claim with *n*-year maturity. The regression only uses observations from the end of December each year. Below the estimates I report *p*-values for the null hypothesis that $\beta^{n,m}_1$ is less than or equal to zero. The *p*-values are based on a simulated distribution of parameter estimates and accounts for Stambaugh (1999) bias in the parameter estimates. Maturities *n* and *m* are both measured in years. "m=*mean(1-7)"* refers to the average return to the available dividend claims with one- through seven-year maturity. The sample period for each regression is the longest possible sample using data from 2003 to 2019.

Panel A: S&P 500

	Maturity of long-maturity claim (*n*)						
	2	3	4	5	6	7	Mkt
m=1	0.26 0.128	0.39 0.066	0.50 0.035	0.58 0.028	0.64 0.024	0.69 0.038	1.59 0.000
m=2		0.13 0.038	0.22 0.028	0.28 0.042	0.33 0.040	0.38 0.046	1.21 0.001
m=3			0.04 0.251	0.08 0.277	0.12 0.214	0.17 0.174	1.09 0.001
m=mean(1-7)							1.07 0.001

Panel B: International Sample

	Nikkei 225		Eurostoxx 50		FTSE 100	
	n =5	*n* = Mkt	*n* = 5	*n* = Mkt	*n* = 5	*n* = Mkt
m=1	1.08 0.001	1.20 0.002	0.59 0.049	0.99 0.024	0.95 0.011	2.06 0.000
m=mean(1-7)		0.35 0.064		0.49 0.042		1.08 0.002

Table V
Counter Cyclical Equity Term Premia: Quarterly Returns

This table shows the relation between term premia and the ex ante dividend price ratio. The table reports the slope coefficients from the regressions

$$R^{n}_{t;t+3} - R^{m}_{t;t+3} = \beta_0^{n,m} + \beta_1^{n,m}(d_t - p_t) + \epsilon_{t,t+3}$$

$$R^{n}_{t;t+3} - R^{m}_{t;t+3} = \beta_0^{n,m} + \beta_1^{n,m}(f_t^1 - p_t) + \epsilon_{t,t+3},$$

where $r^{n}_{t,t+3}$ is the rolling three-month forward return to the dividend claim with *n* year maturity, d_t is index dividend at time *t*, p_t is the price of the index, and f_t^1 is the price of the one-year dividend at time *t*. Below the estimates I report *p*-values for the null hypothesis that $\beta_1^{n,m}$ is less than or equal to zero. The *p*-values are based on a simulated distribution of parameter estimates and accounts for Stambaugh (1999) bias in the parameter estimates. Panel A shows the parameter estimate $\beta_1^{n,m}$ obtained using $d_t - p_t$ as the predictor. Panel B shows the parameter estimate $\beta_1^{n,m}$ obtained using $f_t^1 - p_t$ as predictor. Maturities *n* and *m* are measured in years. "*m=mean(1-7)*" refers to the average return to the available dividend claims with one- through seven-year maturity. The sample period for each regression is the longest possible sample using data from 2003 to 2019.

	Maturity of long-maturity claim (*n*)						
	2	*3*	*4*	*5*	*6*	*7*	*mkt*
Panel A: Using $d_t - p_t$							
m=1	0.05	0.07	0.10	0.12	0.13	0.14	0.20
	0.454	0.397	0.304	0.262	0.315	0.350	0.220
m=2		0.02	0.05	0.07	0.08	0.09	0.13
		0.219	0.071	0.084	0.128	0.157	0.171
m=3			0.02	0.03	0.04	0.05	0.13
			0.168	0.251	0.232	0.256	0.118
m=mean(1-7)							0.12
							0.117
Panel B: Using $f_t - p_t$							
m=1	0.25	0.31	0.40	0.46	0.50	0.55	0.67
	0.069	0.047	0.025	0.018	0.032	0.043	0.022
m=2		0.07	0.16	0.23	0.28	0.32	0.44
		0.045	0.006	0.004	0.010	0.015	0.028
m=3			0.09	0.16	0.21	0.25	0.37
			0.003	0.002	0.008	0.014	0.041
m=mean(1-7)							0.32
							0.064

Table VI
Counter Cyclical Equity Term Premia: Using Option-Implied Dividends and Dividend Futures

This table shows the relation between term premia and the dividend-price ratio of the market portfolio. The table reports the slope coefficient from the regression

$$R^{n}_{t;t+12} - R^{m}_{t;t+12} = \beta^{n,m}_{0} + \beta^{n,m}_{1}(d_t - p_t) + \epsilon_{t,t+12},$$

where $d_t - p_t$ is the dividend-price ratio of the market portfolio and $R^{n}_{t,t+12}$ is the 12-month forward return to the dividend claim with *n*-year maturity. The regression is based on rolling observations. Below the estimates I report *p*-values for the null hypothesis that $\beta^{n,m}_{1}$ is less than or equal to zero. The *p*-values are based on a simulated distribution of parameter estimates and accounts for Stambaugh (1999) bias in the parameter estimates. Maturities *n* and *m* are measured in years. The sample is from 1996 to 2019.

