Equity Yields*

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Abstract

We study a new data set of prices of traded dividends with maturities up to 10 years across three world regions: the US, Europe, and Japan. We use these asset prices to derive equity yields, analogous to bond yields, and decompose these yields into expected dividend growth rates and a risk premium component. We find that both expected dividend growth rates and the risk premium component exhibit substantial variation over time. Further, equity yields may help predict other measures of economic growth such as consumption growth. We relate the dynamics of growth expectations to recent events such as the financial crisis and the earthquake in Japan.

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There exists a large literature studying fluctuations of, and the information contained in, the term structures of nominal and real interest rates. At each point in time, these term structures summarize pricing information of either nominal or real claims with different maturities. In this paper, we study a novel term structure of assets that are direct claims to future dividends paid by firms to shareholders. The prices are available at a daily basis and the assets have maturities of up to 10 years, with 1-year increments. Based on these dividend assets, we construct a term structure of equity yields that are analogous to real and nominal bond yields. The key difference between dividend assets and either nominal or real bonds is that the final payoff of dividend assets is variable whereas the payoff of nominal and real bonds is fixed in nominal and real terms, respectively. In this paper, we explore the information contained in equity yields across three major equity markets: the US, Europe, and Japan.

As a starting point, we show that equity yields are risk-adjusted expected growth rates of dividends. That is, they are the difference between expected dividend growth rates and a risk premium component. Therefore, equity yields must either predict dividend growth rates or returns on dividend assets, or both. This makes equity yields natural candidates to study the predictability of dividend growth rates across various maturities. We further show that the cyclical components of dividends, consumption (and GDP) are highly correlated, in particular during severe economic downturns. This implies that some of the predictive power of equity yields for dividend growth extends to other measures of economic growth.

As dividend assets started trading around the turn of the millennium, our sample is shorter than other commonly-used leading economic indicators, such as the yield spread, credit spreads, and the dividend-to-price ratio. To formally assess the value equity yields may add relative to other predictors, we take the perspective of an economic agent forming beliefs about economic activity given the information available at a given point in time using a Bayesian model averaging (BMA) approach. The economic agent forms beliefs about a set of candidate forecasting models, and has to choose how much weight to assign to each model. The BMA approach trades off a longer time series (and hence a higher accuracy of the predictive relationship) of other predictor variables, against the shorter

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time series of equity yields that appear to predict growth well.

Once we have a measure of expected dividend growth, we uncover the risk premium component from each equity yield by simply taking the difference of the expected growth estimate and the equity yield. The risk premium on the aggregate stock market is a weighted average of risk premia on all the dividend assets with different maturities. This allows us to analyze whether the equity risk premium fluctuates due to risk premium variation for short-term or long-term dividend assets.

Our main results can be summarized as follows. First, equity yields strongly fluctuate over time, for all maturities and for all geographic regions. We find that these fluctuations are both due to expected growth variation as well as to risk premium variation. Particularly during the great recession, equity yields turn strongly negative, with values as low as -35%. We find that during this period expected growth rates are low and risk premia are high. Second, we find that equity yields predict dividend growth rates with high R-squared values above 50%. In the BMA approach, equity yields are preferred as predictors of dividend growth despite their shorter sample, assigning to this model a posterior probability of nearly 90% by the end of our sample (April 2011). Third, we find that risk premia embedded in equity yields vary substantially over time in a counter-cyclical fashion. Our estimates suggest that the risk premium on the 2-year equity yield increases more during the great recession than the 5-year equity yield. Finally, we find that equity yields can be useful as predictors of consumption growth even in addition to commonly used predictors.

One reason for why equity yields may add value in forecasting economic growth, compared to, for example, bond yields, is that there may be instabilities in the relationship between bond yields and economic growth. In particular during this period, when bond yields hit the zero lower bond, economic growth expectations become disconnected from bond yields. By contrast, equity yields can and frequently do become negative.

To construct the prices of dividend assets and equity yields, we use a new data set on dividend futures with maturities up to 10 years. An index dividend future is a standardized contract where at a future time $T$, the owner pays the futures price, which is determined today, and receives the index dividends paid during calendar year $T$. Our daily data set covers the time period between October 2002 and April 2011 and comes from BNP Paribas and Goldman Sachs who are important players in the market for dividends. These banks have provided us with their proprietary dividend databases, which they use firm-wide both as a pricing source and to mark the internal trading books to the market. Before 2008, index dividend futures and swaps were traded in over-the-counter (OTC)
markets. Since 2008, dividend futures are exchange traded for several major indexes in an increasingly liquid market.

Our paper relates to Binsbergen, Brandt, and Koijen (2010) (BBK) who use options on the S&P500 index (LEAPS) to study the asset pricing properties of short-term dividend strips. Using put-call parity, they uncover the prices of short-term dividend strips. An advantage of using index options is that these derivatives have been exchange-traded since 1996, and hence this approach results in a longer time series. BBK document several return properties for short-term dividend strips. In particular they show that dividend strips have a substantial risk premium, that seems to be at least as high as the aggregate market. An important disadvantage, however, is that index options have fairly short maturities of up to three years. The advantage of our data set is that dividend futures contracts have maturities up to ten years and that we use data from three major markets.

1 Defining Equity Yields

An index dividend future is a standardized contract where, at maturity, the buyer pays the futures price, which is determined today, and the seller pays the dollar amount of dividends during a certain calendar year. Take for example the 2019 dividend future on the DJ Eurostoxx 50 index, which on October 13th 2010 traded for 108.23 Euros. On the third Friday of December 2019, the buyer of the futures contract will pay 108.23 Euros, and the seller of the futures contract will pay the cash dividend amount on the DJ Eurostoxx 50 index that has been paid out between the third Friday in December of 2018 and the third Friday in December of 2019. The contract is settled based on the sum of all dividends paid throughout the year, and there is no reinvestment of the dividends in the contract.

Let \( D_{t+n} \) denote the stochastic dividend paid out in \( n \) years from today’s date \( t \). Further, let \( \mu_t^{(n)} \) denote the appropriate per-period discount rate for that dividend. Then the present value \( P_{t,n} \) of \( D_{t+n} \) is given by:

\[
P_{t,n} = \frac{E_t (D_{t+n})}{(1 + \mu_{t,n})^n}.
\]

(1)

Splitting up the discount rate into the interest rate for period \( n \), denoted by \( r_{t,n} \), and the risk premium for maturity \( n \), denoted by \( \theta_{t,n} \), we can rewrite equation (1) as:

\[
P_{t,n} = \frac{E_t (D_{t+n})}{((1 + r_{t,n})(1 + \theta_{t,n}))^n}.
\]

(2)
Further, by defining \( g_{t,n} \) as the per-period expected growth rate of dividends over the next \( n \) periods:

\[
g_t = E_t \left[ \left( \frac{D_{t+n}}{D_t} \right)^{\frac{1}{n}} \right] - 1, \tag{3}
\]

we can rewrite expression (2) as:

\[
P_{t,n} = D_t \left( \frac{1 + g_{t,n}}{(1 + r_{t,n})(1 + \theta_{t,n})} \right)^n.
\]

We then define the equity yield \( g_{t,n}^* \) as follows:

\[
g_{t,n}^* \equiv \frac{1 + g_{t,n}}{1 + \theta_{t,n}} - 1 \approx g_{t,n} - \theta_{t,n}. \tag{4}
\]

