NBER WORKING PAPER SERIES

THE TERM STRUCTURE OF EQUITY RISK PREMIA

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Working Paper 25690
http://www.nber.org/papers/w25690

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 2019

This research was supported by Rodney White Center and Jacob Levy Center. We thank a major financial institution for supplying us the data, and Mete Kilic for providing excellent research assistance. We also thank seminar participants at 2017 Macro-Finance Society Meeting in Chicago, Arizona State University, Duke University, Goethe University, HEC-Montreal-McGill, London Business School, London School of Economics, Stockholm School of Economics, University of California Berkeley, and the University of Michigan (Ann Arbor) for their comments. The views expressed herein are those of the authors and not necessarily those of Bank of Israel nor the National Bureau of Economic Research. A previous version of this paper was entitled "Is the Term Structure of Equity Risk Premia Upward Sloping?"

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NBER Working Paper No. 25690
March 2019
JEL No. E0

ABSTRACT

We use traded equity dividend strips from U.S., Europe, and Japan from 2004-2017 to study the slope of the term structure of equity dividend risk premia. In the data, a robust finding is that the term structure of dividend risk premia (growth rates) is positively (negatively) sloped in expansions and negatively (positively) sloped in recessions. We develop a consumption-based regime switching model which matches these robust data-features and the historical probabilities of recession and expansion regimes. The unconditional population term structure of dividend-risk premia in the regime-switching model, as in standard asset pricing models (habits and long-run risks), is increasing with maturity. The regime-switching model also features a declining average term structure of dividend risk-premia if recessions are over-represented in a short sample, as is the case in the data sample from Europe and Japan. In sum, our analysis shows that the empirical evidence in dividend strips is entirely consistent with a positively sloped term structure of dividend risk-premia as implied by standard asset pricing models.

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1 Introduction

We use traded equity dividend strips from U.S., Europe, and Japan from 2004-2017 to study the slope of the term structure of equity discount rates. We find, across all regions, that the term structure of dividend yields is upward sloping in expansions and downward sloping in recessions while the term structure of expected dividend growth rates is downward sloping in expansions and upward sloping in recessions. We develop a consumption-based regime-switching model (similar to Campbell and Cochrane (1999) and Bansal and Yaron (2004)) which captures these regime-based data features. This regime-switching model, as in the Campbell and Cochrane (1999) and Bansal and Yaron (2004) models, implies that the unconditional slope of the equity dividend risk-premium is positive. We use this model and the data on dividend strips to argue that the evidence on dividend discount rates, in contrast with the arguments made in Binsbergen and Koijen (2017), is entirely consistent with the positive slope implications of standard asset pricing models (Habits and Long Run Risks (LRR)).

Existing research, Binsbergen, Brandt, and Koijen (2012), Binsbergen, Hueskes, Koijen, and Vrugt (2013), Binsbergen and Koijen (2016), and Binsbergen and Koijen (2017), argues that "dividend strips data facts are difficult to reconcile with traditional macro-finance models." Using different modeling and data-analysis we arrive at an entirely different conclusion. We find considerable support in the data for the unconditional strip-yield implications of standard macrofinance models. Our data analysis differs from these papers on three fronts: (i) we use a somewhat longer historical sample and, unlike earlier papers, explicitly acknowledge that the short sample of dividend strip data, running from 2004 till 2017, does not accurately represent the long run balance of expansions and recessions, (ii) using the longer historical dividend sample we use Bayesian Vector Autoregression (BVAR) methods to conduct true out-of-sample analysis of growth rate forecasts and model comparisons and show that our conditional conclusions are robust to the elimination of look-ahead bias, and (iii) we focus on expected hold-to-maturity returns (i.e., dividend discount rates), which are robust to the illiquidity of this market, rather than monthly holding period returns, which also tend to be smaller than average bid-ask spreads. The difference in conclusions is driven largely by our analysis; while we have a somewhat longer data sample compared to Binsbergen and Koijen (2017), the overlapping period of our data set (which is most of the data) and that used in Binsbergen and Koijen (2017) is the same.

An important input in computing the discount rates and dividend risk premia for the dividend strips is a model for dividend growth rates. We conduct real-time forecasting of dividend growth rates by relying on a Bayesian Vector Autoregression (BVAR) framework which allows us to optimally exploit information in forecasting variables with longer histories (beyond our short sample) through priors. Our BVAR representation is general enough to nest forecasting models from the literature, enabling model selection via marginal likelihood comparison. We formally show that our approach, for example, has a higher marginal likelihood and superior forecast accuracy when compared to Binsbergen, Hueskes, Koijen, and Vrugt (2013). The use of predictors with longer data samples allows us to formally conduct out-of-sample forecasting analysis and demonstrate that the conditional conclusions are consistent with the in-sample analysis using either the long-sample predictors (LSP's) which are the focus of this paper or the short-sample predictors (SSP's) of previous work. Thus, our forecasting framework enables us to more precisely measure conditional variation in the expected growth and risk-premium term structures, variation which is robust to model specification and the elimination of look-ahead bias.

The expected hold-to-maturity returns (dividend discount rates) are measured by adding the observed dividend yields by maturity to the expected dividend growth rates by horizon. In terms of the key data findings we find that, across all countries, discount rates and dividend risk-premia rise with maturity during economic expansions and decline with maturity in recessions. Expected growth rates, on the other hand, fall with maturity in expansions and rise with maturity in recessions. While these conditional aspects of the data are robust, the estimates (using 14 years of data) for the sample average slope of discount rates and growth rates are noisy and estimated with large standard errors. The average dividend risk-premium slope is positive for the U.S., zero for Japan, and negative for Europe. The average slopes are quite sensitive to the frequency of expansions and recessions; if the short sample oversamples recessions the average slope can be negative even if its population value is positive. Indeed, in both Europe and Japan the short sample from 2004-2017 has a significantly higher frequency of recessions relative to their long run historical frequency. In the data the sample average discount rate slope is statistically significantly positive in the U.S., where recession frequency is in line with historical means, and is measured with large standard errors in Europe and Japan where recessions are overrepresented. We also observe, on average, a positive hold to matuirty Sharpe Ratio slope in the U.S.. While the Sharpe

Ratio evidence is broadly consistent with the implications of standard models, it should be noted that these statistics are poorly measured in the data.

Consistent with the implications of the Habits and LRR models, which generate a rising term structure of dividend risk premia, we develop a regime-switching model calibrated to the historical sample from the U.S. for recessions and expansions. We use this model to interpret the implications of dividend strip returns and yields for the term structure of macroeconomic risk. The population (long sample) dividend strip risk-premium in the regime-switching model rises with maturity. Further, the term structure of dividend risk premia is conditionally upward sloping in expansions and downward sloping in recessions. This model-implication is consistent with the data features discussed above. The model matches the average upward sloping dividend risk-premium curve for the U.S., whereas when the recession frequencies are too large relative to their population value, as is the case for Japan and Europe, the model generates the zero or negative slope found in the data. This establishes that a model with a positively sloped dividend risk-premium term structure (as in standard asset pricing models) matches the conditional and unconditional term structure of dividend strip risk premia observed in the data.

In our analysis we also focus on buy and hold-to-maturity returns on dividend stripsthese returns are the economic object of interest as they correspond to discount rates for each dividend strip. Our focus on discount rates is motivated by practitioner oriented evidence discussed in Klein (2018) and Mixon and Onur (2017), who highlight the fact that these markets are illiquid. Our more comprehensive dataset also includes expanded information on asset liquidity, specifically bid-ask spreads, unavailable in earlier studies. We show the transaction costs implied by bid-ask spreads are consistent with the conclusion of these articles that dividend strip markets are highly illiquid. The bid-ask spread on these contracts is larger than their monthly returns, the focus of previous studies, across horizons and regions and these contracts have very low liquidity compared to the futures market on the underlying equity index (e.g., S&P 500). This liquidity difference makes the comparison of the relative returns on the strips and the index extremely unreliable. Given the lack of liquidity in the strips we focus on expected hold-to-maturity returns, which we show mitigates the effects of large bid-ask spreads (i.e., trading costs).

Earlier work has also relied on other assets to provide evidence on the returns of strips, for example equity options in the case of Binsbergen, Brandt, and Koijen (2012).

This approach has drawbacks relative to direct evidence from strips. The options-based approach provides no evidence on the strip curve past two years, so it relies on comparing the index to the strips to infer the shape of the strip discount rate curve. Boguth, Carlson, Fisher, and Simutin (2011) and Schulz (2016) show why inference regarding dividend strips based on options data is suspect due to, respectively, micro-structure effects and tax issues. These studies, however, also use sample averages for unconditional inference. We show that correctly accounting for the balance of recessions and expansions makes the data entirely consistent with standard models and that market illiquidity can be appropriately addressed by focusing on hold-to-maturity expected returns[1].

Several papers have examined the implications of the term structure of equity return risk for various models or try to provide equilibrium setup in which the term structure of divided strip returns is downward sloping. For example, Hasler and Marfe (2016) examines the implications of recession recovery for the term structure. Ai, Croce, Diercks, and Li (2018) examine the term structure of equity returns in a production-based general equilibrium economy, finding that differences in dividend exposure to shocks across the term structure can explain high short maturity risk premia, even if consumption risk does not follow this pattern. Notably, both Croce, Lettau, and Ludvigson (2015) and Belo, Collin-Dufresne, and Goldstein (2015) also find that the dividend strip and consumption strip risk premium curves need not coincide if dividend beta to consumption risk changes by horizon. More generally, Hansen (2013), Backus, Boyarchenko, and Chernov (2017), and Piazzesi, Schneider, and Tuzel (2007) study implications of various asset pricing models for different cashflow durations.

2 Equity Yields

This section describes simple fundamental relations about equity prices, dividend yields, and dividend strip returns. These relations will be informative for our subsequent empirical analysis. Note that log-transformed variables are indicated with lower case letters.

[1]Existing work, e.g. Weber (2018), studying discount rates and asset duration from the panel of equities is uninformative on term structure variation in discount rates because it assumes a constant discount rate between firms and across maturities.

2.1 Equity as a portfolio of dividend strips

Let S_t denote the price of a claim on all future dividends. Then, S_t can be written as

$$S_t = \sum_{n=1}^{\infty} P_{n,t}, \tag{1}$$

where $P_{n,t}$ is the price of a claim on dividend at time $t+n$, D_{t+n}. Such a claim is often called "dividend strip" or "zero-coupon equity". We can write $P_{n,t}$ as

$$P_{n,t} = E_t\left[M_{t+n}D_{t+n}\right], \tag{2}$$

where M_{t+n} denotes the stochastic discount factor. The price of this claim tomorrow is $P_{n-1,t+1}$, noting that both the conditioning information and the time to maturity have changed. As a result, we can define the one-period return on the dividend strip with time to maturity n as

$$R_{n,t+1} = \frac{P_{n-1,t+1}}{P_{n,t}}. \tag{3}$$

Note that for $n=1$, the dividend strip return is equal to $R_{1,t+1} = \frac{P_{0,t+1}}{P_{1,t}}$. The price of a claim on the current dividend is the value of the dividend itself which implies $P_{0,t+1} = D_{t+1}$. For maturities longer than one period, the dividend strip does not have a payout at $t+1$ and, therefore, its return only reflects the change in its price.

Using the no-arbitrage relation, we can always write the return on the asset, R_{t+1}, in terms of its payoff as the sum of tomorrow's dividend and the value of all the future strips divided by the purchase price. Therefore, the one-period equity return can be expressed as a weighted average of dividend strip returns where the weights are given by the fraction of the corresponding dividend strip value in the total equity value:

$$R_{t+1} = \sum_{n=1}^{\infty} \frac{P_{n-1,t+1}}{S_t} = \sum_{n=1}^{\infty} \frac{P_{n,t}}{S_t}\frac{P_{n-1,t+1}}{P_{n,t}} = \sum_{n=1}^{\infty} \frac{P_{n,t}}{S_t}R_{n,t+1} = \sum_{n=1}^{\infty} \omega_{n,t}R_{n,t+1} \tag{4}$$

where $\omega_{n,t}$ is the weight of the maturity n strip in the portfolio of all strips for the asset. This equation establishes that the asset return can be viewed as the weighted average of the strip returns, where the weights are the fraction of the value of the asset for which each strip accounts.

2.2 Relation to dividend futures

Dividend futures are agreements where, at time t, the buyer and the seller agree on a contract price of $F_{n,t}$ which the buyer will pay to the seller at $t+n$, and will receive the realized dividend D_{t+n} in exchange. Hence, the price is agreed upon at t while money changes hands at $t+n$. Let $y_{n,t}$ be the time t zero-coupon bond yield with maturity n. Then, the futures price is given by

$$F_{n,t} = P_{n,t}\ \exp(ny_{n,t}), \tag{5}$$

which can be alternatively written as $P_{n,t} = F_{n,t}\ \exp(-ny_{n,t})$. The dividend strip return then becomes the product of the change in the futures price and the return on the bond with maturity n:

$$R_{n,t+1} = \frac{F_{n-1,t+1}}{F_{n,t}} \frac{\exp(-(n-1)y_{n-1,t+1})}{\exp(-ny_{n,t})}. \tag{6}$$

Using the future price $F_{n,t}$ and current dividend D_t, it is also instructive to define the spot equity and forward equity yield for maturity n respectively as:

$$e_{n,t} = \frac{1}{n}\ln\left(\frac{D_t}{P_{n,t}}\right) \tag{7}$$

$$e^f_{n,t} = \frac{1}{n}\ln\left(\frac{D_t}{F_{n,t}}\right) = e_{n,t} - y_{n,t}. \tag{8}$$

2.3 Hold-to-maturity expected returns

What is the relationship of the strip yield to the expected returns on the strip? Note that we can always rewrite the strip return to maturity as:

$$R_{t+n} = \frac{D_{t+n}}{P_{t,n}} = \frac{D_t}{P_{t,n}}\frac{D_{t+n}}{D_t}. \tag{9}$$

This is the n-period return on the dividend strip with time to maturity n, which relies on the same expression provided in (3). For notational simplicity, R_{t+n} is used instead of $R_{n,t+n}$.