Panel A: Option implied dividends (1996 to 2009)

	Spot returns			*Future returns*	
	n=2	*n=mkt*		*n=2*	*n=mkt*
m=1	0.23	0.72	*m=1*	0.22	0.59
	0.046	0.058		0.056	0.101
m=2		0.49	*m=2*		0.37
		0.098			0.169

Panel B: Spliced data (1996 to 2019)

	Spot returns			*Future returns*	
	n=2	*n=mkt*		*n=2*	*n=mkt*
m=1	0.25	0.66	*m=1*	0.24	0.69
	0.040	0.025		0.040	0.033
m=2		0.41	*m=2*		0.45
		0.059			0.075

Table VII
Counter Cyclical Equity Term Premia in the Cross-Section of Stock Returns

This table shows results of predictive regressions using portfolios sorted on duration. I regress excess returns of the portfolios onto the ex ante dividend-price ratio and the contemporaneous market return. I first sort stocks into value and growth stocks based on the median NYSE book-to-market ratio. Then, within each group, I sort stocks into five value-weighted portfolios based on the cash flow duration measure from Weber (2018). I average across the value and growth portfolios to get the duration sorted portfolios. I subtract form each portfolio the return to the U.S. Treasury bond with closest maturity. I calculate the long-short portfolio as the difference between the portfolios with highest and lowest duration. Regressions are monthly unless otherwise stated. I report t-statistics below the parameter estimates. The t-statistics for the annual regressions are based on Newey and West (1987) standard errors corrected for 18 lags. Statistical significance is denoted by *** p<0.01, ** p<0.05, * p<0.1. The results are from the 1963 to 2015 U.S. sample.

Panel A: Controlling for the market and the dividend-price ratio

	Portfolios sorted on duration					Long-minus-short portfolios	
	1	2	3	4	5	Monthly return	Annual return
Duration (years)	9	16	18	20	23		
Excess return	0.01^{***}	0.01^{**}	0.00	0.00^{*}	0.00	0.00^{*}	-0.04^{*}
	(2.88)	(2.26)	(1.55)	(1.84)	(1.46)	(-1.91)	(-1.73)
$d_t - p_t$	-0.003	0.001	0.002	0.002	0.008^{*}	0.011^{**}	0.13^{**}
	(-0.67)	(0.16)	(0.50)	(0.54)	(1.71)	(2.15)	(2.07)
Mkt	1.06^{***}	0.96^{***}	0.96^{***}	0.97^{***}	1.13^{***}	0.09^{*}	
	(28.40)	(27.60)	(27.83)	(24.72)	(25.01)	(1.94)	
Adjusted R^2	0.57	0.55	0.56	0.50	0.51	0.01	0.08
Observations	618	618	618	618	618	618	606

Panel B: Controlling for the dividend-price ratio

	Portfolios sorted on duration					Long-minus-short portfolios	
	1	2	3	4	5	Monthly return	Annual return
Duration (years)	9	16	18	20	23		
Excess return	0.01^{***}	0.01^{**}	0.00	0.00^{*}	0.00	0.00^{*}	-0.04^{*}
	(2.88)	(2.26)	(1.55)	(1.84)	(1.46)	(-1.91)	(-1.73)
$d_t - p_t$	0.002	0.005	0.006	0.007	0.014^{*}	0.012^{**}	0.13^{**}
	(0.34)	(0.88)	(1.10)	(1.12)	(1.95)	(2.23)	(2.07)
Adjusted R^2	0.00	0.00	0.00	0.00	0.00	0.01	0.08
Observations	618	618	618	618	618	618	606

Table VIII
Time-Variation in Equity Yield Spreads: A Variance Decomposition

This table reports $\gamma_1^{n,m}$ from the variance decomposition

$$1 = \frac{\mathrm{var}(e_{t+m}^{n-m} - e_t^n; s_t^{n,m})(n-m)}{\mathrm{var}(s_t^{n,m})m} + \frac{\mathrm{var}(r_{t+m}^{n} - r_{t+m}^{m}; s_t^{n,m})}{\mathrm{var}(s_t^{n,m})m} = \gamma_1^{n,m} + \gamma_2^{n,m},$$

where e_t^n is the equity yield on the n-maturity claim at time t and $s_t^{n,m}$ is the yield spread of the n-maturity claim in excess of the m-maturity claim. Below the estimates I report t-statistics for the hypothesis that $\gamma_1^{n,m} = 1$. Maturities n and m are both measured in years. Below the estimates I report t-statistics for the hypothesis that the coefficient is equal to one, based on Newey and West (1987) standard errors corrected for 1.5m lags. The sample period for each element is the longest possible sample using data from 2003 to 2019.