From equation (4) it can be seen that the equity yield, which has a time subscript \( t \) and a maturity subscript \( n \), can be interpreted as a risk-adjusted expected growth rate, as it describes the difference between the per-period expected growth rate \( g_{t,n} \) and a per-period risk premium \( \theta_{t,n} \). We can compute \( g_{t,n}^* \) using two observables, the price-dividend ratio of dividend strip \( n \) and the risk free interest rate for period \( n \):

\[
g_{t,n}^* = \left( \frac{P_{t,n}}{D_t} \right)^{\frac{1}{n}} (1 + r_{t,n}). \tag{5}
\]

In reality, the way the contract is quoted, is not in terms of the “spot” price \( P_{t,n} \), but in terms of the futures price, which we will denote by \( F_{t,n} \). Under no arbitrage, the spot price and the futures price are linked through the risk free rate:

\[
F_{t,n} = \frac{P_{t,n}}{(1 + r_{t,n})^n}. \tag{6}
\]

This implies that the equity yields follow directly from the futures prices and the risk free rate is no longer required as an input:

\[
g_{t,n}^* = \left( \frac{F_{t,n}}{D_t} \right)^{\frac{1}{n}} - 1. \tag{7}
\]

\footnote{Note that this formula holds for non-dividend paying assets. At first sight this may be confusing, as the focus of the paper is on dividends. Note that the index does indeed pay dividends, and therefore futures on the index are affected by these dividend payments. However, the futures contracts we study are not index futures, but dividend futures. These dividend futures have the dividend payments as their underlying, not the index value. As dividends themselves do not pay dividends, equation \( g_{t,n}^* \) is the appropriate formula.}
The equity yield $g^\star_{t,n}$ is the per-period risk adjusted expected growth rate for the next $n$-years. As such it represents an average expected growth rate. However, when considering a 10-year horizon, for example, it may also be interesting to compute the expected growth rate between year 5 and 10, which we will call the forward growth rate. The forward equity yield between period $n_1$ and $n_2$, where $n_2 > n_1$, is defined as:

$$f_{t,n_1,n_2} \equiv \left( \frac{F_{t,n_2}}{F_{t,n_1}} \right)^{\frac{1}{n_2-n_1}} - 1.$$  

(8)

Finally, we derive what investment strategy is required to earn the risk premium $\theta_{t,n}$. It can be earned by buying the $n$-period futures contract at time $t$, holding it until maturity $t + n$ and collecting the dividends at period $t + n$. The $n$-period return on this strategy is given by:

$$R_{t+n}^D = \frac{D_{t+n}}{F_{t,t+n}} = \frac{D_{t+n}/D_t}{F_{t,t+n}/D_t}.$$  

(9)

Because the futures price is paid at time $t + n$, this is a zero-cost strategy, which implies that no money is exchanged at time $t$. The expected return on this strategy is given by:

$$E_t[R_{t+n}^D] = E_t\left[ \frac{D_{t+n}}{F_{t,t+n}} \right] = E_t\left[ \left( D_{t+n} \right) \left( F_{t,t+n}/D_t \right) \right] = \left( \frac{1 + g_t}{1 + g^\star_t} \right)^n = (1 + \theta_{t,n})^n$$

where $F_{t,t+n}$ is a futures price that is in the information set at time $t$. As with all futures contracts, the replicating strategy of this derivative is to borrow in the $n$-year bond market, buy the asset (dividend strip) in the spot market, collect the payoff (dividend) at maturity and use the proceeds to pay off the bond. Because this replicating strategy involves shorting the $n$-year bond, this strategy involves paying (as opposed to earning) the $n$-year bond risk premium. This will lead to a different risk premium $\theta_{t,n}$ compared to the risk premium that an investor would earn in the dividend strip spot market, as studied in Binsbergen, Brandt, and Koijen (2010). A second difference with Binsbergen, Brandt, and Koijen (2010) is that $\theta_{t,n}$ is the risk premium earned when the investment horizon is equal to the maturity of the futures contract $n$, whereas Binsbergen, Brandt, and Koijen (2010) study the risk premium on monthly returns of dividend strips with an average maturity of 1.5 years. So, for example, if $n$ equals two years, then $\theta_{t,n}$ is the average risk premium earned when buying and holding the futures contract for 2 years and collecting the dividend at maturity.
2 Data and Summary Statistics

2.1 Choice of Stock Indices

We focus our analysis on the dividends of three major stock indices representing three world regions: the US, Europe and Japan. For Europe, we use the EURO STOXX 50 Index. This index is a leading blue-chip index for the Eurozone. The index covers 50 stocks from 12 Eurozone countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain traded on the Eurex. In February 2011, the index has a market capitalization of 2 Trillion Euros (2.8 Trillion dollars) and captures approximately 60% of the free float market capitalization of the Eurostoxx Total Market Index (TMI), which in turn covers approximately 95% of the free float market capitalization of the represented countries. As such, the index seems fairly representative for the euro area despite the fact that it only includes 50 stocks. For Japan, we focus on the Nikkei 225 index, which is the major stock index for the Tokyo Stock Exchange in Japan. The Nikkei 225 has a market capitalization of over 2 Trillion dollars. It is comprised of 225 blue chip stocks on the Tokyo Stock Exchange. Finally, we use the S&P500 index for the US. The S&P 500 is a capitalization-weighted index of the prices of 500 large-cap common stocks actively traded in the United States. The stocks included in the S&P 500 are those of large publicly held companies that trade on one of the two largest American stock market exchanges; the NYSE and the NASDAQ. The market capitalization is just over 12 Trillion dollars. As a comparison, the S&P1500 index, which also includes mid-cap and small-cap companies, has a market capitalization of about 13 Trillion dollars, suggesting that the S&P500 index is a representative index for the US economy.

2.2 Equity Yields

The market for dividend products is relatively young and started around the turn of the millennium. With increased trading activities in options, forwards, and structured products, dividend exposures increased on investment banks’ balance sheets. This exposes banks to dividend risk, the risk between anticipated and actual dividends. Other than investment banks, hedge funds and pension funds are important participants in this market. Most of the trading in dividends occurs in the over-the-counter (OTC) market. Since mid 2008, however, exchange-traded dividend futures markets have started; first in
Europe and later in Japan.

The current size of the exchange traded dividend future market is substantial, particularly in Europe, with a total open interest of $10 billion for the DJ Eurostoxx 50 index. This is in addition to a large OTC market. For example, by mid October 2010, the open interest in the exchange-traded Dec 2010 dividend future on the DJ Eurostoxx 50 was 1.7 billion dollars. The open interest in the Dec 2011 contract was 2.5 billion dollars. The open interest decreases for longer maturity contracts, but even the Dec 2019 contract has a 200 million dollar open interest.

The pay-off of a contract is the sum of the declared ordinary gross dividends on index constituents that go ex-dividend during a given year. Special or extraordinary dividends are excluded. Contracts are cash-settled at the expiration date and there are no interim cash flows. So, for example, the payoff of the 2019 dividend futures contract on the DJ Eurostoxx 50 index are the declared ordinary gross dividends on index constituents that go ex-dividend between the third Friday of December of 2018 and the third Friday of December in 2019.

To compute daily dividends, we obtain daily return data with and without distributions (dividends) from S&P index services for the S&P500 index. We use Global Financial Data and Bloomberg to obtain the same objects for the DJ Eurostoxx 50 index and the Nikkei 225 index. Cash dividends are then computed as the difference between the return with distributions and the return without, multiplied by the lagged value of the index. As the dividend futures prices are based on a full calendar year of dividends, we use the past year of dividends as the denominator in equation (7). For example, if we want to compute the equity yields on October 15th 2010, we use as the denominator the sum of the dividends paid out between October 16th 2009 and October 15th 2010. This also reduces concerns related to seasonalities, as both the future dividend price as the current dividend level refer to a whole year of dividends.