Denote the n period average log return on an n period strip as $r_{t+n} = \frac{1}{n}\ln(R_{t+n})$ and the n period average dividend growth as $g_{d,t+n} = \frac{1}{n}\ln(\frac{D_{t+n}}{D_t})$. Rearranging (9) by applying (7) and (8), we can rewrite the return decomposition as:

$$r_{t+n} = e^f_{n,t} + y_{n,t} + g_{d,t+n} = e_{n,t} + g_{d,t+n}. \tag{10}$$

Therefore, the average expected return is

$$E_t[r_{t+n}] = e_{n,t} + E_t[g_{d,t+n}] \tag{11}$$

which is the sum of the spot equity yield and the average expected dividend growth rates

$$E_t[g_{d,t+n}] = \frac{1}{n} E_t[\ln\big(\frac{D_{t+n}}{D_t}\big)]. \tag{12}$$

(11) is referred to as the hold-to-maturity expected return, which is the conditional discount rate on the strip. Note that $e_{n,t}$ is an inflation neutral quantity, so using an estimate of real growth for $E_t[g_{d,t+n}]$ yields an estimate of real discount rates $E_t[r_{t+n}]$, which is the economic object of interest. One can also compute the premium on the hold to maturity expected return by subtracting the real yield by maturity from both sides of (11)

$$E_t[rx_{t+n}] = E_t[r_{t+n}] - y^r_{n,t}. \tag{13}$$

We can go further in characterizing the economic informational content of the dividend yields by computing the Sharpe ratio. We can compute the variance of returns conditional on the time t information set:

$$V_t[r_{t+n}] = V_t[g_{d,t+n}]. \tag{14}$$

This suggests that the volatility of the contract conditional on time t information is just the expected dividend growth volatility. This allows us to write the annualized conditional Sharpe ratio of the strip conditional on the time t information set as:

$$SR_{n,t} = \frac{E_t[rx_{t+n}]}{\sqrt{V_t[g_{d,t+n}]}}. \tag{15}$$

Note that we are not accounting for the half variance term in defining excess returns.

3 Data

3.1 Data source

Dividend futures prices. The data set covers the period from December 2004 to February 2017 at daily frequency and is provided from the proprietary data of a major financial institution that is active in dividend strips markets. The data consists of pricing and liquidity information on dividend futures. Dividend futures contracts typically mature on or after the third Friday of December in the year they mature. On that date the buyer of the contract pays the agreed amount at the initiation of the contract (which we call "the futures price") and the contract seller pays the realized dividends of the index in the year of maturity. The data is the internal pricing information used to trade in these markets by the providing institution and the data delivered to us by the institution contains MID prices for the entire sample and BID and ASK prices for a slightly shorter sample - starting in July 2008 for the Eurostoxx, in June 2010 for the Nikkei, and in January 2010 for the S&P 500. The main data set that is used to calculate equity yields and returns corresponds to MID prices on the last trading day of the month.

Daily exchange traded volume and open interest are available for Eurostoxx and Nikkei for the same period as BID and ASK prices are available[2]. We also show that for the overlapping periods our data is consistent with that used in Binsbergen, Hueskes, Koijen, and Vrugt (2013) and Binsbergen and Koijen (2017) in terms of descriptive statistics. The S&P 500 contracts are only traded over the counter (OTC) and no comparable public data is available for the spreads on these contracts. Practitioner oriented work in Mixon and Onur (2017) provides data on the volume traded and contracts outstanding in the OTC portions of each market that shows qualitatively consistent evidence on the liquidity of these markets. Section 6 discusses the liquidity data for these markets in detail.

The data set is short (146 months) and it is more practical to analyze the behavior of fixed maturity contracts at monthly frequency. Therefore, we linearly interpolate between futures prices to obtain a finer grid of maturities. For example, we would like to track the futures price with maturity $n = 24$ months. At the end of July 2007,

[2] For much of the post-2010 period data on exchange traded volume, open interest, BID, and ASK prices are also available daily via Bloomberg as well for the Eurostoxx and Nikkei, although we use the institution provided data throughout.

however, we have contracts with maturities of 5, 17, 29, 41, ... months. To obtain a price for the 24-month contract, we linearly interpolate between $F_{17,t}$ and $F_{29,t}$, similar to the process used in Binsbergen, Hueskes, Koijen, and Vrugt (2013).[3] When we compute holding period returns we interpolate between the returns themselves, thus obtaining a portfolio return for a portfolio with the same average maturity as the desired contract. This makes our estimates of holding period returns, particularly spread adjusted returns, achievable portfolio returns as in Binsbergen and Koijen (2016).

Zero-coupon bond yields. As can be seen from (6), the calculation of a monthly return on a 12-month dividend strip requires availability of both futures prices, as well as zero-coupon bond yields with maturities at monthly frequency. In order to ensure a consistent methodology is used in constructing the zero coupon interest rate curve we use the Bloomberg zero curve estimates for all three regions, for the dollar, yen, and for euro-denominated German sovereigns. To extend the data further back than these estimates exist, we use the bond yield data from Gürkaynak, Sack, and Wright (2007) available on FED's website. We obtain maturities at monthly frequency by linearly interpolating between available yields.

Dividend growth rates. We measure realized dividends from index returns. We use realized dividend data to construct dividend growth series starting in December 1979 for the U.S. and December 1994 for Europe and Japan, where the extended sample is reduced due to data availability. We provide the time series of the annualized dividend growth rates in the appendix as Figure A-2 for each region.

Recession frequency. Our most dramatic finding in the data is the stark and robust variation of return and growth term structures across the business cycle. Importantly, we do not use recession or expansion state in forecasting but simply to subsample forecasts and data to emphasize cyclical variation. To identify business cycles we use the NBER recession dates for the U.S., the CEPR recession dates for Europe, and recession dates from the Economic Cycle Research Institute for Japan[4]. Substantial variation in slope across the cycle means that the frequency of recessions in a given short sample can substantially affect the sample mean of the slope. We document that in the sample with strips data, 2005-2017, the frequency of recessions is 12% in the U.S.,

[3] We emphasize that our results are robust to yield interpolation instead of price interpolation method.

[4] The Economic Cycle Research Institute estimates peak-to-trough recession dates for a variety of countries. We have confirmed that the recessions dated by this provider for the U.S. and Europe match those dated by the NBER and CEPR and that they track the cyclical behavior of GDP.

Table 1: Forward equity yields: Summary statistics

n	1y	2y	3y	4y	5y	5y-1y	(t-stat)
			Panel A: S&P 500				
Sample average	-5.08	-4.55	-4.19	-4.01	-3.88	1.20	(0.68)
Expansion average	-7.15	-5.99	-5.17	-4.77	-4.52	2.63	(2.52)
Recession average	18.19	11.68	6.80	4.54	3.33	-14.86	(-6.71)
			Panel B: Eurostoxx 50				
Sample average	1.94	3.11	2.70	2.28	1.94	-0.00	(0.00)
Expansion average	-2.74	-0.92	-0.12	0.19	0.29	3.02	(2.34)
Recession average	18.10	17.04	12.42	9.48	7.64	-10.47	(-2.94)
			Panel C: Nikkei 225				
Sample average	-1.48	-1.47	-1.86	-1.85	-1.73	-0.26	(-0.13)
Expansion average	-6.26	-5.65	-5.18	-4.65	-4.17	2.09	(2.41)
Recession average	10.47	8.97	6.46	5.14	4.35	-6.12	(-1.57)

Notes: Equity yields are constructed by $e^f_{n,t} = \frac{1}{n}\ln(\frac{D_t}{F_{n,t}})$ with $F_{n,t}$ the futures price and D_t the trailing sum of 12 month dividends. We provide the subsample average and standard deviation of the forward equity yields from 2004:M12 to 2017:M2 for the three markets, i.e., S&P 500, Eurostoxx 50, and Nikkei 225. We partition the sample into "expansion periods," and "recession periods." For US, NBER recession dates are 1980:M1-1980:M7, 1981:M7-1982:M11, 1990:M7-1991:M3, 2001:M3-2001:M11, 2007:M12-2009:M6. For Europe, CEPR recession dates are 2008:Q1-2009:Q2, 2011:Q3-2013:Q1. For Japan, recession dates are 1998:M6-1998:M11, 2001:M9-2002:M5, 2008:M9-2009:M8, 2011:M3-2013:M2, 2014:M9-2015:M2. t-statistics are based on Newey-West standard errors. Maturities are in annual units.

26% in Europe, and 36% in Japan. For the U.S., this is relatively close to the long run recession frequency since 1950 of 14%, but it is nearly double the rate for Europe, which was 13% in the long run, and Japan, which was 19%. This strongly suggests that the behavior of any cyclical slopes in Europe and Japan will be substantially biased towards their recession means in the data. We address this formally in a model in Section 5, but emphasize the recession and expansion subsample means throughout our exposition of the data evidence to reinforce the importance of recession frequency.

3.2 The stylized facts about equity yields and dividends

Table 1 provides the summary statistics of the forward equity yields in these three markets from 2004 to 2017. We first look at the average term structure of equity yields.

We find that only the U.S. market seems to show the evidence of upward sloping term structure of equity yields whereas the European and Japanese markets exhibit mildly downward sloping term structure of equity yields.

We then highlight the behavior of equity yields conditional on the state of business cycle, i.e., expansion and recession. There is remarkable consistency across these three markets. We find that the term structure of equity yields is upward (downward) sloping in expansion (recession) in all three markets. The absolute magnitude of the spread between 5-year and 1-year maturity equity yields tends to be much larger during recession than expansion.[5] One can easily deduce from this finding that the unconditional (sample) average of the term structure of equity yields heavily depends on the frequency of recession in the sample.

We will ultimately use a longer sample in forecasting dividend growth rates so that we can conduct real time out-of-sample forecasting, so we present results for both this extended sample and the subsample with strip data. The extended sample begins in 1979 for the U.S. and 1994 for Europe and Japan, due to data availability. Figure A-2 provides the time series of the realized dividend growth rates conditional on the state of the business cycle for the three markets. Note that there were no recessions identified by CEPR in Europe from 1994-2005. We emphasize first that the frequency of recessions in Europe and Japan after 2005 is greater than that in the longer sample, while it is comparable for both samples in the U.S., and second that the behavior of expected dividend growth rates, as documented below, is different in recessions and expansions. Given the behavior of the strip yields in Table 1, this implies that the sample average behavior if the various term structure slopes will be tilted towards thair recession outcomes in Europe and Japan.

4 Forecasting Dividend Growth Rates

We expect that the dynamics of expected dividend growth rates, and consequently, expected returns, see (11), would be quite different conditional on recession and expansion. To show this, we develop a model for forecasting dividend growth rates both in sample and out-of-sample, as discussed below.

[5] The downward sloping pattern of the term structure is most notable during the Great Recession, see Figure A-1.

4.1 VAR-based dividend forecasts

Let $x_{A,t}$ be a vector of monthly variables that predicts dividend growth. We consider an annual first order VAR dynamics for the predictor vector

$$x_{A,t+12} = \mu_A + \Gamma_A x_{A,t} + \varepsilon_{A,t+12}. \tag{16}$$

This is because we are interested in the annual horizon forecasts. There are two ways of estimating the coefficients in (16): The first is via the direct projection method and the second is estimate a monthly first order VAR model[6]

$$x_{A,t+1} = \mu_m + \Gamma_m x_{A,t} + \varepsilon_{m,t+1} \tag{17}$$

and obtain

$$\mu_A \equiv \left(\sum_{i=0}^{11} \Gamma_m^i \right) \mu, \quad \gamma_A \equiv \Gamma_m^{12}, \quad \varepsilon_{A,t+12} \equiv \sum_{i=0}^{11} \Gamma_m^{12-i} \varepsilon_{m,t+i}.$$

Regressing dividend growth on lagged predictor vector gives the estimates for ψ_0 and ψ_1

$$g_{d,t+12} = \psi_0 + \psi_1 x_{A,t} + \varepsilon_{d,t+12}. \tag{18}$$

To recap, $g_{d,t+12} = \ln(\frac{D_{t+12}}{D_t})$ where D_t is the 12-month trailing sum dividends.

For ease of exposition, we stack (16) and (18) together and express them in an annual first order VAR model as

$$\begin{bmatrix} x_{A,t+12} \\ g_{d,t+12} \end{bmatrix} = \begin{bmatrix} \mu_A \\ \psi_0 \end{bmatrix} + \begin{bmatrix} \Gamma_A & 0 \\ \psi_1 & 0 \end{bmatrix} \begin{bmatrix} x_{A,t} \\ g_{d,t} \end{bmatrix} + \begin{bmatrix} \varepsilon_{A,t+12} \\ \varepsilon_{d,t+12} \end{bmatrix}. \tag{19}$$

From (19), we derive the conditional expectation of the annual dividend growth n years ahead as

$$E_t[g_{d,t+12n}] = \psi_0 + \psi_1 \left(\left[\sum_{i=0}^{n-2} \Gamma_A^i \right] \mu_A + \Gamma_A^{(n-1)} x_t \right). \tag{20}$$

[6]Note that Binsbergen, Hueskes, Koijen, and Vrugt (2013) follow the second approach.

The $12n$-month-ahead dividend growth shocks and their cumulative shocks are

$$
\begin{aligned}
g_{d,t+12n} - E_t[g_{d,t+12n}] &= \psi_1 \left(\sum_{i=0}^{n-2} \Gamma_A^i \varepsilon_{A,t+12(n-1-i)} \right) + \varepsilon_{d,t+12n} \\
\sum_{n=1}^{m} \Big(g_{d,t+12n} - E_t(g_{d,t+12n}) \Big) &= \psi_1 \left(\sum_{j=0}^{m-2} (I - \Gamma_A)^{-1} (I - \Gamma_A^{m-1-j}) \varepsilon_{t+12(j+1)} \right) + \sum_{n=1}^{m} \varepsilon_{d,t+12n}.
\end{aligned}
\tag{21}
$$

It is straightforward to compute $V_t[g_{d,t+12n}]$ and $V_t\big[\sum_{n=1}^{m} g_{d,t+12n}\big]$ from (21).

4.2 Bayesian inference

The sample in which we have equity yields is quite short. However, data on dividend growth rates are available much before. We have seen from Figure A-2 that we can potentially rely on the historical data to learn about the future dividend growth dynamics to the extent that dynamics have not changed substantially over time. In this section, we formally show how one could optimally use prior information (extracted from historical data) and improve forecasts.

Posterior. The first-order vector autoregression (19) can be always re-written as

$$
y_t = \Phi x_t + \varepsilon_t, \quad \varepsilon_t \sim N(0, \Sigma) \tag{22}
$$

where $y_t = \left[x'_{A,t}, g_{d,t}\right]'$ and $x_t = \left[1, x'_{A,t-12}\right]'$. Define $Y = [y_{13}, ..., y_T]'$, $X = [x_{13}, ..., x_T]'$, and $\varepsilon = [\varepsilon_{13}, ..., \varepsilon_T]'$. Taking the initial 12 observations as given, if the prior is

$$
\Phi|\Sigma \sim MN\big(\underline{\Phi}, \Sigma \otimes (\underline{V}_\Phi \xi)\big), \quad \Sigma \sim IW(\Psi, d) \tag{23}
$$

then the posterior can be expressed as

$$
\Phi|\Sigma \sim MN\big(\overline{\Phi}, \Sigma \otimes \overline{V}_\Phi\big), \quad \overline{\Phi} = \Big(X'X + (\underline{V}_\Phi \xi)^{-1} \Big)^{-1} \Big(X'Y + (\underline{V}_\Phi \xi)^{-1} \underline{\Phi} \Big) \tag{24}
$$

because of the conjugacy.[7] Here, ξ is a scalar parameter controlling the tightness of the prior information.