	Maturity of long-maturity claim (n)					
	2	3	4	5	6	7
Panel A: S&P 500						
m=1	1.10	1.18	1.26	1.35	1.45	1.50
	(0.21)	(0.39)	(0.68)	(0.90)	(1.17)	(1.36)
m=2		1.48	1.67	1.80	1.92	2.03
		(2.87)	(3.23)	(3.87)	(3.77)	(4.01)
Panel B: Nikkei 225						
m=1	1.74	1.61	1.36	1.25	1.16	1.10
	(1.96)	(1.71)	(1.23)	(0.93)	(0.67)	(0.42)
m=2		0.97	0.86	0.77	0.72	0.69
		(-0.15)	(-0.59)	(-1.09)	(-1.35)	(-1.54)
Panel C: Euro Stoxx 50						
m=1	2.42	3.15	2.51	2.26	2.12	2.06
	(2.22)	(3.90)	(3.95)	(3.80)	(3.67)	(3.65)
m=2		1.44	1.34	1.23	1.15	1.13
		(1.57)	(0.98)	(0.68)	(0.48)	(0.46)
Panel D: FTSE 100						
m=1	-1.10	1.33	1.67	1.68	1.62	1.85
	(-3.61)	(0.41)	(0.97)	(1.24)	(1.36)	(2.22)
m=2		1.50	1.65	1.56	1.50	1.46
		(1.94)	(1.72)	(1.68)	(1.65)	(1.49)

Table IX
Cyclicality of the Investment Duration

This table reports results from a regression of investment characteristics of portfolios on the dividend-price ratio of the market. The portfolios are sorted on duration and the investment characteristics are value-weighted averages of each portfolio. Capital-to-labor is measured as the value of property, plant, and equipment (PPEN) divided by number of employees. Capital is PPEN. All characteristics are measured in cross-sectional percentiles. I report *t*-statistics below the parameter estimates. The *t*-statistics are based on Newey and West (1987) standard errors corrected for 18 lags. Statistical significance is denoted by *** p<0.01, ** p<0.05, * p<0.1. The sample is U.S. equities from 1963 to 2015.

Panel A: Capital-to-labor ratio

	Portfolios sorted on duration					Long-short portfolios			
	1	2	3	4	5	5-1	5-1	5-1	5-1
Sample:	1963-2015	1963-2015	1963-2015	1963-2015	1963-2015	1963-2015	1963-2015	1963-1990	1990-2015
Duration (years)	9	16	18	20	23				
$d_t - p_t$	0.61	-2.73	-7.18***	-14.74***	-13.97***	-14.32***	-13.87***	-12.34	-7.08
	(0.29)	(-1.09)	(-3.59)	(-7.50)	(-6.22)	(-4.26)	(-3.59)	(-1.26)	(-1.64)
NBER dummy							1.69		
							(0.45)		
Bond yield							-0.16		
							(-0.29)		
Adjusted R^2	0.00	0.02	0.16	0.41	0.33	0.21	0.21	0.04	0.06
Observations	618	618	618	618	618	618	618	306	312

Panel B: Capital

	Portfolios sorted on duration					Long-short portfolios			
	1	2	3	4	5	5-1	5-1	5-1	5-1
Sample:	1963-2015	1963-2015	1963-2015	1963-2015	1963-2015	1963-2015	1963-2015	1963-1990	1990-2015
Duration (years)	9	16	18	20	23				
$d_t - p_t$	5.37***	5.15***	-2.99*	-13.03***	-15.29***	-20.69***	-13.92***	-36.13***	-10.46***
	(3.97)	(5.83)	(-1.76)	(-4.63)	(-5.16)	(-6.24)	(-4.73)	(-3.99)	(-3.23)
NBER dummy							-1.51		
							(-0.46)		
Bond yield							-1.30***		
							(-3.08)		
Adjusted R^2	0.09	0.19	0.04	0.29	0.32	0.37	0.41	0.26	0.21
Observations	618	618	618	618	618	618	618	306	312

Table X
A New Model to Explain the Stylized Facts: Estimation and Simulation Results

Panel A of this table shows the results of maximum likelihood estimation of the model in Section VI. The model is fitted to the monthly time series of the global dividend yield curve of annual strips of maturity of one to seven years from December 2006 to June 2019. For ease of readability, the growth rate, g, and the volatilities are multiplied by 100. I report standard errors below the parameter estimates. Panel B shows results of simulation studies. I run 10,000 simulations of 100 years of artificial data and calculate median estimates. I report 95% confidence intervals below the estimates. The empirical estimates are the average estimates across the four exchanges. All returns are measured in excess of the risk-free rate with similar maturity.

Panel A: Maximum likelihood estimates

	$\bar{x}$	φ_z	φ_x	g	$\sigma_{z,1}$	$\sigma_{z,2}$	$\sigma_{x,2}$	$\sigma_{x,3}$
Estimate	0.04	0.94	0.85	0.27	-0.18	0.22	-2.99	12.55
S.e.	(0.02)	(0.00)	(0.03)	(0.42)	(0.30)	(0.24)	(3.33)	(2.86)

Panel B: Simulation results

	$E[R_{t+12}^{mkt} - R_{t+12}^{2}]$	$\beta_1^{Mkt,2}$	$\gamma_1^{5,1}$	$\Phi_1^{5,1}$	$E[R_{t+12}^{Mkt}]$	$\sigma(R_{t+12}^{Mkt})$
Simulated results	0.00	0.29	1.10	-0.15	0.03	0.27
	[-0.013 ; 0.013]	[0.15 ; 0.45]	[0.58 ; 1.76]	[-0.18 ; -0.11]	[0.01 ; 0.06]	[0.26 ; 0.28]
Empirical estimates	-0.037	0.16	1.6	-0.33	0.02	0.27