### 2.2.1 Equity yields of the S&P 500

The equity yields for the S&P 500 index between October 2002 and April 2011 are plotted in Figure 1. The four lines in each graph represent the equity yields for four horizons: 1,
2, 5, and 7 years. The graph shows that between 2003 and 2007, short-maturity equity yields were higher than long-maturity equity yields. During the financial crisis this pattern reversed and short-maturity equity yields plummeted compared to long-maturity equity yields. However, long-maturity equity yields also decreased substantially.

The 1-year equity yield for the S&P500 index displays a double dip, the first occurring on December 15th 2008 and the second occurring on March 4th of 2009, with values of -25.4% and -29.9%, respectively. The S&P 500 index level also exhibits a double dip, but the troughs occurred on November 20th 2008, with a level of 752.44 and March 5th with an index level of 682.55. The 2, 5, and 7 year equity yields do not exhibit a double-dip pattern and coincide with the second dip of the 1-year growth rate on March 4th, with values of -25.6%, -10.0% and -6.7% respectively. Finally, a very steep decline in the one-year rate occurred in October 2008 when the rate dropped from -6.3% on October 1st to -24.4% on October 30th. Interestingly, the S&P 500 index level during this period only dropped from 1161.1 on October 1st to 954.1 on October 30th, which is substantially higher than its two troughs of 752.44 and 682.55. Long-maturity equity yields decline further between October 30th 2008 and November 20th 2008 when the index dropped another 22% from 968.8 to 752.44, but short maturity equity yields, stay roughly constant.

2.2.2 Equity yields of the Eurostoxx 50 Index

In Figure 2, we plot the equity yields for the Eurostoxx 50 index. As before, the four lines in each graph represent the equity yields for four horizons: 1, 2, 5, and 7 years. The trough of the one-year rate occurs on March 31st 2009 with an equity yield of -41.1%. Similar to the S&P 500 index, the trough of the 1-year rate occurred after the trough of the index, with the latter occurring on March 9th 2009, when the index value hit 1810 Euros. Compared to the troughs of the S&P500 index, the troughs of the Eurostoxx 50 index occurred later, both for the index and for the 1-year expected growth rate.

As with the S&P500 index, there is one particular period of very steep decline for the one-year rate. Between October 1st and October 24th 2008 the one-year equity yield decreased from -8.4% to -39.7%.

2.2.3 Equity yields of the Nikkei 225

In Figure 3, we plot the equity yields for the Nikkei 225 index. The trough of the one-year rate occurs on March 25th 2009 with an equity yield of -44.3%. The index reached its trough on March 10th 2009 with an index level of 7055.0, which as with the other two indexes is before the 1-year growth rate reached its trough.
Between October 1st and October 30th 2008, the one-year equity yield decreased from -5.4% to -25.6%. Apart from this steep decline, there is no particular period over which the growth rate declined abruptly and the growth rate drifts downward gradually to its trough of -44.3%. There is also a marked decline by the end of the sample as a consequence of the earthquake in March 2011.

In figure 4 we plot the corresponding forward equity yields. Forward equity yields between 2 and 5 years and 5 and 7 years did initially not decrease during the crisis but increased instead.

### 2.2.4 Summary Statistics of the Equity Yields of All Three Markets

We report in Table 1 the summary statistics of the equity yields for all three indexes and for all ten maturities. The average 1-year equity yield is highest for Japan (5.31%) and lowest for Europe (-1.2%). The average 1-year equity yield for the US is 3.4%. The average 7-year equity yield 2.6% for the US and Japan and -0.6% for Europe.

The volatilities of the equity yields decline monotonically with maturity for all three indices, similar to bond yields (see for instance Dai and Singleton (2003)). The volatility of equity yields is highest for Japan and lowest for the US at all maturities. Further, over this sample period the equity yields are negatively skewed, which is induced by the large negative numbers during the financial crisis.

### 2.3 Bond yields

We use monthly Fama-Bliss bond yields with maturities of 1, . . . , 5 years from the Center for Research in Security Prices (CRSP). We use the data from Gurkaynak and Wright (2008), which is updated until March 2011.

We use the credit spread data as published by the Board of Governors.

### 2.4 Consumption growth

We construct seasonally-adjusted real consumption growth from the NIPA tables of the Bureau of Economic Analysis using a chain-weighted index of non-durable consumption and services.

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7The same is true for the forward equity yields of the S&P 500 and Eurostoxx 50 which are available upon request. They are omitted from this draft due to space constraints.

3 Dividends and Economic Activity

Dividend markets provide us with a term structure of expected dividend growth. One may wonder to what extent aggregate dividends and aggregate dividend growth are related to more common measures of economic activity such as real consumption and GNP growth. To illustrate this relationship, we plot in Figure 5 the cyclical component of the Hodrick-Prescott filtered series for annual real consumption (levels), annual real GNP, and annual dividends, at a quarterly frequency. We set the smoothing parameter to $\lambda = 1,600$.

The graph shows that for many periods of expansions and recessions, the cyclical components of dividends, GNP, and consumption align. However, they are not perfectly aligned. Sometimes dividends lead consumption and GNP, and sometimes consumption and GNP lead dividends. The series align for the recent financial crisis as well as the recession in the early 2000s.

To illustrate the correlation between the cyclical components of consumption, GNP, and dividends, we compute the 10-year rolling time-series correlation between the series. The results are reported in Figure 6. First, the figure indicates that the correlation between the cyclical components of consumption and dividends or GNP and dividends are very similar. The time series of the rolling correlations strongly co-move. Second, apart from the early sixties and the nineties, the time-series correlation appears well above 0.5 and peaks in periods with deep recessions. This suggests that dividends and other measures of economic activity are strongly related. The last data point in the figure shows that the correlation between consumption and dividends over the past ten years, which roughly corresponds to our sample period, is around 0.8.

4 Dividend Growth Predictability and Risk Premia

In this section we explore to what extent equity yields can be used to predict dividend growth of the S&P 500 index. This approach follows a long tradition in macro-finance using yield-based variables to forecast either returns or cash flows. Examples include Campbell and Shiller (1988), Cochrane (1991), and Binsbergen and Koijen (2010) for the aggregate stock market, Fama (1984) for currency markets, and Fama and Bliss (1987), and Campbell and Shiller (1991), and Cochrane and Piazzesi (2005) for bond markets.

As equity yields are equal to expected dividend growth minus a risk premium component, they are natural candidates to predict dividend growth. We use a Bayesian Model Averaging (BMA) approach to compare the performance of equity yields to a set
of linear prediction models that are commonly used in the empirical literature to predict economic growth. Once we obtain an estimate of expected dividend growth, it is then straightforward to back out the risk premium component, see equation 4.

4.1 Dividend Growth Predictability and Equity Yields

First, we run a set of univariate regressions to explore the predictability of dividend growth by equity yields. In the next subsection, we will explore bivariate regressions. The main reason to include two (or more) equity yields is that equity yields do not only move because of expected dividend growth variation but also because of risk premium variation. This risk premium variation can negatively affect the predictive power of each individual equity yield. If the risk premium variation across equity yields of different maturities is correlated, including multiple yields will improve the forecasting power.