[7] Since we are mainly interested in the conditional expectation, we omit the expression for Σ. The readers are referred to Giannone, Lenza, and Primiceri (2015).

The elicitation of prior. Suppose that we can divide the sample into the pre-sample, estimation sample, and prediction sample. We set the prior mean $\underline{\Phi}$ equal to the pre-sample OLS estimate, from the 1980-2004 sample for the U.S. and the 1995-2004 sample for Europe and Japan. Here, prior becomes more informative when $\xi \to 0$. In the limit, posterior equals the pre-sample OLS estimate, i.e., prior. In contrast, when $\xi = \infty$, then it is easy to see that $\overline{\Phi} = \hat{\Phi} = (X'X)^{-1}(X'Y)$, i.e., an OLS estimate from the estimation sample. In this case, prior does not play any role. We can optimize the scaling parameter by choosing the value that maximizes the marginal likelihood function, $\hat{\xi} = \text{argmax}\ p(Y|\xi)$. The closed form of the marginal likelihood function is available in the appendix. We refer to Giannone, Lenza, and Primiceri (2015) for a detailed discussion.

4.3 Model selection and estimation

The VAR expression in (19) can describe the approach of Binsbergen, Hueskes, Koijen, and Vrugt (2013) where the predictor vector x_A comprises the 2-year and 5-year forward equity yields. We refer to this three-variable (dividend growth plus two predictors) VAR, identical to that of BHKV, as the Short Sample Predictor (SSP) approach for simplicity. We propose a different three-variable VAR where the predictor vector x_A comprises the 5y-1y nominal bond yield spread and dividend to earnings ratio, which is referred to as the Long Sample Predictor (LSP) approach. In addition to improved forecast accuracy, the LSP will allow us to conduct out-of-sample forecasting because these predictors have a longer history than dividend yields.

Ideally, we would like to conduct both in-sample and out-of-sample forecast exercises for the SSP and LSP approaches. Unfortunately, we cannot conduct out-of-sample forecast exercise for the SSP approach since their predictor variables, the 2-year and 5-year forward equity yields, are only available from 2004:M12 according to our data vendor. The VAR coefficients in the SSP approach cannot be recursively estimated unless the prediction sample is substantially shortened. This is not ideal given the data availability. The reason we desire to use recursive updating and out-of-sample forecasting using the LSP is to establish that our results hold in real-time forecasts. This study is the first to show the term structure of expected growth and returns in real time.

To minimize confusion, we define two estimation strategies. The in-sample estimation is carried out with data from 2004:M12 to 2017:M2 using the maximum available data. We can formally conduct model selection and compare the in-sample forecasting performance of the SSP and LSP approaches. When we generate in-sample forecasts, we allow for look-ahead bias by including all the data in the estimation at once. Here, we briefly describe the model selection result. The forecast results are discussed shortly. We choose the LSP approach over the SSP approach based on the model selection via the marginal likelihood maximization. For U.S., the log marginal likelihood values are 430 versus 374; for Europe, they are 704.4 versus 58.5; for Japan, 596 versus 135, all in favor of LSP over SSP approach.

To define the out-of-sample estimation period, we first set the prediction sample to 2005:M1 to 2013:M2. The initial out-of-sample estimation starts from 2001:M1 to 2004:M12. When we move the forecast origin from 2005:M1 to 2013:M2, the posterior VAR coefficients are also updated as we recursively increase the sample. In doing so, we optimize the scaling parameter ξ that controls the tightness of the prior.

With respect to prior information, we use the sample before the prediction sample to obtain prior for the VAR coefficients. Specifically, we use data from 1979:M12 to 2000:M12 (U.S.) and from 1994:M12 to 2000:M12 (Europe and Japan) to elicit prior information. It is possible for the LSP approach because the 5y-1y nominal bond yield spread and dividend to earnings ratio are available. Since elicitation of prior information is not possible for the SSP approach, we set the scaling parameter to $\xi = \infty$ so that (whichever specified) prior does not play any role and the posterior mean is identical to the OLS estimate. Thus, we can rely on the same expression (24) to generate posterior forecasts for both the SSP and LSP approaches.

4.4 Forecast results

The dividend growth rate forecasts are generated up to 5-year-out to maximize the data availability.[8] Table 2 summarizes the root mean squared errors (RMSEs) of the dividend growth rate forecasts for the three markets. Let us focus on Panel A: U.S. and compare the RMSEs from the out-of-sample LSP (o.o.s.) with those from the in-sample SSP approach. The results are surprising given that the LSP approach (o.o.s.) is at

[8]One could generate upto 7-year-out horizon which results in shortening the prediction sample to 2005:M1-2011:M2 instead of 2005:M1-2013:M2.

Table 2: Root mean squared errors for the dividend growth rate forecasts

	Panel A: U.S.			Panel B: Europe			Panel C: Japan		
	SSP	LSP	LSP	SSP	LSP	LSP	SSP	LSP	LSP
n			o.o.s.			o.o.s.			o.o.s.
1y	8.41	9.82	10.10	8.46	7.59	20.14	11.62	12.79	18.32
2y	9.51	8.60	9.43	10.24	7.10	15.73	9.91	8.70	14.98
3y	9.19	7.03	8.10	9.11	6.38	12.01	7.96	6.78	11.80
4y	8.20	5.87	6.89	6.32	4.26	10.05	5.68	5.22	9.00
5y	6.73	4.68	5.75	4.98	3.07	9.33	4.44	3.93	8.26

Notes: For the in-sample forecasts, we use data from 1979:M12 to 2004:M12 (U.S.) and from 1994:M12 to 2004:M12 (Europe and Japan) to elicit prior information. The estimation sample is from 2005:M1 to 2017:M2. Our prediction sample is from 2005:M1 to 2013:M2. For the out-of-sample forecasts, we use data from 1979:M12 to 2000:M12 (U.S.) and from 1994:M12 to 2000:M12 (Europe and Japan) to elicit prior information. The initial estimation sample is from 2001:M1 to 2004:M12. We increase the estimation sample recursively as we move the forecast origin. The root mean squared errors based on the out-of-sample forecasts are indicated with o.o.s.

a clear informational disadvantage compared with the SSP approach. Except at the 1-year horizon, we find that the RMSEs for the respective horizons are much smaller than those from the SSP approach. What is interesting is the magnitude of the RMSEs, whether they are based on in-sample or out-of-sample forecasts, are similar for the LSP approach. This evidence strongly suggests the superior forecast performance of our VAR approach and the usefulness of extracting information embedded in the historical data in the form of priors.

The RMSEs from the out-of-sample forecasts are uniformly larger (roughly by a factor of two) than those of the in-sample SSP forecasts for Europe and Japan. Again, the large RMSE and apparent changes in dividend dynamics relative to the pre-sample suggests that these dividend growth events were unexpected. For in sample forecasts, our model continues to produce superior estimates to those of Binsbergen, Hueskes, Koijen, and Vrugt (2013) and dominates in marginal likelihood.

Once the expected dividend growth rates are generated, given the forward equity yields and real rates, we are able to compute the expected return (see (11)), excess return (see (13)), and hold to maturity Sharpe Ratio (see (15)) as well. We construct the real rate proxy by subtracting the average inflation from the nominal yields.[9] To

[9]Given the relatively small variation of inflation rates, especially relative to the large movements in real growth and discount rates, by horizon within the recession and expansion subsamples, it is highly

Table 3: Out-of-sample forecasts of dividend growth, prices, and returns: U.S.

	Exp. growth	Exp. return	Premium	Sharpe ratio	STRIPS	YLD
			Entire period			
1y	2.93	0.39	0.35	0.08	-4.58	2.04
2y	2.61	0.82	0.65	0.23	-3.96	2.17
3y	2.59	1.30	0.93	0.38	-3.66	2.37
4y	2.62	1.75	1.16	0.50	-3.46	2.59
5y	2.65	2.22	1.39	0.65	-3.26	2.83
5y-1y	-0.28	1.83	1.04	0.57	1.32	0.79
			Expansion period			
1y	5.03	-2.99	-3.28	-0.96	-10.31	2.29
2y	3.87	-1.38	-1.77	-0.61	-7.64	2.39
3y	3.40	-0.20	-0.73	-0.29	-6.14	2.53
4y	3.19	0.53	-0.18	-0.09	-5.37	2.72
5y	3.07	1.16	0.25	0.10	-4.83	2.92
5y-1y	-1.96	4.14	3.52	1.06	5.48	0.62
			Recession period			
1y	-3.45	10.65	11.39	3.24	12.84	1.26
2y	-1.22	7.51	8.00	2.78	7.22	1.52
3y	0.10	5.86	5.99	2.38	3.89	1.87
4y	0.88	5.45	5.25	2.32	2.36	2.20
5y	1.36	5.43	4.86	2.34	1.49	2.58
5y-1y	4.81	-5.22	-6.54	-0.90	-11.34	1.32

Notes: We provide the annualized average expected dividend growth rates $E_t[g_{t+n}]$ ("Exp. growth"); the expected discount rate $E_t[r_{t+n}]$ ("Exp. return"), computed as in (11): $E_t[r_{t+n}] = e_{n,t} + E_t[g_{d,t+n}]$; the expected excess return $E_t rx_{t+n}$ ("Premium"), computed as in (13): $E_t[rx_{t+n}] = E_t[r_{t+n}] - y^r_{n,t}$; the Sharpe ratio $SR_{n,t}$ ("Sharpe ratio"), computed as in (15): $SR_{n,t} = \frac{E_t[rx_{t+n}]}{\sqrt{V_t[g_{d,t+n}]}}$; the forward equity yields $e^f_{n,t}$ ("STRIPS"); and the nominal bond yields $y_{n,t}$ ("YLD"). Results are based on the LSP approach, a 3-variable VAR approach that includes 5y-1y nominal bond yield spread, asset dividend to earnings ratio, and dividend growth. The initial estimation sample for the LSP approach is from 2001:M1 to 2004:M12. We increase the estimation sample recursively as we move the forecast origin, i.e., 2005:M1 to 2013:M2. The sample average of inflation rates is around 2%.

be conservative and to save space, we only show the out-of-sample forecast results for the U.S. market. We provide the in-sample forecast results for the three markets in the appendix in Tables A-2, A-3, and A-4.

unlikely that compensation for inflation risk substantively has any bearing on our measure of risk premia. For U.S., we later replace with the Treasury Inflation-Protected Securities (TIPS) to confirm the robustness of our results.

Table 3 provides the annualized average expected dividend growth rates $E_t[g_{t+n}]$ ("Exp. growth"); the expected discount rate $E_t[r_{t+n}]$ ("Exp. return"); the expected excess return $E_t rx_{t+n}$ ("Premium"); the Sharpe ratio $SR_{n,t}$ ("Sharpe ratio"); the forward equity yields $e^f_{n,t}$ ("STRIPS"); and the nominal bond yields $y_{n,t}$ ("YLD"). We provide the corresponding averages of the entire prediction sample and the averages conditional on whether the forward equity yield spread between 5-year and 1-year is positive or negative. This is because we believe that the negative spread of forward equity yields between 5-year and 1-year closely tracks the recession dates.[10] Remember that these are the averages of real time out-of-sample forecasts. We provide the evidence for the remaining regions in the appendix. We refrain from using the recession indicators to forecast as they are determined ex post. On the other hand, the equity yields and LSP predictors are available to investors in real time.

We summarize the main findings as follows. The slope of the expected dividend growth is negative (positive) during expansions (recessions). The slopes of the expected return, excess return, and sharpe ratio are positive (negative) during expansion (recession). The slopes of the entire period averages of expected return, expected excess return, and sharpe ratio are positive. Both the in and out-of-sample hold to maturity Sharpe Ratios are either upward-sloping (U.S. and Japan) or flat (Europe in sample), however these statistics have large standard errors relative to risk premium estimates. To check the statistical significance of the findings, Table 4 provides the 90% credible intervals associated with the selective forecasts: expected return and growth. It is interesting to observe that all slopes of the conditional moments are statistically significantly different from zero at the 90% confidence level. The findings are largely robust to the out-of-sample and in-sample forecast results. The in-sample forecast results based on the SSP approach deliver qualitatively similar message, which is provided in Table A-5. Finally, we note that while the estimates of hold to maturity Sharpe Ratios are substantially noisier, the Sharpe Ratio slope is significantly positive in the U.S., where the estimates are best and the recession frequency is in line with the long run mean, at 0.39 for 5y-1y in sample and 0.51 out-of-sample.

We find that the sign of the conditional slopes for the European and Japanese markets are broadly consistent with the U.S. market with expected returns sloping downward in

[10]Figure A-3 plots the two series, which appear to be highly correlated. The correlation between the equity yield spread and recession indicator is around 65% for the U.S. and Europe and 40% for Japan, respectively. The seemingly low correlation than it appears is because we are computing correlation with a dummary variable.

Table 4: The spread between 5-year and 1-year forecasts

	In-sample						Out-of-sample					
	Exp. return			Exp. growth			Exp. return			Exp. growth		
	50%	[5%	95%]	50%	[5%	95%]	50%	[5%	95%]	50%	[5%	95%]
	Entire period											
U.S.	2.52*	[1.13,	3.85]	0.40	[-0.98,	1.73]	1.83*	[1.40,	2.25]	-0.28	[-0.72,	0.14]
Europe	-0.28	[-2.68,	2.25]	-0.45	[-2.85,	2.07]	2.21	[-0.32,	4.96]	2.21	[-0.30,	4.99]
Japan	-3.07*	[-5.27,	-0.90]	-1.06	[-3.26,	1.11]	-2.76*	[-5.54,	-0.04]	-0.62	[-3.41,	2.18]
	Expansion period											
U.S.	4.18*	[3.01,	5.32]	-1.91*	[-3.09,	-0.78]	4.14*	[3.83,	4.47]	-1.96*	[-2.28,	-1.63]
Europe	0.04	[-2.17,	2.39]	-7.23*	[-9.44,	-4.88]	9.85*	[7.23,	12.75]	2.85	[-0.47,	5.75]
Japan	1.19	[-0.85,	3.13]	-2.34*	[-4.38,	-0.44]	1.68	[-0.90,	4.23]	-1.92	[-4.49,	0.63]
	Recession period											
U.S.	-2.55*	[-4.58,	-0.64]	7.48*	[5.45,	9.38]	-5.22*	[-6.00,	-4.51]	4.81*	[4.03,	5.51]
Europe	-0.68	[-3.34,	2.06]	8.44*	[5.78,	11.19]	-7.79*	[-10.21,	-5.25]	1.37	[-1.05,	3.91]
Japan	-7.79*	[-10.18,	-5.37]	0.36	[-2.03,	2.78]	-7.48*	[-10.49,	-4.41]	0.75	[-2.25,	3.83]

Notes: We provide the results based on the in-sample and out-of-sample forecasts for $E_t[g_{d,t+5} - g_{d,t+1}]$ and $E_t[r_{t+5} - r_{t+1}]$ computed as in (11): $E_t[r_{t+n}] = e_{n,t} + E_t[g_{d,t+n}]$. For the in-sample forecasts, we use data from 1979:M12 to 2004:M12 (U.S.) and from 1994:M12 to 2004:M12 (Europe and Japan) to elicit prior information. The estimation sample is from 2005:M1 to 2017:M2. Our prediction sample is from 2005:M1 to 2013:M2. For the out-of-sample forecasts, we use data from 1979:M12 to 2000:M12 (U.S.) and from 1994:M12 to 2000:M12 (Europe and Japan) to elicit prior information. The initial estimation sample is from 2001:M1 to 2004:M12. We increase the estimation sample recursively as we move the forecast origin. We use $*$ to indicate the statistical significance at the 90% confidence level.

recession and upward in booms. Caution is required in interpreting the sample average as an unconditional mean because the balance of recessions in the short sample is not representative for these regions. If the sample overrepresents recessions, as is the case in Europe and Japan, the behavior of the sample average expected growth and dividend discount rate slopes will be biased towards their recession means.