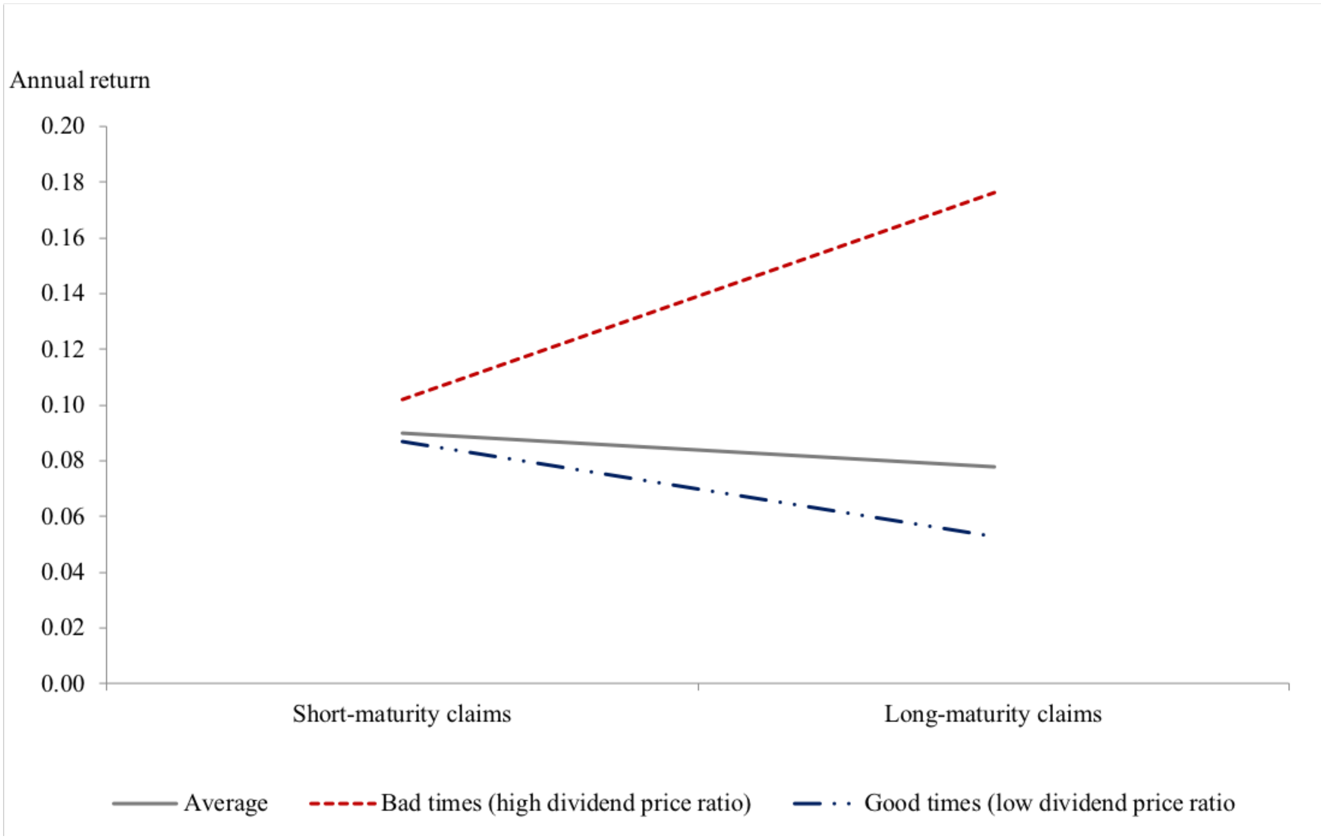

Figure 1. The term structure of one-year equity returns. This figure plots the term structure of holding-period equity returns for the S&P 500. The figure shows the unconditional average return (solid line), the average return in bad times (dashed line), and the average return in good times (dash-dotted line). Bad times are periods in which the ex ante dividend-price ratio is in the top quintile of the time series. Short-maturity equity claims is the average return to dividend strips of one to seven years maturity, using a spliced dataset of option implied dividends and dividend futures. The long-maturity claim is the average return to the market portfolio. Returns are annual spot returns, 1996 to 2019.

Figure 2. Realized long-minus-short returns and dividend-price ratios. This figure shows, for four different indexes, the ex ante log dividend-price ratio and the realized return difference between long- and short-maturity claims. The future long-minus-short return is the average two-year log return to the six- and seven-year dividend claim minus the average two-year log return to the one- and two-year dividend claim. The graph indicates the starting date of the two-year period. If the six and seven-year claim is unavailable, the long-leg is the five-year claim. Before dividend futures become available, the U.S. term premium is the two-year return difference between the two-year and one-year option-implied dividend returns.