We focus on annual dividend growth to avoid the impact of seasonal patterns in corporate payout policies, but we use overlapping monthly observations to improve the power of our tests. We thus run the following regressions for \( n = 1, \ldots, 5 \):

\[
\hat{d}_{t+12} = \alpha + \beta g_{t,n}^* + \varepsilon_{t+12}
\]

(10)

where:

\[
\hat{d}_{t+12} = \frac{\sum_{i=1}^{12} D_{t+i}}{\sum_{i=1}^{12} D_{t-12+i}} - 1.
\]

(11)

The growth rate \( \hat{d} \) is based on the summed dividends within the year, which is also the measure of aggregate annual dividends the futures contract is based upon.

If the risk premium on the one-year equity yield is constant, then it holds that \( \beta_1 = 1 \). If there is time variation in the risk premium that is not perfectly correlated with expected dividend growth, this is reflected by a deviation of \( \beta_1 \) from one.

The results are presented in panel A of Table 2. The first column reports the point estimate. The second column reports the Hansen Hodrick standard errors. The final column reports the R-squared value. We find that all equity yields have strong predictive power for future dividend growth. The R-squared values are high and vary between 48% for the 5-year yield and 76% for the 1-year yield. This suggests that dividend growth


\[10\] Summing the dividend within the year is also done by Fama and French (1988). Alternatively, one could reinvest dividends at the 1-month T-bill. Binsbergen and Koijen (2010) show that the resulting aggregate dividend growth series is very similar for both reinvestment policies.
rates, at least during this sample period, are strongly predictable. The R-squared value of the regression monotonically decrease with the maturity of the equity yield. As we are predicting one-year dividend growth, it is not surprising that the one-year equity yield has the highest R-squared value and the 5-year equity yield has the lowest. Recall that the 5-year equity yield is the average risk-adjusted expected growth rate over the next 5 years.

Second, we find that the predictive coefficients are monotonically increasing in maturity. As a point of reference, it may be useful to derive what these coefficients look like under two, admittedly strong, assumptions. Namely, if we assume that the risk premium on short-dividend strips is constant and expected dividend growth is an AR(1) process with autoregressive coefficient $\rho$, then it is straightforward to show that:

$$\beta_n \approx \frac{n(1-\rho)}{1-\rho^n}. \quad (12)$$

This expression directly implies $\beta_1 = 1$, as discussed before. We can also solve for $\rho$ for $n = 5$ given $\beta_5 = 2$. This corresponds to an annual autoregressive coefficient of $\rho = 0.64$.

### 4.2 Bayesian Model Averaging

We now compare the performance of equity yields as a predictor of US dividend growth with several other common predictors of economic growth using a BMA approach. The main advantage of BMA in our setting, is that it trades off a longer time series of other common predictor variables, which is more informative about the predictive relationship, against the shorter time series of equity yields that appear to predict growth more accurately. We follow Fernandez, Ley, and Steel (2001) and Wright (2008) and the references therein, and consider a set of $k$ linear models $M_1, \ldots, M_k$. We will predominantly focus on models with two forecasting variables. Let the $i^{th}$ linear model be given by:

$$\hat{d}_{t+12} = \beta_i z_{i,t} + \varepsilon_{t+12} \quad (13)$$

where $z_i$ is the matrix of regressors for model $i$. The econometrician knows that one of these models is the true model, but does not know which one.

Let $\pi(M_i)$ denote the prior probability of model $i$ being the true model. Conditional on seeing the data up to time $s$, (denoted by $X_s$) for dividend growth and the predictor
variables, the posterior probability of model \( i \) being the true model is given by:

\[
\pi(M_i | X_s) = \frac{\pi(X_s | M_i) \pi(M_i)}{\sum_{i=1}^{k} \pi(X_s | M_i) \pi(M_i)}.
\]  

(14)

In January 1954, we start with a flat prior over all models, in the sense that we assign equal probability to each model:

\[
\pi(M_i) = \frac{1}{k}.
\]  

(15)

We make the following assumptions regarding the prior distributions of the parameters. For \( \beta \), we take the natural conjugate g-prior specification (Zellner (1986)), so that the prior for \( \beta \) conditional on the variance of the error term \( \sigma^2 \) is \( N(0, \phi \sigma^2 (X'X)^{-1}) \), where \( \phi \) is a shrinkage parameter. For \( \sigma \), we assume the improper prior that is proportional to \( 1/\sigma \). Finally, we take into account the fact that we use overlapping data, by modeling an MA-structure for \( \varepsilon_t \):

\[
cov(\varepsilon_t, \varepsilon_{t-j}) = \sigma^2 h - j
\]  

(16)

where \( h \) measures the amount of overlap in the data, that is, \( h = 12 \) for monthly data, and \( h = 4 \) for quarterly data. Under these assumptions, the likelihood of the data up until time \( s \), denoted by \( X_s \), given the model, is given by:

\[
\pi(X_s | M_i) = \frac{\Gamma(s/2) \sqrt{\pi}^{p/2} (1 + \phi)^{-p/2}}{\sqrt{\pi}^{1/2}} H^{-s/h}_i
\]  

(17)

where \( \Gamma(\cdot) \) is the gamma function, \( p \) is the number of regressors, and \( H^2_i \) is given by:

\[
H^2_i = \hat{d}'\hat{d} - \hat{d}'z_i(z_i'z_i)^{-1}z_i'\hat{d} \frac{\phi}{1 + \phi}
\]  

(18)

where \( \hat{d} = (\hat{d}_1, \ldots, \hat{d}_s)' \) is the vector of realized dividend growth rates up until time \( s \) (the subscript \( s \) is dropped for ease of notation), and \( z_i \) is the matrix with the regressors of model \( i \) up until time \( s \).

The parameter \( p \) can be interpreted as a penalty on the number of regressors, and a higher number of \( p \) will lead to a lower likelihood value, even if the predictive power is the same. We set the shrinkage parameter \( \phi \) to 1, following Wright (2008).

Without loss of generality, we demean all variables on the right hand side of the equation. If for a certain value of \( s \) the sample is such that the predictors do not exist in the beginning of the sample, but do exist later in the sample, the parameter \( p \) is set to 2, and a maximum mean-squared error is added to the likelihood for the missing
observations. The latter is equivalent to setting the value of the predictor variables equal to 0 for these periods. In this way we take a conservative approach towards the value added of equity yields when predicting dividend growth. Put differently, this assumption works against the model for equity yields, and relaxing this assumption would make our findings stronger.

We consider five different models using data between 1954 and 2011. The first four models have 2 predictor variables and the fifth model has no predictor variables, that is, under model 5, dividends follow a random walk. The first model has two equity yields as the predictors (the 2-year and the 5-year equity yield), the second model has two bond yields (the 2-year and the 5-year bond yield), the third model has the 2-year bond yield and the credit spread, and the fourth model has the dividend yield and the credit spread. Adding two real bond yields as a model leaves our results unaffected and the posterior probability of this model converges to 0. For ease of presentation, we focus on the five models above.

For models 2, 3, 4, the data exists for every value of \( s \). For equity yields, the data starts in October 2002, indicated by the vertical black line. Even though for equity yields there are many subsamples \( X_s \) where no data is available, we still set \( p = 2 \) for every value of \( s \). In other words, equity yields do receive the penalty for 2 regressors, despite the fact that for all subsamples before 2002 no data is available. Finally, for the fifth model where dividends are a random walk, we set \( p = 0 \) as there are no regressors for any subsample. Because the random walk model does not receive a penalty for including regressors, it can outperform the other models despite having a larger mean-squared error.