We have shown that the most robust feature of this data is the recession and expansion variation of the growth rate and risk premium term structures. Due to the large differences between recessions and expansions, we develop a regime-switching model in the next section that preserves the core implications of standard asset pricing models - risk unconditionally increases with horizon, both risk and expected growth vary across the cycle, and the riskfree rate is nearly constant - while matching the conditional facts on expected growth and risk premia we document via the BVAR. This model allows us to formally address issues of short sample biases and recession-expansion balance in context and show that both the conditional and sample average facts documented in this section are wholly consistent with standard models like the LRR or habits.

5 The regime-switching model

Motivated by the empirical findings, we introduce a regime-switching consumption-based asset pricing model to understand its implications for both the conditional and unconditional moments.

5.1 Cash flow dynamics

The joint dynamics of monthly consumption and dividend growth are

$$\begin{aligned} \Delta c_t &= \mu(S_t) + x_t + \sigma_c \eta_{c,t}, \quad \eta_{c,t} \sim N(0,1), \\ \Delta d_t &= \bar{\mu} + \phi(\Delta c_t - \bar{\mu}) + \sigma_d \eta_{d,t}, \quad \eta_{d,t} \sim N(0,1), \\ x_t &= \rho x_{t-1} + \sigma_x(S_t)\epsilon_t, \end{aligned} \tag{25}$$

where $\bar{\mu}$ is the unconditional mean of consumption growth, x_t is the persistent component of consumption growth, and S_t is a discrete Markov state variable that takes on two values $S_t \in \{1, 2\}$. We assume $\mu_1 > \mu_2$ without loss of generality and indicate $S_t = 1$ an expansion state and $S_t = 2$ a recession state.

The model-implied average expected dividend growth is

$$E_t[g_{d,t+n}] = \frac{1}{n} E\big[\sum_{i=1}^{n} \Delta d_{t+i} | S_t\big]. \tag{26}$$

The agent in the model observes the current regime, S_t, and makes forecast of future regime, S_{t+i}, based on the transition matrix

$$\mathbb{P} = \begin{bmatrix} p_1 & 1-p_1 \\ 1-p_2 & p_2 \end{bmatrix}. \tag{27}$$

It is easy to understand from (26) that the path of $E_t[g_{d,t+n}]$ significantly depends on the current state S_t. To provide a preview, the slope of the expected dividend growth is negative (positive) if the economy is in expansion (recession). This is illustrated in

Figure 1. Later, we argue that the model characterizes an important aspect of the data especially when it comes to the short-horizon forecasts.

5.2 Stochastic discount factor

We assume that the log stochastic discount factor (SDF) follows

$$m_{t+1} = -r_{t+1} - \frac{1}{2}\lambda(S_{t+1})^2 - \lambda(S_{t+1})\epsilon_{t+1} \tag{28}$$

with an exogenously specified risk-free rate, r_{t+1}. We set $r_{t+1} = \bar{r}$ so that the risk-free rate does not depend on the state. The market price of risk depends on the state $\lambda(S_{t+1})$. We impose that $\lambda(1) < \lambda(2)$ in the spirit of Campbell and Cochrane (1999), e.g., higher risk aversion in bad times. Since $\mu_1 > \mu_2$, this allows us to match the recession and expansion dynamics of both returns and growth while preserving the implications of standard models. In both Habits and LRR, short term risk goes up in bad states then gradually comes down over time, generating the conditional features we have explicitly modeled in this regime-switching model in a simpler implementation. Along with capturing expected growth variation in a convenient way that is consistent with the data, an improvement relative to standard calibrations, this will also allow us to match the conditional yield and dividend discount rate slopes.

5.3 Price to dividend ratio of the zero-coupon equity

The price of zero-coupon equity is $P_{n,t} = Z_{n,t}D_t$. In the economy of (25) with the SDF of (28), we can conjecture that the log price to dividend ratio of the zero-coupon equity $z_{n,t}$ depends on the regime and persistent growth component, i.e., $z_{n,t} = z_{n,0}(S_t) + z_{n,1}(S_t)x_t$. Exploiting the law of iterated expectations, we can solve for $z_{n,t} = \ln E\big(E\big[\exp(m_{t+1} + z_{n-1,t+1} + \Delta d_{t+1})|S_{t+1}\big]|S_t\big)$. The detailed derivation is provided in the appendix.

5.4 Hold-to-maturity expected excess return

Define the m-month holding period return of the n-month maturity equity by

$$R_{n,t+m} = \frac{Z_{n-m,t+m}}{Z_{n,t}}\frac{D_{t+m}}{D_t}. \tag{29}$$

The average log expected return is

$$E_t r_{n,t+m} = \frac{1}{m} E_t[z_{n-m,t+m} - z_{n,t} + \sum_{i=1}^{m} \Delta d_{t+i}]. \tag{30}$$

When $m = n$, the equation (30) becomes the hold-to-maturity expected return of the n-month maturity equity. We show in the appendix that

$$e_{t,n} = -\frac{1}{n} z_{n,t} \tag{31}$$

and how to calculate $E_t[g_{d,t+n}]$, $z_{n,t}$, and $y^r_{n,t}$. It is then straightforward to compute (11), (13), and (15).

5.5 The model-implied term structure of equity risk premia

We calibrate the model to match the U.S. data moments for consumption and dividend growth rates and market equity premium. The calibrated parameters for consumption growth are standard (the expansion state is associated with higher mean and lower volatility).

The conditional moments. Note that the conditional moments will be function of consumption growth component x_t and the regime (discrete state) S_t. For ease of illustrating the model implications, we set $x_t = 0$ for simplicity and highlight the role of regime S_t.[11] Panel A of Figure 1 provides the model-implied (7), (11), (12), and (13). We summarize the model implications as follow:

1. The slope of the expected dividend growth is negative (positive) if the economy is in expansion (recession).[12]

2. The slope of the term structure of the riskfree rate is zero (by construction).

3. The slope of the equity yields, dividend discount rates, and dividend risk premia is positive (negative) if the economy is in expansion (recession).

[11] This means that the risk associated with x_t is priced, but we assume that the realization is $x_t = 0$ for graphical illustration.

[12] One thing to emphasize is that the expected dividend growth rate is much lower in recession even though we calibrated $\mu_2 = 1.2\%$ (annualized). What matters is whether the current economic state is below the long-run mean $\bar{\mu}$ or not.

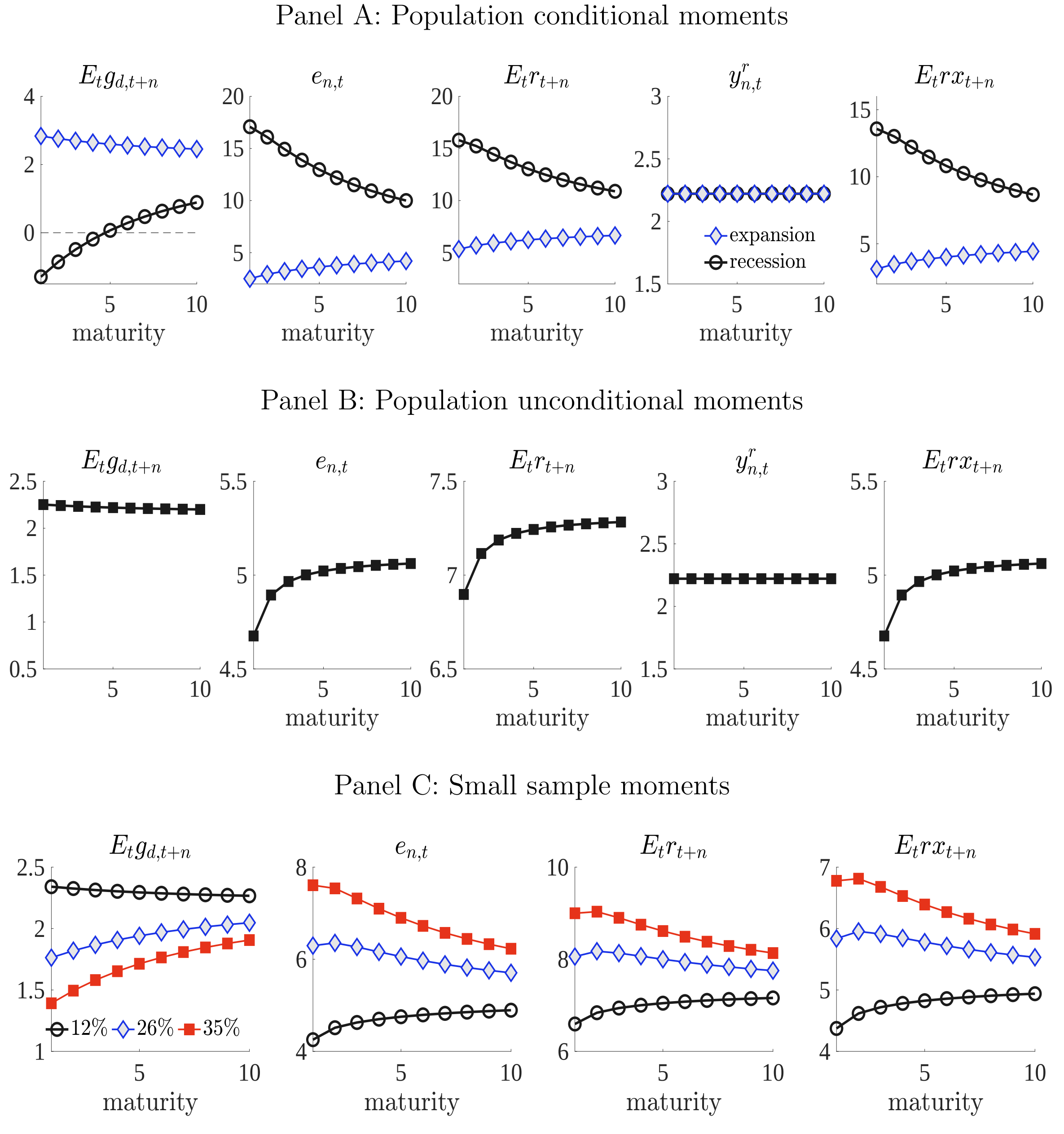
We match the key conditional expected growth rate and dividend discount rate slope features documented in the data in Tables 1 and 4. We also calibrate the regime transition probabilities to match the long run frequency of recessions across regions - about 15%.

The population moments. Panel B of Figure 1 provides the population unconditional moments of the term structure of the equity risk premia and expected growth in the model. The model generates unconditional term structure of discount rate and equity risk premia in which both macroeconomic and dividend risk rises with horizon. Empirically speaking, the unconditional price and return moments can be hard to measure, since they involve calculating the unconditional probabilities of the state of the business cycle. The results depend on the sample over which the probabilities are calculated. The small sample bias is especially relevant in this context. For example, if recessions are overrepresented in the sample, then the sample average moments of prices and returns would be biased towards those in the recession state. Hence, there is substantial risk of misinterpreting the results if sample averages are used to estimate unconditional means without attention to the frequency of recessions.

To show this, we average the conditional moments implied from the model across the two states with recession frequency that is different from the steady state probability of recession, which is around 15%. We proceed with three cases of recession frequency based on the realized short sample recession frequencies in the three regions of 12%, 26%, and 35% of the sample from 2005:M1 to 2013:M2 for the U.S., Europe, and Japan, respectively. We use the prediction sample to estimate the recession probabilities. Panel C of Figure 1 provides the small-sample averages of the term structure of the equity risk premia and expected growth among others based on three cases of recession frequency. One could clearly observe the pattern of downward sloping term structure of discount rate and equity risk premia when recession frequency is much greater than the model steady-state recession frequency, as is the case in Europe and Japan in the data. If the small sample recession frequency is below the model steady state recession probability, then the term structure of discount rate and equity risk premia are strongly upward sloping, as is the case in the U.S. in the data.

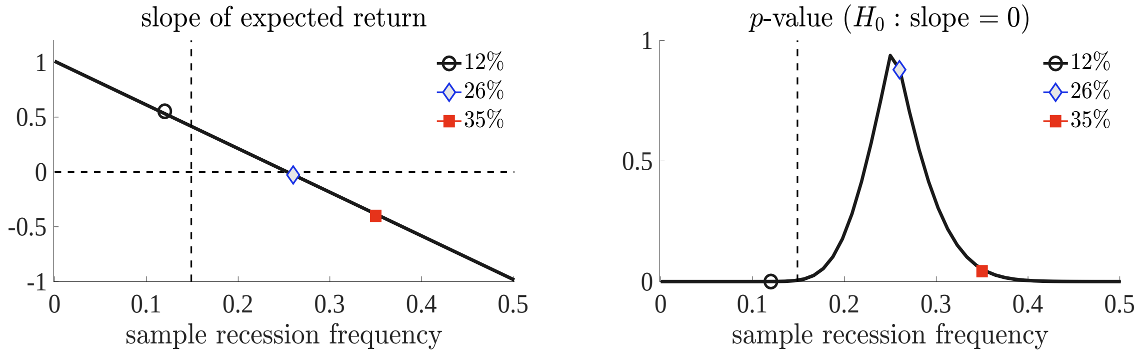
Figure 2 pursues this idea more formally. We simulate the time series of economic state (recession and expansion) from the model that matches the length of our prediction sample, which is roughly eight years (T = 96 months). Conditional on the economic state at each time t, we pick the corresponding moments of expected return for the

Figure 1: The model-implied conditional moments



Notes: We set $\mu(1) = 2.4, \mu(2) = 1.2, \sigma_c = 2.2, \rho = 0.50, \sigma_x(1) = 1.13, \sigma_x(2) = 2.41$, $p_1 = 0.9965, p_2 = 0.98$. Dividend growth dynamics are set according to $\phi = 4, \sigma_d = 6$. The market price of risk is set to $\lambda(1) = 0.13$ and $\lambda(2) = 0.28$. The risk-free rate is 2.2. While we use a monthly model to compute these components, parameter calibration is reported in annualized term. Panel A and B - We examine the case of $x_t = 0$. Panel C - In the data, the recession periods were 12%, 26%, 35% of the sample from 2005:M1 to 2013:M2 for the U.S., Europe, and Japan, respectively. Motivated from this, we average the moments implied from the model across the two states with the probabilities obtained from the data to compute the sample averages.