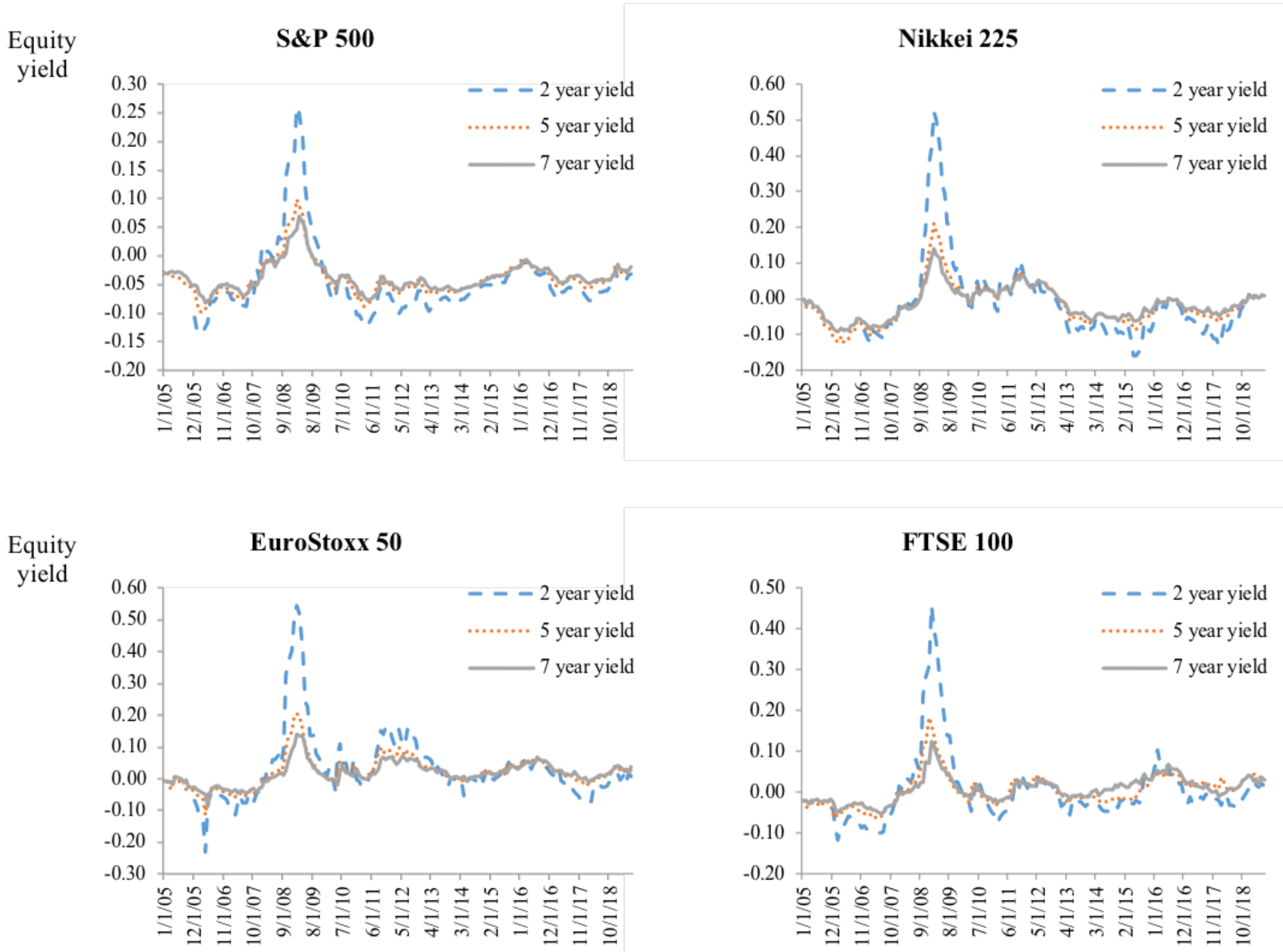

Figure 3. Time-variation in the equity yield curve. This figure shows the time-variation in the term structure of equity yields. The figure shows the yield for the two-, five-, and seven-year dividend claim. On the observations where the seven-year claim is unavailable it is replaced by the five-year claim. The equity yield for dividends that are paid out at time $t+n$ are defined as

$$e_t^n = \frac{1}{n}(d_t - f_t^n),$$

where d_t is the rolling annual dividends at time t and f_t^n is the forward price of the n-maturity claim at time t.