The results are summarized in Figure 7. The figure shows that an economic agent who in 1954 assigns a probability of 0.20 to each of the four models, in 2011 has a updated probability of about 0.9 that the model with 2 equity yields is the right model to predict dividend growth with, despite its very short sample and hence its large uncertainty regarding the predictive relationship.

Finally, we compare the model without predictors (a random walk for dividends) with the model of two equity yields. That is, we perform the thought experiment where a real-time investor has to choose between a model in which dividend growth is unpredictable, and a model where dividend growth is predictable by two equity yields. The investor knows that one of these two models is the true model. The results are presented in Figure 8. The vertical line shows the point at which data for equity yields becomes

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11 As before, this assumption works against the model for equity yields. Relaxing this assumption would make our findings stronger.
available (October 2002). Because the penalty parameter \( p \) is set to a value of 2 for the model with equity yields and to 0 for the random walk model, and the prediction error is equal for both models up until 2002, the posterior probability for the random-walk model is higher than that for the equity yields model to the left of the black line. However, as soon as data for equity yields becomes available, this model quickly takes over. At the end of our sample the posterior probability of the model with two equity yields approaches the upper bound of 1, suggesting that an agent who has to choose between unpredictable dividend growth and dividend growth that is predictable by two equity yields, will choose the latter.

4.3 Risk Premia

Using the estimates of expected dividend growth from the previous section, we can now uncover the risk premium component present in the yields. Given that the posterior probability of using 2 equity yields as the predictors is 0.9 at the end of our sample (April 2011), we use this specification as our model for expected dividend growth. We could include the predictions from the other models as well, weighted by their posterior probabilities. However, given that the probabilities of each of the other models is so small compared to the equity yield specification, it seems reasonable to proceed with just equity yields.\(^{12}\)

Let \( x \) denote the vector of the 2-year and 5-year equity yields:

\[
x_t = \begin{bmatrix} g_{t,2}^*, & g_{t,5}^* \end{bmatrix}'.
\]

(19)

Our model for expected dividend growth is then given by:

\[
g_{t,n} = E_t \left( \hat{d}_{t+12} \right) = \psi_0 + \psi_1' x_t
\]

(20)

where we estimate the coefficients \( \psi_0 \) and \( \psi_1 \) by ordinary least squares (OLS) using overlapping monthly observations of annual dividend growth. Recall that equity yields relate to expected growth rates and the risk premium component as follows:

\[
g_{t,n}^* \equiv \frac{1 + g_{t,n}}{1 + \theta_{t,n}} - 1.
\]

(21)

\(^{12}\)If one has a strong prior that other predictors should be added to the predictive relationship, then these predictors can easily be included. As argued before, given the definition of equity yields, any estimate of expected dividend growth can be combined with the equity yields to arrive at an estimate of the risk premium.
Rewriting this equation we find:

\[ \theta_{t,n} = \frac{1 + g_{t,n}}{1 + g_{t,n}} - 1. \]  

(22)

To compute the \( n \)--year expectations (where \( n > 1 \)), we model the time-series dynamics of equity yields as a first-order vector autoregressive (VAR) model:

\[ x_{t+1} = \mu + \Gamma x_t + \varepsilon_{t+1}. \]  

(23)

The monthly VAR model implies and annual VAR model:

\[ x_{t+12} = \mu_A + \Gamma_A x_t + \varepsilon_{A,t+12}, \]

where:

\[ \mu_A \equiv \left( \sum_{i=0}^{11} \Gamma^i \right) \mu, \quad \Gamma_A \equiv \Gamma^{12}, \quad \varepsilon_{A,t+12} \equiv \sum_{i=1}^{12} \varepsilon_{t+i}. \]

As before, we estimate the parameters using OLS.

Using the joint dynamics for dividend growth from (20) and the equity yields (23), we can compute the conditional expectation of one-year dividend growth as:

\[ E_t \left( \dd_t^{12} \right) = \psi_0 + \psi_1' x_t \equiv \gamma_{0(1)} + \gamma_{1(1)}' x_t. \]

and the expectation of annual dividend growth \( n \) years ahead \((n > 1)\) as:

\[ E_t \left( \dd_t^{12n} \right) = E_t \left( \psi_0 + \psi_1' x_{t+12(n-1)} \right) \]

\[ = \psi_0 + \psi_1' \left( \sum_{i=0}^{n-2} \Gamma_A^i \right) \mu_A + \Gamma_A^{(n-1)} x_t \]

\[ \equiv \gamma_{0(n)} + \gamma_{1(n)}' x_t. \]

The equity yield can now be written as:

\[ g_{t,n}^* = (1 + g_{t,n})(1 + \theta_{t,n}) - 1 \]

\[ = \left( \frac{1}{n} \sum_{i=1}^{n} \left( \gamma_{0(n)} + \gamma_{1(n)}' x_t \right) \right) (1 + \theta_{t,n}). \]
We observe the left-hand side, \( g_{i,n}^* \), and we estimate the first term on the right-hand side, using the VAR, resulting in an estimate for the risk premium for all maturities \( n \).

The results are presented in the top panel of Figure 9, where the solid line plots the 2-year risk premium and the dotted line plots the 5-year risk premium. The graphs show that risk premium varies over time, and increases during the recent financial crisis. The average risk premium for the 2-year and 5-year yield are equal and about 3.2% per year for the 2-year yield and 3.5% per year for the 5-year yield.

We find that the risk premium estimates fluctuate substantially over time. In fact, the estimates imply that the short-term risk premium component in fact fluctuates more than the longer-maturity component.\(^{13}\) Perhaps most interestingly, we find that the term structure of risk premia is more inverted during the recession. The results in Binsbergen, Brandt, and Koijen (2010) already suggest that the risk premium component on the short-maturity dividend claims is on average higher than on the long-maturity dividend claims.\(^{14}\) We extend this evidence by showing that the steepness of the decline in the term structure of risk premia is counter-cyclical.

In the top panel of Figure 10, we decompose the 2-year equity yield of the S&P 500 into expected growth rates and risk premia. The plot shows that both risk premia and expected growth rates vary substantially over time. Furthermore, during the financial crisis, expected growth rates went down, whereas risk premia sharply increased.

### 4.4 Predictability and Risk Premia in Europe and Japan

We then repeat the same analysis for Europe (the DJ Eurostoxx 50) and Japan (the Nikkei 225). All the results are consistent with the results found for the S&P500 index. The univariate predictability results are presented in panels B and C of Table 2. As for the S&P 500 index, dividend growth seems strongly predictable, with \( R^2 \) values above 50%. The risk premia, shown in the second and third panel of figure 9, vary strongly over time and are always positive. The average value of the risk premia is high and higher than for the US. For Europe the average risk premium is 10.9% for the 2-year contract and 10.6% for the 5-year contract. For Japan, the average risk premium is 7.2% for the 2-year

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\(^{13}\)The two-year risk premium component turns somewhat negative during the period 2006-2007, which is attributable to the short sample we have available. As an extension, one can consider to estimate the model under the condition that the risk premium component needs to be positive, see also Campbell and Thompson (2007).

\(^{14}\)This is consistent with the models developed in Lettau and Wachter (2007), Lettau and Wachter (2010), Croce, Lettau, and Ludvigson (2009), Barro, Nakamura, Steinsson, and Ursua (2011), Lynch and Randall (2011), and Buraschi, Porchia, and Trojani (2010).
contract and 6.7% for the 5-year equity yield. We do stress again that the sample period is rather short, which makes the estimation of these unconditional means imprecise.