Figure 2: The 5y-1y slope of expected return from simulation



Notes: We set $\mu(1) = 2.4, \mu(2) = 1.2, \sigma_c = 2.2, \rho = 0.50, \sigma_x(1) = 1.13, \sigma_x(2) = 2.41, p_1 = 0.9965, p_2 = 0.98$. Dividend growth dynamics are set according to $\phi = 4, \sigma_d = 6$. The market price of risk is set to $\lambda(1) = 0.13$ and $\lambda(2) = 0.28$. The risk-free rate is 2.2. While we use a monthly model to compute these components, parameter calibration is reported in annualized term. We simulate eight years of data T and repeat the simulation N=10,000 times. Thus, we have a panel $N \times T$ of the model-implied slope of expected return. We compute the average probability of recession for each time series. We then sort this N dimensional vector of recession probability from low to high. Starting from low to high recession probability, we report the sample average slope of expected return (first panel). We also test the null hypothesis that the slope of expected return is zero (second panel). In the data, the recession periods were 12%, 26%, 35% of the sample from 2005:M1 to 2013:M2 for the U.S., Europe, and Japan, respectively.

entire maturity from Panel A of Figure 1. We repeat the exercise by $N = 10,000$ times to provide variation in the realization of recession states. Thus, we have an $N \times T$ panel of the model-implied slope of expected return. Next, we compute the realized recession frequency for each simulated time series and sort the set of time series on the realized frequency. Starting from low to high recession probability, we report the sample average slope of expected return (first panel). We also test the null hypothesis that the slope of expected return is zero (second panel). Since the risk-free rate is constant in the model, this is equivalent to testing the slope of equity risk premia.

We cannot reject the null hypothesis, i.e., slope is zero, if recession frequencies are around 19%-33%. In this range, the corresponding p-values are greater than 10% at least. Once the recession frequency falls below 19%, the p-value approaches zero and the model-implied slope of expected return is statistically strongly positive. In contrast, if recession frequency is greater than 33%, the opposite is true. In the data, we find that the recession periods were 12%, 26%, 35% of the sample from 2005:M1 to 2013:M2 for the U.S., Europe, and Japan, respectively. From the perspective of our model, only the U.S. seems to show the evidence of upward-sloping term structure of expected return (discount rate) which is statistically significant. On the opposite end of the spectrum, Japan shows the evidence of downward-sloping term structure of expected return, which is statistically significant both in the model and the data. Despite the statistical significance of the slope, this is a poor estimate of the unconditional mean, which helps to rationalize the sample average slopes we observe in the data. Further, the model's prediction is qualitatively consistent with the forecasts of the slope of expected returns (the sample average) in Table 4 across regions.[13]

5.6 Summary of the model

We introduced a standard no-arbitrage model extended with regime-switching growth dynamics, which inherits key features of the leading asset pricing models (e.g., long-run risks and habit formation models). The regime-switching growth dynamics produce conditional dynamics of expected growth and dividend discount rates consistent with data documented via the BVAR. The model generates unconditional discount rate term structures in which risk rises with horizon. We also show that, in spite of the unconditional upward slope, in finite samples the sample average dividend discount rate term structure can slope down when recessions are overrepresented, a key feature of the data. The model matches both the conditional and sample average slopes across regions when the recession frequenies match in the small sample. Based on these results we conclude that the implications of the Habits and Long Run Risks models are entirely consistent with the strip data. This is in direct contrast to the conclusions drawn by Binsbergen and Koijen (2017), among others, who rely directly on sample averages of monthly holding period returns as estimates of the unconditional term structure.

6 Illiquidity and Holding Period Returns

Some of the literature on dividend strips relies on monthly holding period returns at the mid of bid and ask prices to estimate the term structure of dividend discount rates. We show that monthly dividend strip holding period returns are poorly measured, highly sensitive to spreads, and are smaller than average spreads almost universally. Based on these returns there are two claims (see Binsbergen and Koijen (2017)) - that the holding period returns decline with maturity and are below the index (implying a

[13]The forecast of slope of expected dividend growth rates turns out to be statistically insignificant for all regions. Thus, we do not attempt to compare with the model counterpart.

downward slope) and that Sharpe Ratios follow a similar pattern. In Table 5, below, we replicate this evidence for our dataset and show that these returns are measured with large standard errors at mid prices. More importantly, we show that holding period returns are contaminated by severe illiquidity as reflected in large bid-ask spreads. Indeed, spreads are larger than monthly returns, making these holding period returns unreliable for measuring the underlying discount rates of economic interest.

6.1 Holding period returns at mid prices

First, we reproduce the evidence on mean holding period returns at mid prices, the focus of earlier work. We examine whether the index is above or crosses the term structure of dividend strip returns and Sharpe Ratios and whether returns Sharpe Ratios rise with maturity. Table 5 displays the point estimates for returns in excess of the index and strip Sharpe Ratios for the S&P 500, Eurostoxx, and Nikkei. Table 5 shows that there is no significant difference between index and strip returns, even if the point estimates of dividend strip returns are below the monthly index for the S&P 500 but are above the monthly index for Nikkei and Eurostoxx. Strip returns slope up in the U.S. and Japan and down in Europe, a fact which is again insignificant. Finally, there are no significant differences in Sharpe Ratio, although the point estimates slope up and are below the index in the U.S. and slope down and are above the index elsewhere. As emphasized by Cochrane (2017), there is no reliable inference to be drawn from monthly holding period returns at mid prices because they are both poorly measured and have a short sample. The fact that average spreads are universally larger than returns in these markets casts a deeper pall on the reliability of the holding period return evidence, as we discuss next.

6.2 Illiquidity and the level of returns

Recent work by Mixon and Onur (2017), who document the illiquidity of the strip market and its causes, and analysis in news media, e.g., Klein (2018), both suggest that these markets are highly illiquid and are dominated by liability hedging at long horizons. Motivated by these studies and the avilability of our novel dataset of spreads for the OTC S&P 500 strip market we directly examine the implications of spreads in these markets for mean holding period and hold to maturity returns and Sharpe Ratios. Note that our bid-ask data are the spread faced by a large financial institution trading

Table 5: Dividend strip returns less market return

Maturity		1-M	2-M	3-M	4-M	5-M	Asset
Panel A: S&P 500							
1-month-hold	average	-4.32	-2.31	-0.94	-0.06	1.33	6.58
	t-stat ($\neq 0$)	-1.24	-1.03	-0.40	-0.02	0.83	
	stdev of Strip	12.07	11.39	11.53	11.87	12.55	14.10
	Sharpe ratio of Strip	0.13	0.27	0.37	0.41	0.47	0.47
Panel B: Eurostoxx 50							
1-month-hold	average	2.70	2.90	2.10	1.89	2.05	4.28
	t-stat ($\neq 0$)	0.66	0.86	0.62	0.58	0.65	
	stdev of Strip	15.22	14.41	14.34	14.23	14.19	17.14
	Sharpe ratio of Strip	0.46	0.31	0.25	0.23	0.24	0.25
Panel C: Nikkei 225							
1-month-hold	average	2.29	2.25	3.82	5.40	6.28	7.63
	t-stat ($\neq 0$)	0.45	0.42	0.72	1.00	1.38	
	stdev of Strip	17.40	19.86	20.17	19.54	18.99	19.79
	Sharpe ratio of Strip	0.82	0.47	0.48	0.53	0.55	0.38

Notes: The time series of dividend strip returns less the market return $R_{M,t+1}$ is calculated as $R_{n,t+1} - R_{M,t+1} = \frac{F_{n-1,t+1}}{F_{n,t}} \frac{\exp(-(n-1)y_{n-1,t+1})}{\exp(-ny_{n,t})} - R_{M,t+1}$ with $F_{n,t}$ the futures price for maturity n and $y_{n,t}$ the risk free zero coupon bond yield for maturity n. Returns for maturities not currently traded are constructed from portfolios of returns on traded maturities. Means, standard deviations, and Sharpe Ratios are annualized for monthly hold periods. Results are reported for the period from January 2005 to February 2017. The asset is the monthly total return on the index used to settle the contract. t-statistics are based on Newey-West standard errors. Maturities are in annual units.

in these markets, the data provider for the remaining data. The sample of spread data is shorter for all regions than the mid price data, starting in 2008-2010 across regions.

To estimate the magnitude of transaction costs relative to our historical return estimates, we compute the bid-ask spread as follows:

$$BA_{n,t} = \frac{F_{n,t}^{ask} - F_{n,t}^{bid}}{0.5 \cdot (F_{n,t}^{ask} + F_{n,t}^{bid})}. \tag{32}$$

Table 6 reports average bid-ask spreads for fixed maturity contracts. It is evident the bid-ask spreads are very large in all three markets and strongly increase in both mean and volatility with horizon in the Eurostoxx and Nikkei markets. While short run Eurostoxx strips trade in the most liquid of these markets, the differences in liquidity by

Table 6: Dividend strip bid-ask spreads

n	1y	2y	3y	4y	5y	Asset
Panel A: S&P 500						
Sample average	1.31	1.60	1.78	2.06	2.26	0.04
Standard deviation	0.57	0.68	0.74	0.77	0.84	0.05
Panel B: Eurostoxx 50						
Sample average	0.45	0.86	1.43	2.59	3.73	0.04
Standard deviation	0.46	0.91	1.40	2.98	4.89	0.02
Panel C: Nikkei 225						
Sample average	1.42	2.39	2.98	3.41	4.63	0.56
Standard deviation	0.99	2.02	2.36	2.16	2.47	0.47

Notes: The period starts in July 2008 for the Eurostoxx, in June 2010 for the Nikkei, and in January 2010 for the S&P 500, and ends in February 2017 for all. The time series of bid-ask spreads for dividend futures is calculated as $BA_{t,n} = \frac{F^{ask}_{n,t} - F^{bid}_{n,t}}{0.5 \cdot (F^{ask}_{n,t} + F^{bid}_{n,t})}$ with $F^{ask}_{t,n}$ the dividend futures ask price for maturity n and $F^{bid}_{n,t}$ the bid. Spreads are presented in percentages (multiplied by 100). Results are reported using monthly data. The period starts in July 2008 for Eurostoxx, in June 2010 for Nikkei, and in January 2010 for S&P 500, and ends in February 2017 for all. The asset or index is the nearest to maturity Chicago Mercantile Exchange futures contract on the same index in local currency (Eurex for the Eurostoxx 50). Maturities are in annual units.

horizon are particularly large outside the U.S., increasing by a factor of between 3 and 8 for spread mean and 2.5-9 for spread volatility, from 1 to 5 years. Note that strongly increasing spreads and spread volatility with horizon will particularly contaminate evidence comparing the long and short end of the term structures of expected returns and Sharpe Ratios.

Importantly, bid-ask spread means are dramatically larger than monthly strip returns at all horizons, and spread variance is on the same order of magnitude as return variance for most markets at all but the shortest horizons. Further, all of these markets are substantially less liquid than the counterpart markets for short run index futures on the same indexes[14]. Liquidity differences contaminate comparisons both between markets and across maturities. Drawing conclusions on relative index and strip returns and Sharpe Ratios in the presence of such large illiquidity is highly unreliable. In comparison, index returns are relatively well measured, even accounting for spreads.

[14] Chicago Mercantile Exhcange E-Mini futures for the S&P 500 and Nikkei, Eurex futures for the Eurostoxx.

The illiquidity in longer dated contracts makes it difficult to justify drawing strong conclusions about the relative economic risk of dividend strips by horizon based on the monthly holding period return data. To show why, we estimate what the actual return would be if one were to buy the dividend strip at the ask and sell at the bid on a monthly basis. We present the results of this analysis in Table 7. Note that the bid-ask adjusted returns at the monthly horizon are negative for all three markets, and massively so for the longer maturity contracts. All of these achievable returns are well below the returns on the asset. Given that transaction costs swamp the returns at short holding horizons, the marginal investor in these contracts is unlikely to evaluate the contract at these horizons and therefore the economic information about their discount rates is not reflected in the monthly return information.[15]

One way to mitigate the impact of large transaction costs is to increase the holding period. However, we find that increasing the holding period to 12 months does not resolve these issues at any but the shortest maturities. The discrepancy between returns and returns net of transaction costs is still on the same order of magnitude as the mean return in all three markets. For longer maturity contracts it is still difficult to justify the assumption that the marginal investor intends to give up between 30% and all of the return on the contract by trading it at a 1 year horizon.

Mixon and Onur (2017) reinforce the view that these markets are highly illiquid using trading volume and open interest information. They show that across exchanges and OTC markets, dividend futures trade in markets orders of magnitude smaller than their associated index futures, both in terms of notional and contracts outstanding.[16].. Both Mixon and Onur (2017) and Klein (2018) indicate that the issuers of structured notes are long these products to reduce their exposure to dividends. This suggests buy and hold liability hedging could be driving a considerable volume of trade.

Given the bid-ask spreads and Mixon and Onur (2017)'s evidence, we mitigate the effects of illiquidity consistent with contracts held by hold to maturity investors. These investors would buy the contract at the ask price then receive the dividend growth at

[15]Investors may implement trading strategies that mitigate the impact of spreads but nevertheless these spreads reflect the considerable transaction costs that any investor would face.

[16]For instance, the Eurostoxx dividend futures market, the largest strip market, is less than 10% the size of the associated index futures market by notional. In addition Klein (2018) claims that U.S. domiciled traders could not invest in Eurostoxx markets until 2017. Note that Mixon and Onur (2017)'s data is exclusively from 2015, when this market was relatively mature compared to the majority of the sample period, thus the liquidity of these markets was likely substantially smaller for most of the sample for which we have strip data.