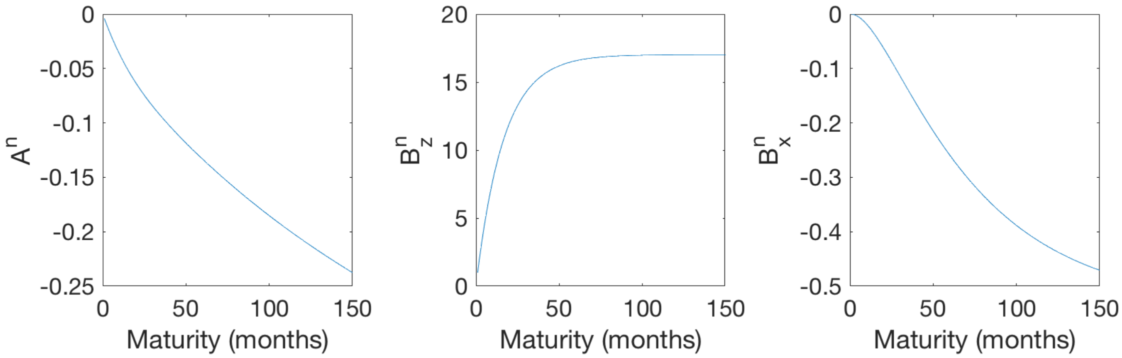

Figure 4. Model solution. This figure shows $\boldsymbol{A^n}$, $\boldsymbol{B_z^n}$, and $\boldsymbol{B_x^n}$ in the estimated model as defined by (20), (21), and (22) as functions of the maturity of dividends (*n)*.

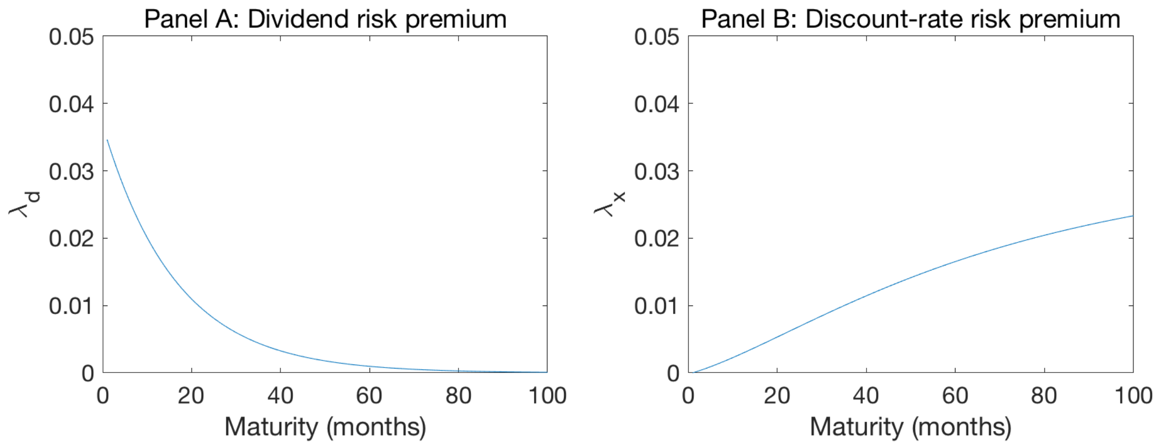

Figure 5. The term structure of the dividend risk and the discount rate risk premium. This figure reports the premium for exposure to dividend risk and the premium for exposure to discount-rate risk as a function of the maturity of the underlying claim. The premia are defined in (25).