The decomposition of the equity yields into expected growth rates and risk premia is presented in the middle and bottom panel of Figure. As for the S&P 500 index, equity yields seem to vary both due to risk premium fluctuations as well as due to variation in expected dividend growth.

5 Consumption Growth

5.1 Univariate Regressions

The previous results show that our newly-constructed data set of equity yields is useful in forecasting future dividend growth. We now extend these results for the US and show that S&P500 equity yields also predict future annual consumption growth. We study the same type of forecasting regressions as before, but now predict annual growth rates using overlapping quarterly data:

\[
\dot{c}_{t+4} = \frac{\sum_{i=1}^{4} C_{t+i}}{\sum_{i=1}^{4} C_{t-4+i}} - 1, \tag{24}
\]

where \( C_t \) is real quarterly consumption of nondurables and services.

We present the results in Panel A of Table. The structure of the table is the same in Table 2. Consistent with our results for dividend growth predictability, we uncover predictability of one-year consumption growth as well. The coefficients are much smaller in this case, which follows from the fact that dividend growth is more volatile than consumption growth during our sample period. As expected, the coefficients are increasing with maturity as long-term equity yields are less exposed to fluctuations in short-term expected growth rates.

As a point of reference, we use in Panel B of Table nominal bond yields to forecast annual consumption growth. We use either the 1-year or the 5-year bond yield, or the yield spread between the 5-year and 1-year bond yields. Even though the 5-year bond yield is a fairly strong predictor of consumption growth, it is not nearly as powerful as the equity yields as reported in Panel A. In Panel C, we show that even using real bond yields, we do not uncover strong predictability.

Note also that the average risk premia on the 2-year and 5-year equity yield are higher than the average excess return on the corresponding index, as also pointed out by Binsbergen, Brandt, and Koijen (2010).
There is a long literature studying the predictability of consumption growth using bond yields, see for instance Harvey (1988) and Kandel and Stambaugh (1991). The reason why our bond yields may be superior predictors of growth may be due to the fact that the link between short-term interest rates and expected inflation has been unstable, see for instance Clarida, Gali, and Gertler (2000), Cogley and Sargent (2005), and Ang, Boivin, Dong, and Loo-Kung (2010). In addition, the sample period that we are studying may be special in that the nominal short rate is close to zero for some part of the sample. The zero lower bound on interest rates may introduce non-linear relations between growth and both nominal and real bond yields, see for instance Christiano, Eichenbaum, and Rebelo (2011). Equity yields are not subject do these concerns. Equity yields can and frequently do become negative.

5.2 Bayesian Model Averaging

We then apply the BMA approach to consumption growth. We use the exact same setup as in Section 4.2 but now use consumption growth as the left-hand-side variable. As before, we take a conservative approach with respect to equity yields as predictors of consumption growth by setting the penalty parameter \( p = 2 \) even for subsamples where no data is available.

First, we compare the model without predictors (a random walk for consumption) with the model of two equity yields. That is, we perform the thought experiment where a real-time investor has to choose between a model in which consumption growth is unpredictable, and a model where consumption growth is predictable by two equity yields. The investor knows that one of these two models is the true model. The results are presented in Figure 11. As before, the vertical black line shows the point at which data for equity yields becomes available (2002). Because the penalty parameter \( p \) is set to a value of 2 for the model with equity yields and to 0 for the random walk model, and the prediction error is equal for both models up until 2002, the posterior probability for the random walk model is higher than that for the equity yields model before 2002. However, as soon as data for equity yields becomes available, this model takes over. At the end of our sample the posterior probability of the model with two equity yields increases from 0.33 to 0.56, and the random walk model changes from a probability of 0.67 to 0.44. Note that this change is not as large as the change for dividend growth in the previous section, but it does suggest that equity yields have some value in predicting consumption growth.

We then include the other three models with two regressors (two bond yields, credit spread and short-term bond yield, and credit spread and dividend yield). The results are
presented in Figure 12. Recall that for all the other predictors the data exists for the whole sample period. The figure shows that for the early part of the sample, the posterior probability of the other models increases substantially, and the probability that the equity yields model is the correct one decreases to as low as 4.9%. After 2002, this probability almost doubles to 9.1%. It thereby outperforms both the model with 2 bond yields as well as the random walk model. However, given the success of the other models in the earlier period, the data sample of equity yields is too short to outperform the models that include the credit spread in the sense that these models are assigned a higher posterior probability.

6 Do Equity Yields Contain Other Information Than Bond Yields?

To formally assess whether equity yields contain information beyond and above the information contained in bond yields, we compute the principal components of nominal and real bond yields and regress each of the equity yields on these principal components. In all cases, the first principal component explains more than 95% of the variation in either equity, nominal bond or real bond yields. Table 4 reports the R-squared values of these regressions. We only report results for the first two principal components for nominal and real bonds, because adding the third component leads to almost identical results as using two principal components. Furthermore, nearly all variation in nominal and real bond yields is captured by their first two principal components.

The table shows that the R-squared-values when including the first two principal components of nominal yields are between 30 and 39%. The $R^2$ values are increasing in the maturity. The largest share of the variation is explained by the first principal component, and the second principal component does not seem to add much. When using the principal components of real yields, we find very low $R^2$ values, never exceeding 5%. However when we include the first two principal components of real yields and the first two principal components of nominal yields in one regression, the $R^2$ values jump up to 73% for the 1-year equity yield, and 60% for the 5-year equity yield. This still leaves a substantial fraction of the variation in equity yields that is unexplained by the term structure of interest rates.

To further assess the relation between bond yields and equity yields, Table describes

\[ \text{An advantage of using principal components is that they are less sensitive to measurement error than individual yields.} \]
the correlations between the first two principal components of equity yields, the first two principal components of bond yields and the first two principal components of real yields. We find that equity yields seem generally positively correlated with nominal bond yields, but negatively correlated with real yields, both in levels as in innovations. Further, the correlation with real yields is low.

7 Applications

7.1 Economic outlook around the world

Next, we use the framework we develop in Section 4.3 to compute longer-term growth expectations. As before, instead of using a single equity yield, we use two equity yields with maturities equal to 2 and 5 years, respectively. We use multiple equity yields as there may be separate factors driving expected growth rates and the risk premium component, as suggested by the models of Bansal and Yaron (2004), Lettau and Wachter (2007), Lettau and Wachter (2010), and Menzly, Santos, and Veronesi (2004).

In Figure 13, we plot the 2-year and 5-year expected growth rates across regions. First, the troughs of the financial crisis for the 2-year expected growth rate were more severe for Japan and Europe than for the US. Second, 2-year expected growth rates decline substantially to -30% in Europe in the bottom of the crisis. Even during a 5-year period, there is a double digit decline in expected growth. The figures also show a marked decline in both 2-year and 5-year growth expectations in Japan following the earthquake.

7.2 Growth Expectations and the Financial Crisis

In this section we study the term structure of growth during the financial crisis. We focus on particular months in which there was a large decline in either the short-term or the long-term growth rates (or both). Our main focus is on the S&P500 index.