Table 7: Average dividend strip spread-adjusted returns

Return		Maturity					Asset
		1y	2y	3y	4y	5y	
Panel A: S&P 500							
1-month-hold	mid-price	2.91	6.76	8.45	9.34	9.94	12.43
	bid/ask spread-adj.	-12.84	-12.61	-13.07	-15.51	-16.95	-
hold-to-maturity exp.	mid-price	-0.44	-0.38	0.11	0.48	0.74	-
	ask-price	-1.02	-0.75	-0.19	0.22	0.54	-
Panel B: Eurostoxx 50							
1-month-hold	mid-price	7.06	6.40	5.32	4.50	4.60	3.81
	bid/ask spread-adj.	1.00	-4.49	-11.35	-25.96	-38.96	-
hold-to-maturity exp.	mid-price	2.49	3.66	2.81	2.04	1.42	-
	ask-price	2.13	3.25	2.52	1.75	1.06	-
Panel C: Nikkei 225							
1-month-hold	mid-price	8.71	12.78	15.76	17.73	18.77	13.68
	bid/ask spread-adj.	-8.62	-16.26	-19.99	-23.38	-36.67	-
hold-to-maturity exp.	mid-price	0.57	2.04	2.86	3.59	4.13	-
	ask-price	-0.16	1.48	2.35	3.11	3.59	-

Notes: The period starts in July 2008 for the Eurostoxx, in June 2010 for the Nikkei, and in January 2010 for the S&P 500, and ends in February 2017 for all. The asset is the monthly total return on the index used to settle the contract, less the spread on the nearest to maturity futures contract where appropriate. Dividend strip returns are computed as in (6) and spread adjusted dividend strip returns correspond to

$$R_{h,t+k} = \left(\frac{F^{bid}_{n-k,t+k}}{F^{ask}_{n,t}} \frac{\exp(-(n-k)y_{n-k,t+k})}{\exp(-ny_{n,t})} \right)^{1/k} - 1,$$

where results are reported for maturities $n = 1, ..., 5$ years, and holding period of k=1, 12 month. Returns for maturities not currently traded are constructed from portfolios of returns on traded maturities. Hold-to-maturity expected returns are computed from the BMSY approach. Means and standard deviations are monthly annualized percentages. Maturities are in annual units.

maturity. This strategy accurately reflects the returns achievable by investors while mitigating the impact of transaction costs to the greatest extent possible. We report the hold to maturity expected returns, averaged over the sample with bid-ask data using the purchase price as the last price and the ask price in the last two lines of each panel of Table 7. Within the sample for which spreads are available, spread adjusted expected returns also reflect the same qualitative and quantitative patterns as the expected returns unadjusted for transaction costs. Further, the level effect of transaction costs is small, consistent with the evidence presented and referenced above.

This suggests that the economic information contained in the strip yields, which strongly supports the leading asset pricing models, is substantially more robust to the liquidity issues in these markets than is the short horizon holding period return-based evidence.

Once we have corrected for the dramatic illiquidity of the dividend futures markets and the substantial variation in liquidity by horizon, the data continue to provide strong support for the implications of standard asset pricing models of short horizon dividend claims carrying less macroeconomic risk than long horizon claims. There is no reliable evidence supporting the existing claims of the literature because monthly holding period returns are both too poorly measured too illiquid to be useful for inference. Short holding period return estimates are so heavily contaminated by spread and spread volatility that it is difficult to justify drawing economic conclusions about dividend risk, as opposed to microstructure and trading risk, from these realized returns.

7 Conclusion

Using additional asset prices to learn about risk and reward in financial markets is a welcomed endeavor. At the same time as more esoteric markets are analyzed, any inference has to be judicious and with an eye to institutional features of such markets and the limitations of the data. Recently, several papers suggest that the term structure of dividend strip returns is downward sloping and thus poses a challenge to existing asset pricing models. In this paper we show that the term structure of dividend strip risk premia and discount rates implied by equity strip yields is downward sloping in recessions and upward sloping in expansion periods, a finding which is statistically significant and robust across regions, in and out of sample estimation, and predictive models. We also show that the frequency of recessions in the very short sample for which strips data is available is much higher than the long run recession frequency in both Europe and Japan.

We develop a regime-switching model that is consistent with the implication of leading models that the unconditional risk premium term structure slopes upwards and also matches the recession and expansion slopes of expected growth and returns. We show that when recessions are in line with the long run frequency in a short sample the discount rate term structure will be upward sloping, but when recessions are overrepresented the slope can be flat or negative as we see in the data for Europe and Japan. The regime switching model shows that the discount rate term structure evidence from dividend strips is consistent both conditionally and unconditionally with the implications of leading asset pricing models like habits or LRR.

Finally, we show that dividend discount rates, the object of economic interest, are also the preferred focus for statistical and institutional reasons. First, holding period returns on the strips do not provide statistically significant evidence for or against any model, either via the term structure slope or comparisons against the asset return. Second, holding period returns are contaminated by the dramatic illiquidity of dividend strip markets, where average trading costs, bid ask spreads, are larger than monthly returns. Finally, we show that discount rates and their associated evidence are robust to these issues. In totality, we find strong evidence that all the robust features of the strip evidence are both conditionally and unconditionally consistent with the implications of leading asset pricing models.

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Online Appendix:

The Term Structure of Equity Risk Premia

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A Bayesian Linear Regression

Without loss of generality, we can express any linear dynamics by

$$y_t = \Phi x_t + \varepsilon_t, \quad \varepsilon_t \sim N(0, \Sigma). \tag{A-1}$$

For ease of exposition, define $Y = [y_p, ..., y_T]'$, $X = [x_p, ..., x_T]'$, and $\varepsilon = [\varepsilon_p, ..., \varepsilon_T]'$. Assume that the initial p observations are available. Because of the conjugacy if the prior is

$$\Phi|\Sigma \sim MN\big(\underline{\Phi}, \Sigma \otimes (\underline{V}_\Phi \xi)\big), \quad \Sigma \sim IW(\Psi, d) \tag{A-2}$$

then the posterior can be expressed as $\Phi|\Sigma \sim MN\big(\overline{\Phi}, \Sigma \otimes \overline{V}_\Phi\big)$ where

$$\overline{\Phi} \;=\; \Big(X'X + (\underline{V}_\Phi \xi)^{-1}\Big)^{-1}\Big(X'Y + (\underline{V}_\Phi \xi)^{-1}\underline{\Phi}\Big), \quad \overline{V}_\Phi = \Big(X'X + (\underline{V}_\Phi \xi)^{-1}\Big)^{-1}.$$

We follow the exposition in Giannone, Lenza, and Primiceri (2015). ξ is a scalar parameter controlling the tightness of the prior information. For instance, prior becomes more informative when $\xi \to 0$. In contrast, when $\xi = \infty$, then it is easy to see that $\overline{\Phi} = \hat{\Phi}$, i.e., an OLS estimate. We can choose ξ that maximizes the marginal likelihood function (A-3), which is available in closed form

$$\begin{aligned} p(Y|\xi) \;&=\; \left(\frac{1}{\pi}\right)^{\frac{n(T-p)}{2}} \frac{\Gamma_n(\frac{T-p+d}{2})}{\Gamma_n(\frac{d}{2})} |\underline{V}_\Phi \xi|^{-\frac{n}{2}} |\Psi|^{\frac{d}{2}} \Big| X'X + (\underline{V}_\Phi \xi)^{-1}\Big|^{-\frac{n}{2}} \\ &\Big|\Psi + \hat{\varepsilon}'\hat{\varepsilon} + (\hat{\Phi} - \underline{\Phi})'(\underline{V}_\Phi \xi)^{-1}(\hat{\Phi} - \underline{\Phi})\Big|^{-\frac{T-p+d}{2}}. \end{aligned} \tag{A-3}$$

We refer to Giannone, Lenza, and Primiceri (2015) for a detailed description.

B Solving the Regime-Switching Model

This section provides approximate analytical solutions for the asset prices.

B.1 Exogenous dynamics

The joint dynamics of consumption and dividend growth are

$$\begin{aligned}\Delta c_{t+1} &= \mu(S_{t+1}) + x_{t+1} + \sigma_c \eta_{c,t+1}, \quad \eta_{c,t+1} \sim N(0,1), \\ \Delta d_{t+1} &= \bar{\mu} + \phi(\Delta c_{t+1} - \bar{\mu}) + \sigma_d \eta_{d,t+1}, \quad \eta_{d,t+1} \sim N(0,1), \\ x_{t+1} &= \rho x_t + \sigma_x(S_{t+1})\epsilon_{t+1},\end{aligned} \tag{A-4}$$

where $\bar{\mu}$ is the unconditional mean of consumption growth and x_t is the persistent component of consumption growth. Agents observe the current regime, S_t, and make forecast of future regime, S_{t+1}, based on the transition matrix below

$$\mathbb{P} = \begin{bmatrix} p_1 & 1-p_1 \\ 1-p_2 & p_2 \end{bmatrix}. \tag{A-5}$$

B.2 Stochastic discount factor

Assume that the log stochastic discount factor is

$$m_{t+1} = -r_{t+1} - \frac{1}{2}\lambda(S_{t+1})^2 - \lambda(S_{t+1})\epsilon_{t+1}. \tag{A-6}$$

The risk-free rate is exogenously defined by $r_{t+1} = r_0(S_{t+1}) + r_1(S_{t+1})x_{t+1}$. We assume that the market price of risk is $\lambda_{t+1} = \lambda(S_{t+1})$.

B.3 Real bond prices

Conjecture that $b_{n,t}$ depends on the regime S_t and x_t,

$$b_{n,t} = b_{n,0}(S_t) + b_{n,1}(S_t)x_t. \tag{A-7}$$

Exploit the law of iterated expectations

$$b_{n,t} = \ln E_t\Big(E[\exp(m_{t+1} + b_{n-1,t+1})|S_{t+1}]\Big)$$

and log-linearization to solve for $b_{n,t}$

$$b_{n,t} \approx \sum_{j=1}^{2} \mathbb{P}_{ij}\Big(E[m_{t+1} + b_{n-1,t+1}|S_{t+1}] + \frac{1}{2}Var[m_{t+1} + b_{n-1,t+1}|S_{t+1}]\Big).$$

The solution to (A-7) is

$$\begin{bmatrix} b_{n,0}(1) \\ b_{n,0}(2) \end{bmatrix} = \mathbb{P} \times \begin{bmatrix} b_{n-1,0}(1) - r_0(1) + 0.5\big(b_{n-1,1}(1) - r_1(1)\big)^2\sigma_x(1)^2 - \big(b_{n-1,1}(1) - r_1(1)\big)\sigma_x(1)\lambda(1) \\ b_{n-1,0}(2) - r_0(2) + 0.5\big(b_{n-1,1}(2) - r_1(2)\big)^2\sigma_x(2)^2 - \big(b_{n-1,1}(2) - r_1(2)\big)\sigma_x(2)\lambda(2) \end{bmatrix} \tag{A-8}$$

$$\begin{bmatrix} b_{n,1}(1) \\ b_{n,1}(2) \end{bmatrix} = \mathbb{P} \times \begin{bmatrix} \big(b_{n-1,1}(1) - r_1(1)\big)\rho \\ \big(b_{n-1,1}(1) - r_1(1)\big)\rho \end{bmatrix}$$

with the initial condition $b_{0,0}(i) = 0$ and $b_{0,1}(i) = 0$ for $i \in \{1, 2\}$. The real yield of the maturity n-period bond is $y^r_{n,t} = -\frac{1}{n}b_{n,t}$.

B.4 Price to dividend ratio of zero coupon equity

Conjecture that the log price to dividend ratio of zero coupon equity $z_{n,t}$ depends on the regime S_t and persistent component x_t,

$$z_{n,t} = z_{n,0}(S_t) + z_{n,1}(S_t)x_t. \tag{A-9}$$

Exploit the law of iterated expectations

$$Z_{n,t} = E_t\Big(E[M_{t+1}Z_{n-1,t+1}\frac{D_{t+1}}{D_t}|S_{t+1}]\Big)$$

Take log

$$z_{n,t} = \ln E_t\Big(E[\exp(m_{t+1} + z_{n-1,t+1} + \Delta d_{t+1})|S_{t+1}]\Big)$$

and log-linearization to solve for $z_{n,t}$

$$z_{n,t} \approx \sum_{j=1}^{2} \mathbb{P}_{ij} \Big(E[\exp(m_{t+1} + z_{n-1,t+1} + \Delta d_{t+1})|S_{t+1}] + \frac{1}{2} Var[\exp(m_{t+1} + z_{n-1,t+1} + \Delta d_{t+1})|S_{t+1}] \Big).$$

The solution is

$$\begin{bmatrix} z_{n,0}(1) \\ z_{n,0}(2) \end{bmatrix} = \begin{bmatrix} (1-\phi)\bar{\mu} + \frac{\phi^2}{2}\sigma_c^2 + \frac{1}{2}\sigma_d^2 \\ (1-\phi)\bar{\mu} + \frac{\phi^2}{2}\sigma_c^2 + \frac{1}{2}\sigma_d^2 \end{bmatrix} + \mathbb{P} \times \begin{bmatrix} z_{n-1,0}(1) + \phi\mu(1) - r_0(1) + \Xi(1) \\ z_{n-1,0}(2) + \phi\mu(2) - r_0(2) + \Xi(2) \end{bmatrix} \tag{A-10}$$

$$\Xi(j) = \frac{1}{2}\big(z_{n-1,1}(j) - r_1(j) + \phi\big)^2 \sigma_x(j)^2 - \big(z_{n-1,1}(j) - r_1(j) + \phi\big)\sigma_x(j)\lambda(j)$$

$$\begin{bmatrix} z_{n,1}(1) \\ z_{n,1}(2) \end{bmatrix} = \mathbb{P} \times \begin{bmatrix} \big(z_{n-1,1}(1) - r_1(1) + \phi\big)\rho \\ \big(z_{n-1,1}(1) - r_1(1) + \phi\big)\rho \end{bmatrix}. \tag{A-11}$$

The initial condition is $z_{0,0}(i) = 0$ and $z_{0,1}(i) = 0$ for $i \in \{1, 2\}$.