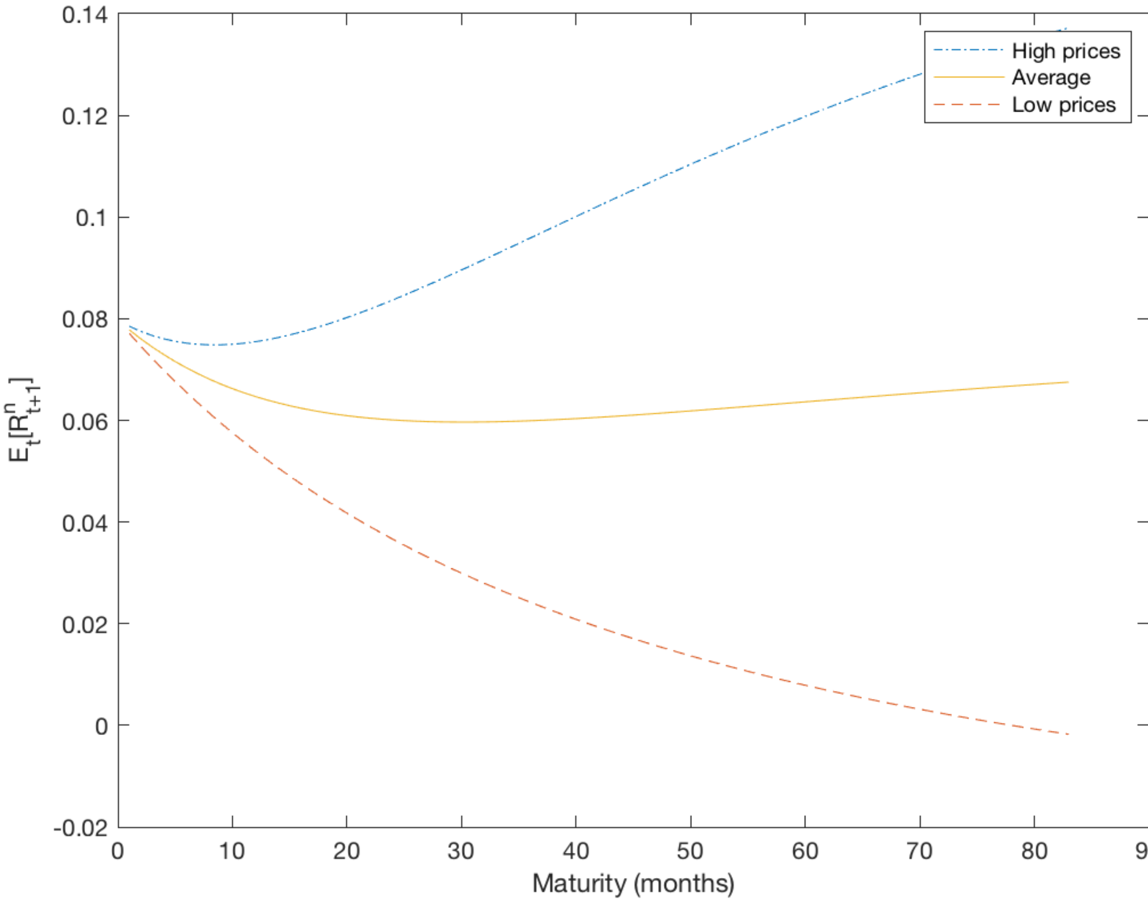

Figure 6. The equity term structure in good and bad times: simulation results. This figure shows the term structure of holding-period equity returns in good and bad times in the model. The results are based on 10,000 simulations of 100 years of artificial data. For each simulation, I calculate the average equity term structure of one-period returns. I also divide the sample into two parts based on whether the ex-ante dividend-price ratio is above or below the time-series median. I then calculate the equity term structure of one-period returns for good and bad times (bad times are periods in which the dividend-price ratio is above the time-series median). The figure includes 95% confidence intervals based on the distribution across simulations. All estimates are based on expected returns. The figure plots the median estimates of the term structure across simulations.

Table AI
Summary Statistics on Dividend Futures

This table provides summary statistics for dividend futures. Returns and standard deviations are for annualized claims. The loading on the dividend-price ratio refers to the slope coefficient in a regression of realized futures returns on the ex ante log dividend-price ratio of the market portfolio. Good and bad times are based on the median dividend price ratio. The sample is 2007 to 2019, the period for which the one-year claim is available on all exchanges.

	Maturity of dividend claim (years)							
	1	2	3	4	5	6	7	Mkt
Panel A: S&P 500								
Average spot returns	0.034	0.056	0.072	0.085	0.095	0.103	0.123	0.116
St. dev. annual returns	0.032	0.102	0.130	0.141	0.153	0.173	0.189	0.157
Loading on $d_t - p_t$	0.069	0.315	0.382	0.459	0.545	0.588	0.626	0.865
Average good times	0.031	0.042	0.049	0.052	0.053	0.062	0.084	0.083
Average bad times	0.036	0.068	0.093	0.114	0.131	0.144	0.154	0.143
Average yields	-0.039	-0.039	-0.037	-0.036	-0.034	-0.035	-0.034	
St. dev. of yield	0.096	0.067	0.047	0.037	0.032	0.030	0.029	
Panel B: Nikkei 225								
Average spot returns	0.085	0.118	0.133	0.152	0.162	0.169	0.172	0.098
St. dev. annual returns	0.103	0.254	0.305	0.322	0.332	0.337	0.341	0.226
Loading on $d_t - p_t$	0.194	0.847	1.112	1.220	1.287	1.333	1.381	0.976
Average good times	0.061	0.026	0.012	0.019	0.024	0.026	0.027	0.015
Average bad times	0.115	0.227	0.278	0.310	0.327	0.338	0.344	0.197
Average yields	-0.001	-0.001	-0.005	-0.005	-0.004	-0.004	-0.003	
Standard dev. of yield	0.142	0.118	0.085	0.066	0.054	0.046	0.040	
Panel C: Euro Stoxx 50								
Average spot returns	0.044	0.084	0.079	0.073	0.066	0.063	0.057	0.055
St. dev. annual returns	0.070	0.215	0.255	0.254	0.251	0.245	0.241	0.173
Loading on $d_t - p_t$	0.093	0.637	0.662	0.632	0.624	0.614	0.619	0.753
Average good times	0.037	0.016	0.008	0.006	-0.001	-0.005	-0.013	0.006
Average bad times	0.050	0.144	0.140	0.131	0.124	0.122	0.119	0.097
Average yields	0.048	0.053	0.046	0.040	0.035	0.032	0.029	
St. dev. of yield	0.115	0.107	0.073	0.053	0.041	0.034	0.029	
Panel D: FTSE 100								
Average spot returns	0.048	0.107	0.112	0.109	0.105	0.114	0.132	0.075
St. dev. annual returns	0.065	0.197	0.248	0.254	0.248	0.238	0.274	0.133
Loading on $d_t - p_t$	0.153	1.037	1.161	1.178	1.137	1.038	0.984	1.168
Average good times	0.029	0.042	0.042	0.042	0.043	0.068	0.085	0.046
Average bad times	0.070	0.184	0.195	0.190	0.179	0.164	0.196	0.110
Average yields	0.003	0.019	0.019	0.018	0.017	0.017	0.013	
St. dev. of yield	0.084	0.086	0.060	0.045	0.036	0.030	0.030	