7.2.1 November 2007

Between October 31st and November 29th 2007, the one-year equity yield (risk-neutral growth rate) for the S&P500 index decreased from 9.4% to 2.7%. The 5-year equity yield dropped from 5.5% to 3.6%, the 10-year equity yield dropped from 4.1% to 3.2% and the index value changed from 1549.4 to 1469.7, a drop of 5%. During this period

\[17\] Other examples include Croce, Lettau, and Ludvigson (2009) and Bekaert, Engstrom, and Xing (2009).
several major events occurred. First, on October 31st, Meredith Withney, an analyst at Oppenheimer and Co. predicted that Citigroup had so mismanaged its affairs that it would have to cut its dividends or go bankrupt.\footnote{See “The Big Short” by Michael Lewis.} By the end of that day, Citigroup shares had dropped 8%, and four days later, Citigroup CEO Chuck Prince resigned. Also, on October 31st, the FOMC lowered the target rate by 25bp to 4.5%. Second, on November 2nd, the Fed approved the Basel II accord. Third, on November 27th, Citigroup raised $7.5 billion from the Abu Dhabi investment authority. Finally, the St. Louis Fed crisis time line notes for November 1st 2007: “Financial market pressures intensify, reflected in diminished liquidity in interbank funding markets.”

7.2.2 September 2008

The month of September 2008 was a very turbulent month for financial markets. For example, on September 7th, the Federal Housing Finance Agency (FHFA) placed Fannie Mae and Freddie Mac in government conservatorship, and on September 15th, Lehman Brothers Holdings Incorporated files for Chapter 11 bankruptcy protection. Perhaps surprisingly, growth expectations for the US did not change all that much in September for all maturities. As an illustration, the 1-year yield was -6.2% on September 1st and -6.1% on September 30th, and the volatility of the 1-year equity yield was low. For the US, most of the drop in short- and long-term expectations occurred in October. Growth expectations in Japan and Europe on the other hand, did substantially drop in September as well as in October. For Europe, between September 1st and September 30th, the 1-year yield dropped from -3.9% to -7.9%, and the 10-year yield dropped from -0.8% to -1.8%. For Japan, the 1-year yield dropped from 5.6% to -4.6% and the 10-year yield dropped from 2.0% to 0%.

7.2.3 October 2008

During the month October the 1-year yield dropped from -6.3% on October 1st to -24.4% on October 30th. Over the same period, the 2-year yield dropped from -3.4% to -16.9%, the 5-year yield dropped from -0.5% to -5.8%, and the 10-year rate dropped from 0% to -1.4%. Several major events happen during this time period. Interestingly we find that the one of the largest drops in the one-year equity yield occurred around the time when former Federal Reserve chairman Alan Greenspan testifies before the House Committee of Government Oversight and Reform.
7.3 Growth Expectations and the Earthquake in Japan

The earthquake and subsequent tsunami in Japan in mid March of 2011 have had a significant impact on implied growth in Japan for all maturities. Growth rates for all maturities fell each day from Monday 14 to Thursday 17 March, to recover slightly on the joint G-7 intervention on Friday 18. The one-year equity yield dropped from almost 3% to more than -6.6% in the first four days, to rebound to -5% on Friday. Similarly, the 2-year equity yield dropped from 1.4% to -4.7% to settle at -4.2%. Even the 7-year equity yield changed from 0% to -2.3% and eventually settled at -1.8%. This indicates that financial markets expected long-lasting influence on Japanese economy. The US and Europe were much less affected by the Japanese situation, which illustrates that financial markets view these events as Japan-specific, rather than having an impact on global growth.

We use the same approach as before to extract the expected growth component from equity yields. The growth expectations for Europe seem unaltered by the events. During this period, the short-term growth expectations of the US slightly lowered, but the long-term growth expectations are unaffected. It is unclear whether this can be attributed to the crisis in Japan. For Japan, by contrast, we see that the short-term growth expectations are adjusted downwards by as much as 5%.

8 Conclusion

We use a new data set on traded dividends of three major stock indices with maturities up to 10 years to uncover expected dividend growth rates across three major regions around the world: the US, Europe, and Japan. We use these asset prices to derive equity yields, analogous to bond yields, and decompose these yields into expected growth rates of dividends and a risk premium component. We find that both risk premia as well as expected growth rates exhibit substantial variation over time. Further, we find that equity yields are strong predictors of dividend growth and may also be helpful when predicting consumption growth. We relate the dynamics of growth expectations to recent events related to the financial crisis and the recent turmoil following the earthquake in Japan.

References


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Table 1: Summary statistics equity yields
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<td>3</td>
<td>1.36</td>
<td>5.02</td>
<td>57%</td>
</tr>
<tr>
<td>4</td>
<td>1.59</td>
<td>4.45</td>
<td>51%</td>
</tr>
<tr>
<td>5</td>
<td>1.75</td>
<td>3.90</td>
<td>45%</td>
</tr>
</tbody>
</table>

Panel B: Eurostoxx 50

<table>
<thead>
<tr>
<th>$n$</th>
<th>$\beta_n$</th>
<th>t-statistic</th>
<th>R-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.04</td>
<td>8.01</td>
<td>74%</td>
</tr>
<tr>
<td>2</td>
<td>1.15</td>
<td>7.24</td>
<td>70%</td>
</tr>
<tr>
<td>3</td>
<td>1.55</td>
<td>6.93</td>
<td>68%</td>
</tr>
<tr>
<td>4</td>
<td>1.95</td>
<td>6.47</td>
<td>64%</td>
</tr>
<tr>
<td>5</td>
<td>2.29</td>
<td>6.13</td>
<td>61%</td>
</tr>
</tbody>
</table>

Panel C: Nikkei 225

<table>
<thead>
<tr>
<th>$n$</th>
<th>$\beta_n$</th>
<th>t-statistic</th>
<th>R-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.67</td>
<td>5.06</td>
<td>65%</td>
</tr>
<tr>
<td>2</td>
<td>0.83</td>
<td>5.56</td>
<td>65%</td>
</tr>
<tr>
<td>3</td>
<td>1.08</td>
<td>5.66</td>
<td>64%</td>
</tr>
<tr>
<td>4</td>
<td>1.32</td>
<td>5.56</td>
<td>64%</td>
</tr>
<tr>
<td>5</td>
<td>1.56</td>
<td>5.43</td>
<td>63%</td>
</tr>
</tbody>
</table>

Table 2: Predictability of dividend growth by equity yields
### Table 3: Predictability of consumption growth by equity yields (Panel A) and bond yields (Panel B).

#### Panel A: Consumption growth predictability by equity yields

<table>
<thead>
<tr>
<th>Maturity</th>
<th>Estimate</th>
<th>T-statistic</th>
<th>R-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-year</td>
<td>0.16</td>
<td>2.48</td>
<td>18.9%</td>
</tr>
<tr>
<td>4-year</td>
<td>0.16</td>
<td>2.86</td>
<td>23.2%</td>
</tr>
<tr>
<td>3-year</td>
<td>0.14</td>
<td>3.29</td>
<td>28.6%</td>
</tr>
<tr>
<td>2-year</td>
<td>0.12</td>
<td>3.97</td>
<td>36.9%</td>
</tr>
<tr>
<td>1-year</td>
<td>0.10</td>
<td>4.24</td>
<td>40.0%</td>
</tr>
</tbody>
</table>

#### Panel B: Consumption growth predictability by nominal bond yields

<table>
<thead>
<tr>
<th>Maturity</th>
<th>Estimate</th>
<th>T-statistic</th>
<th>R-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-year</td>
<td>0.20</td>
<td>1.18</td>
<td>4.9%</td>
</tr>
<tr>
<td>5-year</td>
<td>0.64</td>
<td>2.20</td>
<td>15.2%</td>
</tr>
<tr>
<td>5-1-year</td>
<td>-0.01</td>
<td>-0.02</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

#### Panel C: Consumption growth predictability by real bond yields

<table>
<thead>
<tr>
<th>Maturity</th>
<th>Estimate</th>
<th>T-statistic</th>
<th>R-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-year</td>
<td>-0.14</td>
<td>-0.49</td>
<td>1.1%</td>
</tr>
<tr>
<td>5-year</td>
<td>-0.15</td>
<td>-0.32</td>
<td>0.4%</td>
</tr>
<tr>
<td>5-2-year</td>
<td>0.66</td>
<td>1.16</td>
<td>5.8%</td>
</tr>
</tbody>
</table>

### Table 4: \( R^2 \) values of contemporaneous regressions of equity yields, with maturities n=1,...,5 years on principal components of nominal and real bond yields. We use the first two principal We use monthly observations between October 2002 and March 2011.