B.5 m-holding-period and hold-to-maturity expected return

The price of zero coupon equity is $P_{n,t} = Z_{n,t} D_t$. Define the m-holding period return of the n-maturity equity is

$$R_{n,t+m} = \frac{Z_{n-m,t+m}}{Z_{n,t}} \frac{D_{t+m}}{D_t}. \tag{A-12}$$

The corresponding log expected return is defined by

$$E_t[r_{n,t+m}] = \frac{1}{m} E_t\Big(z_{n-m,t+m} - z_{n,t} + \sum_{i=1}^{m} \Delta d_{t+i}\Big) \tag{A-13}$$

To compute the excess return, we subtract the real rate of the same maturity

$$E_t[r_{n,t+m}] - y^r_{m,t}. \tag{A-14}$$

We consider two cases

- $m \neq n$: This is the m-holding-period expected excess return of the n maturity equity.

$$\begin{aligned} E_t[g_{d,t+m}] &= \frac{1}{m}E_t\big(\sum_{i=1}^{m}\Delta d_{t+i}\big) \\ e_{n,m,t} &= \frac{1}{m}E_t\big(z_{n-m,t+m}-z_{n,t}\big) \\ E_t[r_{n,t+m}] &= e_{n,m,t}+E_t[g_{d,t+m}] \\ E_t[rx_{n,t+m}] &= E_t[r_{n,t+m}]-y^r_{m,t}. \end{aligned} \tag{A-15}$$

- $m = n$: This is the hold-to-maturity expected excess return of the n maturity equity. Define

$$\begin{aligned} E_t[g_{d,t+n}] &= \frac{1}{n}E_t\big(\sum_{i=1}^{n}\Delta d_{t+i}\big) \\ e_{n,t} &= \frac{1}{n}E_t\big(-z_{n,t}\big) \\ E_t[r_{t+n}] &= e_{n,t}+E_t[g_{d,t+n}] \\ E_t[rx_{t+n}] &= E_t[r_{t+n}]-y^r_{n,t}. \end{aligned} \tag{A-16}$$

B.6 Computing moments

The cumulative sum of log dividend growth rates are

$$\begin{aligned} \sum_{i=1}^{n}\Delta d_{t+i} = n(1-\phi)\bar{\mu}+\phi\big(\mu(S_{t+1})+...+\mu(S_{t+n})\big)+\phi\rho\left(\frac{1-\rho^n}{1-\rho}\right)x_t \\ +\phi\left(\frac{1-\rho^n}{1-\rho}\right)\sigma_x(S_{t+1})\epsilon_{t+1}+...+\phi\left(\frac{1-\rho}{1-\rho}\right)\sigma_x(S_{t+n})\epsilon_{t+n} \\ +\phi\sigma_c(\eta_{c,t+1}+...+\eta_{c,t+n})+\sigma_d(\eta_{d,t+1}+...+\eta_{d,t+n}). \end{aligned} \tag{A-17}$$

For ease of exposition, we introduce the following notations

$$\boldsymbol{\mu} = [\mu(1),\mu(2)]', \quad \boldsymbol{\sigma_x^2} = [\sigma_x(1)^2,\sigma_x(2)^2]'.$$

Similarly, define

$$\boldsymbol{\mu_G} = [\mu_G(1),\mu_G(2)]', \quad \boldsymbol{\sigma_G^2} = [\sigma_G(1)^2,\sigma_G(2)^2]'.$$

The first two moments of the average log dividend growth rates are

$$\begin{aligned} E_t[g_{d,t+n}] &= \frac{1}{n}E_t[\sum_{i=1}^{n}\Delta d_{t+i}] = \frac{1}{n}\mu_G \\ V_t[g_{d,t+n}] &= \frac{1}{n^2}V_t[\sum_{i=1}^{n}\Delta d_{t+i}] = \frac{1}{n^2}\sigma_G^2 \end{aligned} \quad \text{(A-18)}$$

where

$$\begin{aligned} \boldsymbol{\mu_G} &= \begin{bmatrix} n(1-\phi)\bar{\mu} + \phi\rho\left(\frac{1-\rho^n}{1-\rho}\right)x_t \\ n(1-\phi)\bar{\mu} + \phi\rho\left(\frac{1-\rho^n}{1-\rho}\right)x_t \end{bmatrix} + \sum_{j=1}^{n}\phi\mathbb{P}^j\boldsymbol{\mu} \quad \text{(A-19)} \\ \boldsymbol{\sigma_G^2} &\approx \begin{bmatrix} n(\phi^2\sigma_c^2 + \sigma_d^2) \\ n(\phi^2\sigma_c^2 + \sigma_d^2) \end{bmatrix} + \phi^2\sum_{j=1}^{n}\left(\frac{1-\rho^{n+1-j}}{1-\rho}\right)^2\mathbb{P}^j\boldsymbol{\sigma_x^2}. \end{aligned}$$

We acknowledge that the expression for $\boldsymbol{\sigma_G^2}$ is not exact because we are ignoring the variance component associated with uncertainty about $\mu(S_{t+j})$.

The expressions in (A-18) allow us to calculate the Sharpe ratio

$$SR_{n,t} = \frac{e_{n,t} + E_t[g_{d,t+n}] - y_{n,t}^r}{\sqrt{V_t[g_{d,t+n}]}} \quad \text{(A-20)}$$

In the main text, we report the case of $x_t = 0$ for ease of illustration, e.g., $E_t g_{d,t+n}|_{x_t=0}$ and $V_t g_{d,t+n}|_{x_t=0}$.

B.7 Market return

We derive the market return via Campbell-Shiller approximation

$$\begin{aligned} r_{m,t+1} &= \kappa_0 + \kappa_1 z_{m,0}(S_{t+1}) - z_{m,0}(S_t) + \bar{\mu}(1-\phi) + \phi\mu(S_{t+1}) \quad \text{(A-21)} \\ &+(\phi\rho + \kappa_1 z_{m,1}(S_{t+1})\rho - z_{m,1}(S_t))x_t \\ &+(\phi + \kappa_1 z_{m,1}(S_{t+1}))\sigma_x(S_{t+1})\epsilon_{t+1} + \phi\sigma_c\eta_{c,t+1} + \sigma_d\eta_{d,t+1} \end{aligned}$$

where the log price-dividend ratio is given by

$$z_t = z_{m,0}(S_t) + z_{m,1}(S_t)x_t. \quad \text{(A-22)}$$

The market equity premium is

$$E_t[r_{m,t+1}] - y^r_{n,t} + \frac{1}{2}V_t[r_{m,t+1}] \; = \; -Cov_t(r_{m,t+1}, m_{t+1}) \tag{A-23}$$

$$= \; \mathbb{P} \times \begin{bmatrix} (\phi + \kappa_1 z_{m,1}(1))\sigma_x(1)\lambda(1) \\ (\phi + \kappa_1 z_{m,1}(2))\sigma_x(2)\lambda(2) \end{bmatrix}.$$

The conditional variance of the market return is

$$V_t[r_{m,t+1}] \approx \begin{bmatrix} \phi^2\sigma_c^2 + \sigma_d^2 \\ \phi^2\sigma_c^2 + \sigma_d^2 \end{bmatrix} + \mathbb{P} \times \begin{bmatrix} (\phi + \kappa_1 z_{m,1}(1))^2\sigma_x(1)^2 \\ (\phi + \kappa_1 z_{m,1}(2))^2\sigma_x(2)^2 \end{bmatrix}. \tag{A-24}$$

The market Sharpe ratio is

$$SR_t = \frac{E_t[r_{m,t+1}] - y^r_{n,t}}{\sqrt{V_t[r_{m,t+1}]}}. \tag{A-25}$$

Here, we are not accounting for $\frac{1}{2}V_t[r_{m,t+1}]$ in the numerator.

B.8 Calibration

With this calibration, we derive the market return via Campbell-Shiller approximation and compute the expected excess return of the market. The equity premium is 4.13 and 18.60 in expansion and recession, respectively. The unconditional average (weighted by steady state probability) is around 6.29.

Table A-1: Calibration

Parameters

$\mu(1)$	0.0020	ρ	0.50	$\lambda(1)$	0.1315
$\mu(2)$	0.0010	$\sigma_x(1)$	0.0033	$\lambda(2)$	0.2789
σ_c	0.0063	$\sigma_x(2)$	0.0070	$r(1)$	0.0019
ϕ	4.0	p_1	0.9965	$r(2)$	0.0019
σ_d	0.0173	p_2	0.98		

Simulated moments

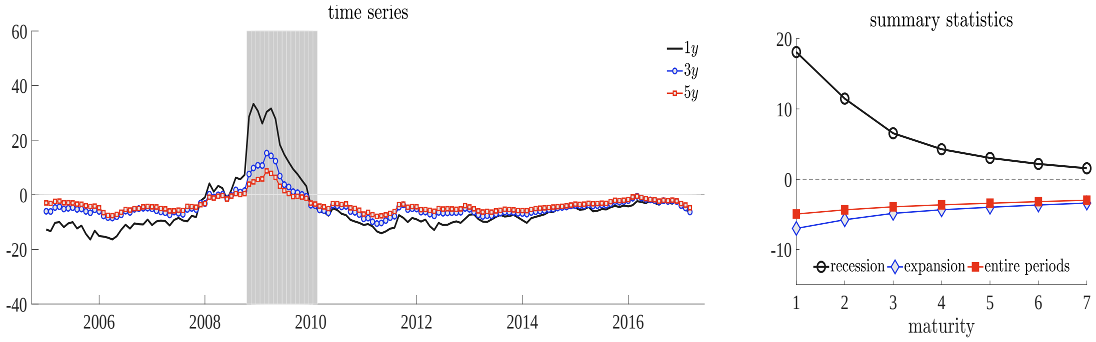
	data	model		
		50%	[5%	95%]
$E(\Delta c)$	1.83	2.24	[1.35	3.08]
$\sigma(\Delta c)$	2.19	2.82	[2.13	3.65]
$\rho(\Delta c)$	0.48	0.24	[0.01	0.46]
$E(\Delta d)$	1.00	2.26	[-1.85	5.96]
$\sigma(\Delta d)$	11.15	12.34	[9.89	15.64]
$\rho(\Delta d)$	0.20	0.23	[0.01	0.45]

Notes: Top panel - The steady state probabilities for the expansion and recession states are $(1-p_2)/(2-p_1-p_2) = 0.8511$ and $(1-p_1)/(2-p_1-p_2) = 0.1489$, respectively. The steady state consumption growth mean is $\bar{\mu} = (1-p_2)/(2-p_1-p_2)\mu(1) + (1-p_1)/(2-p_1-p_2)\mu(2) = 0.0019$. Risk-free rate coefficients are $r(1) = r(2) = \bar{\mu}$. Bottom panel - The table is constructed based on $T = 50$ years of simulated data which is repeated $N = 10,000$ times.