Table AII
Counter Cyclical Equity Term Premia: HAR Standard Errors

This table shows the relation between term premia and the dividend-price ratio of the market portfolio. The table reports slope coefficient from the regression

$$R^n_{t;t+12} - R^m_{t;t+12} = \beta_0^{n,m} + \beta_1^{n,m}(d_t - p_t) + \epsilon_{t,t+12},$$

where $d_t - p_t$ is the dividend-price ratio of the market portfolio and $r^n_{t,t+12}$ is the 12-month forward return to the dividend claim with *n* year maturity. The regression is based on monthly rolling regressions. Below the estimates I report *t*-statistics based on Newey and West (1987) errors corrected for 18 lags, Hansen and Hodrick (1980) errors corrected for 12 lags and the for standard errors using the equal weighted periodogram estimator for long run variance as in Lazarus, Lewis, and Stock (2021). "*m=mean(1-7)"* refers to the average return to the available dividend claims with one- through seven-year maturity. The sample period for each regression is the longest possible sample using data from 2003 to 2019. Statistical significance is denoted by *** p<0.01, ** p<0.05, * p<0.1.

	Maturity of long-maturity claim (*n*)						
	2	3	4	5	6	7	Mkt
	Panel A: Newey and West standard errors						
m=1	0.30***	0.40***	0.48***	0.58***	0.63***	0.69***	0.88***
	(5.04)	(5.13)	(5.26)	(5.36)	(6.22)	(6.07)	(5.40)
m=2		0.08**	0.18***	0.28***	0.32***	0.36***	0.50***
		(2.62)	(3.26)	(3.83)	(5.18)	(5.25)	(3.29)
m=3			0.06**	0.10	0.12	0.15	0.41***
			(2.04)	(1.32)	(1.10)	(1.21)	(3.24)
m=mean(1-7)							0.54***
							(2.74)
	Panel B: Hansen and Hodrick standard errors						
m=1	0.30***	0.40***	0.48***	0.58***	0.63***	0.69***	0.88***
	(6.51)	(15.71)	(8.20)	(6.58)	(9.03)	(7.97)	(5.27)
m=2		0.08**	0.18***	0.28***	0.32***	0.36***	0.50***
		(2.37)	(2.89)	(3.42)	(4.73)	(4.82)	(3.06)
m=3			0.06*	0.10	0.12	0.15	0.41***
			(1.84)	(1.21)	(1.02)	(1.13)	(3.16)
m=mean(1-7)							0.54**
							(2.45)
	Panel C: Lazarus, Lewis, and Stock standard errors						
m=1	0.30***	0.40***	0.48***	0.58***	0.63***	0.69***	0.88***
	(3.06)	(3.33)	(3.73)	(4.08)	(4.36)	(4.46)	(5.18)
m=2		0.08**	0.18***	0.28***	0.32***	0.36***	0.50***
		(2.33)	(3.25)	(3.83)	(5.07)	(5.05)	(3.21)
m=3			0.06*	0.10	0.12	0.15	0.41**
			(2.04)	(1.32)	(1.12)	(1.22)	(2.94)
m=mean(1-7)							0.54**
							(2.58)

Table AIII
Alternative Predictor Variables

This table shows the relation between term premia and a series of predictor variables. The table reports the slope coefficient from the following regression

$$R^{n}_{t;t+12} - R^{m}_{t;t+12} = \beta_0^{n,m} + \beta_1^{n,m} x_t + \epsilon_{t,t+12},$$

where x_t is the value of the given predictor variable and $R^{n}_{t,t+12}$ is the twelve-month futures return to the dividend claim with *n* year maturity. The regression is based on either monthly or quarterly rolling regressions, depending on the predictor variable. The predictor variables include cay (Lettau and Ludvigson, 2001), the one-year change in aggregate consumption, the Chicago Fed National Financial Conditional Index (NFCI), and the output gap, measured as the potential GDP relative to real GDP. The NFCI is dividend by 100 for ease of readability. Regressions that use cay as predictor variable also include a time trend to account for the fact that the measure trends down over the sample. Below the estimates I report *t*-statistics based on Newey-West errors corrected for 18 lags. The maturities *n* and *m* are both measured in years. "*m=mean(1-7)*" refers to the average return to the available dividend claims with one- through seven-year maturity. The sample period for each regression is the longest possible sample using data from 2003 to 2019. Statistical significance is denoted by *** p<0.01, ** p<0.05, * p<0.1.

	$-\Delta Cons$		cay		NFCI		$-Y_{gap}$	
	n = 5	Mkt	5	Mkt	5	Mkt	5	Mkt
m=1	3.98***	5.42***	5.62***	9.41***	4.60	4.52	2.80**	1.19
	(4.26)	(2.98)	(5.64)	(5.31)	(1.03)	(0.69)	(2.07)	(0.61)
m=2	1.60***	2.31*	2.55***	4.44	3.32**	2.53	1.44***	-0.34
	(4.22)	(1.78)	(5.10)	(2.71)	(2.31)	(0.66)	(3.02)	(-0.26)
m=mean(1-7)		3.00*		5.31***		3.71		0.53
		(1.93)		(3.34)		(1.00)		(0.35)