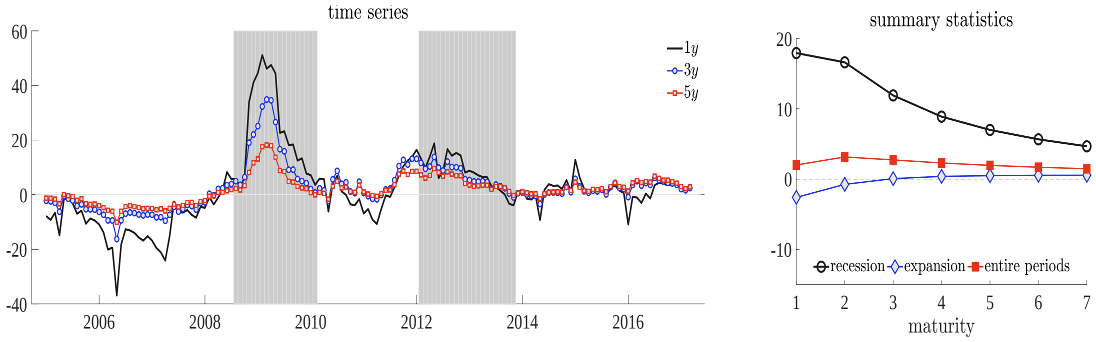
C Supplementary Figures and Tables

Figure A-1: Forward equity yields

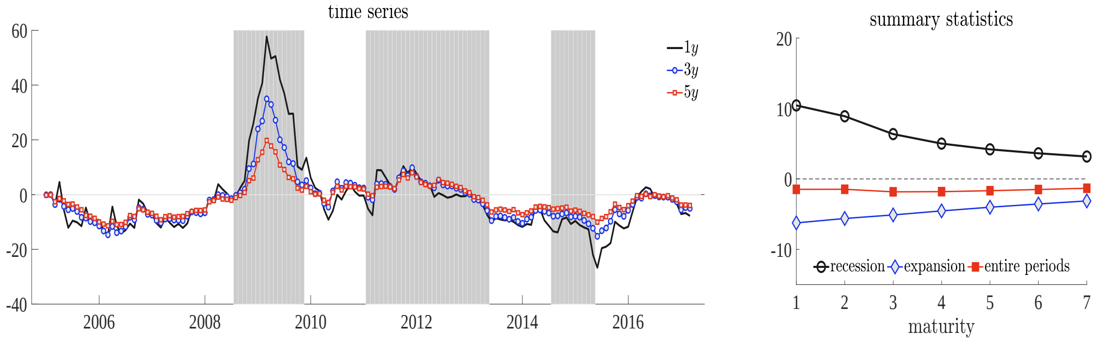
US: S&P 500



Europe: Eurostoxx 50

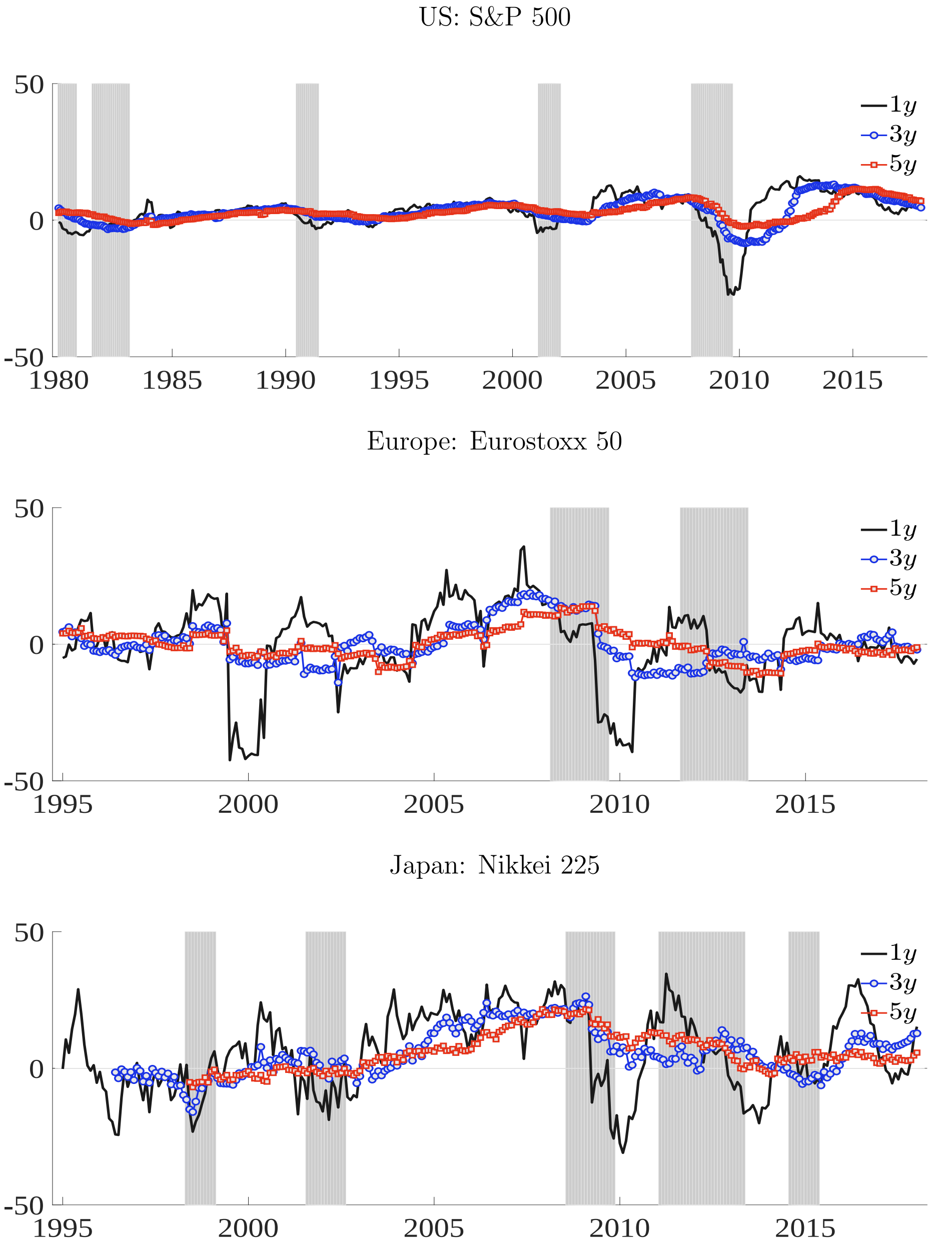


Japan: Nikkei 225



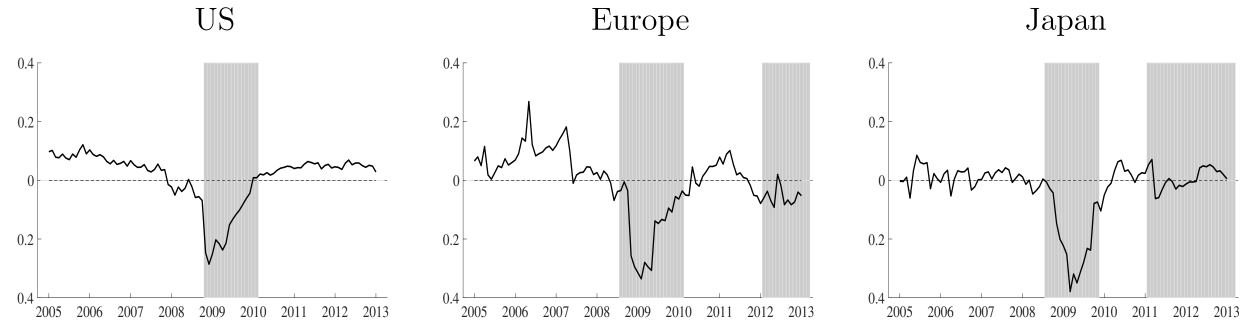
Notes: We provide the time series of the forward equity yields from 2004:M12 to 2017:M2. Equity yields are $e^f_{n,t} = \frac{1}{n}\ln(\frac{D_t}{F_{n,t}})$ with $F_{n,t}$ the futures price and D_t the trailing sum of 12 month dividends.

Figure A-2: Dividend growth: Time series evidence



Notes: For US, dividend growth data are available from 1979:M12 to 2017:M2 for all horizons. For Europe, dividend growth data are available from 1994:M12 to 2017:M2 for all horizons. For Japan, 1-year dividend growth data are available starting from 1994:M12, 3-year dividend growth data from 1996:M5, and 5-year dividend growth from 1998:M5. Data end in 2017:M2. Shaded bars indicate recession dates. The provider for the recession dates is the Economic Cycle Research Institute, which estimates peak-to-trough recession dates for a variety of countries. We have confirmed that the recessions dated by this provider for the US and Europe match those dated by the NBER and CEPR and that they track the cyclical behavior of GDP.

Figure A-3: The equity yield spread between 5y and 1y



Notes: Shaded bars indicate recession dates. Negative spread coincides with recession. The prediction sample starts from 2005:M1 to 2013:M2.

Table A-2: The expected dividend growth rates and the expected excess returns: U.S.

	RMSE		Premium		Exp. return		Sharpe Ratio		Exp. growth		STRIPS	YLD	INF
horizon	SSP	LSP	SSP	LSP	SSP	LSP	SSP	LSP	SSP	LSP			
Entire period													
1y	8.41	9.82	1.43	1.22	1.46	1.26	0.19	0.14	4.01	3.80	-4.58	2.04	2.00
2y	9.51	8.60	2.22	1.95	2.39	2.13	0.37	0.24	4.18	3.91	-3.96	2.17	2.00
3y	9.19	7.03	2.65	2.39	3.02	2.76	0.48	0.34	4.31	4.05	-3.66	2.37	2.00
4y	8.20	5.87	2.94	2.69	3.53	3.28	0.56	0.44	4.40	4.14	-3.46	2.59	2.00
5y	6.73	4.68	3.21	2.95	4.04	3.78	0.63	0.54	4.47	4.21	-3.26	2.83	2.00
5y-1y	-	-	1.78	1.72	2.58	2.52	0.44	0.40	0.46	0.41	1.32	0.79	-
Positive strips spread													
1y	5.90	5.24	-0.60	-1.86	-0.30	-1.57	-0.08	-0.21	7.71	6.44	-10.31	2.29	2.00
2y	8.41	7.01	1.58	-0.58	1.97	-0.20	0.27	-0.07	7.21	5.05	-7.64	2.39	2.00
3y	8.65	6.72	2.69	0.53	3.23	1.06	0.49	0.08	6.83	4.66	-6.14	2.53	2.00
4y	7.55	5.90	3.16	1.19	3.88	1.91	0.60	0.20	6.53	4.56	-5.37	2.72	2.00
5y	5.82	4.66	3.47	1.71	4.39	2.62	0.68	0.31	6.30	4.53	-4.83	2.92	2.00
5y-1y	-	-	4.07	3.57	4.69	4.18	0.76	0.52	-1.41	-1.91	5.48	0.62	-
Negative strips spread													
1y	13.33	17.41	7.59	10.61	6.84	9.87	1.01	1.21	-7.25	-4.23	12.84	1.26	2.00
2y	12.12	12.16	4.17	9.67	3.69	9.19	0.70	1.19	-5.05	0.45	7.22	1.52	2.00
3y	10.51	7.84	2.52	8.06	2.39	7.93	0.46	1.15	-3.37	2.17	3.89	1.87	2.00
4y	9.77	5.71	2.28	7.24	2.48	7.44	0.43	1.18	-2.08	2.88	2.36	2.20	2.00
5y	8.85	4.66	2.41	6.73	2.99	7.31	0.47	1.20	-1.08	3.24	1.49	2.58	2.00
5y-1y	-	-	-5.17	-3.87	-3.85	-2.55	-0.54	-0.01	6.17	7.48	-11.34	1.32	-

Notes: Tables are generated from models that are estimated from 2005:M1 to 2017:M2 sample. We show two approaches: (1) SSP and (2) BMY, i.e., a 3-variable VAR approach that includes the 5y-1y nominal bond spread, asset dividend to earnings ratio, and dividend growth.

Table A-3: The expected dividend growth rates and the expected excess returns: Europe

	RMSE		Premium		Exp. return		Sharpe Ratio		Exp. growth		STRIPS	YLD	INF
horizon	SSP	LSP	SSP	LSP	SSP	LSP	SSP	LSP	SSP	LSP			
Entire period													
1y	8.46	7.59	3.70	2.76	3.56	2.62	0.47	0.38	-0.53	-1.47	2.12	1.96	2.10
2y	10.24	7.10	5.08	4.30	5.07	4.30	0.68	0.63	-0.80	-1.58	3.78	2.09	2.10
3y	9.11	6.38	4.16	3.33	4.33	3.50	0.55	0.51	-0.89	-1.72	2.95	2.27	2.10
4y	6.32	4.26	3.37	2.46	3.76	2.84	0.46	0.41	-0.90	-1.81	2.17	2.49	2.10
5y	4.98	3.07	2.83	1.83	3.37	2.37	0.40	0.33	-0.88	-1.88	1.61	2.64	2.10
5y-1y	-	-	-0.87	-0.93	-0.18	-0.24	-0.08	-0.05	-0.36	-0.42	-0.51	0.68	-
Positive strips spread													
1y	6.39	7.61	2.01	0.85	2.46	1.30	0.26	0.12	8.55	7.39	-8.64	2.55	2.10
2y	10.34	8.14	3.05	1.06	3.58	1.59	0.41	0.16	5.90	3.91	-4.94	2.63	2.10
3y	9.99	7.43	3.19	0.87	3.85	1.53	0.42	0.13	4.23	1.91	-3.14	2.77	2.10
4y	7.00	4.60	2.95	0.60	3.78	1.44	0.40	0.10	3.14	0.80	-2.29	2.93	2.10
5y	5.24	3.08	2.63	0.38	3.60	1.35	0.37	0.07	2.42	0.17	-1.89	3.06	2.10
5y-1y	-	-	0.62	-0.47	1.14	0.05	0.11	-0.05	-6.13	-7.22	6.75	0.52	-
Negative strips spread													
1y	10.49	7.48	5.90	5.25	4.99	4.34	0.76	0.72	-12.42	-13.07	16.22	1.19	2.10
2y	9.99	5.40	7.73	8.54	7.02	7.83	1.03	1.26	-9.58	-8.77	15.21	1.39	2.10
3y	7.68	4.61	5.43	6.56	4.95	6.08	0.72	1.01	-7.59	-6.46	10.92	1.62	2.10
4y	5.23	3.76	3.92	4.88	3.73	4.69	0.53	0.81	-6.20	-5.24	8.02	1.91	2.10
5y	4.56	3.05	3.08	3.72	3.08	3.72	0.43	0.67	-5.21	-4.57	6.19	2.10	2.10
5y-1y	-	-	-2.81	-1.53	-1.91	-0.62	-0.32	-0.05	7.21	8.50	-10.03	0.90	-

Notes: Tables are generated from models that are estimated from 2005:M1 to 2017:M2 sample. We show two approaches: (1) SSP and (2) BMY, i.e., a 3-variable VAR approach that includes the 5y-1y nominal bond spread, dividend to price ratio, and dividend growth.

Table A-4: The expected dividend growth rates and the expected excess returns: Japan

	RMSE		Premium		Exp. return		Sharpe Ratio		Exp. growth		STRIPS	YLD	INF
horizon	SSP	LSP	SSP	LSP	SSP	LSP	SSP	LSP	SSP	LSP			
Entire period													
1y	11.62	12.79	8.86	11.99	8.91	12.04	0.73	0.87	6.45	9.58	2.18	0.28	0.23
2y	9.91	8.70	8.88	11.25	9.02	11.39	0.94	1.27	7.07	9.44	1.57	0.38	0.23
3y	7.96	6.78	8.28	9.80	8.53	10.05	0.97	1.34	7.55	9.08	0.49	0.49	0.23
4y	5.68	5.22	8.11	8.97	8.50	9.35	1.01	1.38	7.93	8.78	-0.04	0.62	0.23
5y	4.44	3.93	8.17	8.46	8.68	8.97	1.06	1.42	8.22	8.51	-0.28	0.74	0.23
5y-1y	-	-	-0.69	-3.53	-0.24	-3.08	0.33	0.55	1.77	-1.07	-2.46	0.46	-
Positive strips spread													
1y	12.60	13.39	5.43	5.07	5.49	5.12	0.44	0.37	11.51	11.14	-6.31	0.29	0.23
2y	8.47	8.33	6.54	5.30	6.71	5.47	0.70	0.60	11.25	10.01	-4.94	0.40	0.23
3y	7.65	7.02	7.08	5.55	7.36	5.83	0.83	0.76	11.05	9.52	-4.20	0.51	0.23
4y	5.81	4.55	7.43	5.63	7.84	6.04	0.92	0.87	10.90	9.10	-3.70	0.64	0.23
5y	4.37	2.61	7.77	5.76	8.30	6.29	1.00	0.97	10.79	8.78	-3.25	0.76	0.23
5y-1y	-	-	2.34	0.70	2.81	1.16	0.56	0.60	-0.72	-2.37	3.06	0.47	-
Negative strips spread													
1y	10.62	12.33	12.67	19.67	12.71	19.71	1.04	1.42	0.83	7.84	11.61	0.27	0.23
2y	11.31	9.14	11.48	17.75	11.59	17.95	1.22	2.01	2.45	8.81	8.80	0.35	0.23
3y	8.21	6.44	9.60	14.45	9.83	14.73	1.13	1.98	3.68	8.58	5.69	0.46	0.23
4y	5.50	5.82	8.87	12.59	9.23	13.03	1.10	1.95	4.63	8.42	4.01	0.59	0.23
5y	4.47	4.96	8.62	11.46	9.09	11.93	1.11	1.92	5.37	8.21	3.01	0.71	0.23
5y-1y	-	-	-4.06	-8.22	-3.62	-7.78	0.08	0.50	4.54	0.38	-8.59	0.44	-

Notes: Tables are generated from models that are estimated from 2005:M1 to 2017:M2 sample. We show two approaches: (1) SSP and (2) BMY, i.e., a 3-variable VAR approach that includes the 5y-1y nominal bond spread, dividend to price ratio (pd12SPXD1), and dividend growth.

Table A-5: The spread between 5-year and 1-year forecasts: the SSP approach

	Exp. return			Exp. growth		
	50%	[5%	95%]	50%	[5%	95%]
			Entire period			
U.S.	2.58*	[0.80,	3.60]	0.19	[-1.23,	1.57]
Europe	-0.18	[-2.86,	1.73]	-0.36	[-2.96,	1.63]
Japan	-0.24	[-3.44,	1.78]	1.77	[-1.41,	3.81]
			Expansion period			
U.S.	4.69*	[2.16,	5.83]	-1.41*	[-2.88,	-0.22]
Europe	1.14	[-0.41,	2.80]	-6.13*	[-8.67,	-4.46]
Japan	2.81	[-0.26,	3.49]	-0.72*	[-2.79,	-0.08]
			Recession period			
U.S.	-3.85*	[-4.40,	-1.07]	6.17*	[4.72,	7.95]
Europe	-1.91	[-4.45,	0.65]	7.21*	[5.68,	10.75]
Japan	-3.62*	[-5.92,	-0.16]	4.54*	[2.42 ,	8.18]

Notes: We provide the SSP results based on the in-sample forecasts. The estimation sample is from 2005:M1 to 2017:M2. Our prediction sample is from 2005:M1 to 2013:M2. We use $*$ to indicate the statistical significance at the 90% confidence level.