<table>
<thead>
<tr>
<th>Maturity</th>
<th>n=1</th>
<th>n=2</th>
<th>n=3</th>
<th>n=4</th>
<th>n=5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right hand side variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC1 nominal bonds</td>
<td>0.3030</td>
<td>0.2995</td>
<td>0.3413</td>
<td>0.3703</td>
<td>0.3768</td>
</tr>
<tr>
<td>PC1 + PC2 nominal bonds</td>
<td>0.3163</td>
<td>0.3105</td>
<td>0.3413</td>
<td>0.3728</td>
<td>0.3831</td>
</tr>
<tr>
<td>PC1 real bonds</td>
<td>0.0371</td>
<td>0.0372</td>
<td>0.0129</td>
<td>0.0041</td>
<td>0.0012</td>
</tr>
<tr>
<td>PC1 + PC2 real bonds</td>
<td>0.0458</td>
<td>0.0442</td>
<td>0.0150</td>
<td>0.0042</td>
<td>0.0013</td>
</tr>
<tr>
<td>PC1 + PC2 nominal and PC1 + PC2 real bonds</td>
<td>0.7483</td>
<td>0.7059</td>
<td>0.6585</td>
<td>0.6473</td>
<td>0.6071</td>
</tr>
</tbody>
</table>
## Correlations

### Panel A: Levels

<table>
<thead>
<tr>
<th></th>
<th>PC1 Eq</th>
<th>PC2 Eq</th>
<th>PC1 Nom B.</th>
<th>PC2 Nom B.</th>
<th>PC1 Real B.</th>
<th>PC2 Real B.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC1 Equity</td>
<td>1</td>
<td>0</td>
<td>0.60</td>
<td>-0.05</td>
<td>-0.06</td>
<td>-0.04</td>
</tr>
<tr>
<td>PC2 Equity</td>
<td>1</td>
<td>-0.06</td>
<td>-0.36</td>
<td>-0.50</td>
<td>-0.27</td>
<td></td>
</tr>
<tr>
<td>PC1 Nom Bonds</td>
<td>1</td>
<td>0</td>
<td>0.59</td>
<td></td>
<td>-0.26</td>
<td></td>
</tr>
<tr>
<td>PC2 Nom Bonds</td>
<td>1</td>
<td>0.14</td>
<td>0.86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC1 Real Bonds</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC2 Real Bonds</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

### Panel B: Innovations

<table>
<thead>
<tr>
<th></th>
<th>PC1 Eq</th>
<th>PC2 Eq</th>
<th>PC1 Nom B.</th>
<th>PC2 Nom B.</th>
<th>PC1 Real B.</th>
<th>PC2 Real B.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC1 Equity</td>
<td>1</td>
<td>-0.05</td>
<td>0.40</td>
<td>-0.23</td>
<td>-0.28</td>
<td>-0.14</td>
</tr>
<tr>
<td>PC2 Equity</td>
<td>1</td>
<td>0.03</td>
<td>0.07</td>
<td>-0.30</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>PC1 Nom Bonds</td>
<td>1</td>
<td>-0.76</td>
<td>0.28</td>
<td>0.28</td>
<td>-0.65</td>
<td></td>
</tr>
<tr>
<td>PC2 Nom Bonds</td>
<td>1</td>
<td>-0.31</td>
<td>0.74</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC1 Real Bonds</td>
<td>1</td>
<td></td>
<td>-0.17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC2 Real Bonds</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5: Correlations between principal components. The Panel A describes correlations in levels, and Panel B describes the correlation in innovations of a VAR(1) model of all six variables.
Figure 1: Equity yields: S&P500 Index
The graph displays the equity yields $g_{t,n}^*$ for $n = 1, 2, 5, \text{and } 7$ years for $t$ varying between October 7th 2002 and April 8th 2011.
Figure 2: Equity yields: DJ Eurostoxx 50 Index
The graph displays the equity yields \( g_{t,n} \) for \( n = 1, 2, 5, \) and \( 7 \) years for \( t \) varying between October 7th 2002 and April 8th 2011.
Figure 3: Equity yields: Nikkei 225 Index
The graph displays the equity yields $g_{t,n}^*$ for $n = 1, 2, 5,$ and 7 years for $t$ varying between October 7th 2002 and April 8th 2011.
Figure 4: Forward equity yields: Nikkei 225 Index
The graph displays the forward equity yields $f_{t,n_1,n_2}$ for $n_1 = 1, 2$, and 5 years and $n_2 = 2, 5$, and 10 years.
Figure 5: Cyclical components of GNP, consumption, and dividends
The graph displays the cyclical residue of Hodrick-Prescott filtered series for real GNP, real consumption (nondurables and services) and dividends.

Figure 6: Rolling correlations between the cyclical components of consumption, GNP, and dividends
The graph displays the rolling correlation between the cyclical residue of Hodrick-Prescott filtered series for real GNP, real consumption (nondurables and services) and dividends. We use a 10-year window to construct the correlations.
Figure 7: Posterior probabilities of the Bayesian model averaging approach: Dividends
The graph displays the posterior probabilities of five predictive models of annual dividend growth, using monthly data. The first four models all have two predictor variables ($p = 2$). The first model uses two equity yields (2-year and 5-year) to predict dividend growth, the second model uses two bond yields, the third model has the 2-year bond yield and the credit spread, and the fourth model uses the dividend yield and the credit spread. The fifth model has no predictor variables ($p = 0$), which implies a random walk for dividends.
Figure 8: Posterior probabilities of the Bayesian model averaging approach: Dividends
The graph displays the posterior probabilities of two predictive models of annual dividend growth, using monthly data. The first model uses two equity yields (2-year and 5-year) to predict dividend growth \( (p = 2) \). The second model has no predictor variables \( (p = 0) \), which implies a random walk for dividends.
Figure 9: Risk-premium dynamics across maturities
The graph displays the risk premium component for 2-, and 5-year equity yields for all three regions.
Figure 10: Decomposition of 2-Year Equity Yields
The top panel decomposes the 2-year equity yield of the S&P 500 index into expected dividend growth $g_{t,2}$ and the risk premium component $\theta_{t,2}$. The middle and bottom panel show the same decompositions but for the DJ Eurostoxx 50 and the Nikkei 225.
Figure 11: Posterior probabilities of the Bayesian model averaging approach: Consumption
The graph displays the posterior probabilities of two predictive models of annual consumption growth, using monthly data. The first model uses two equity yields (2-year and 5-year) to predict dividend growth ($p = 2$). The second model has no predictor variables ($p = 0$), which implies a random walk for consumption.
The graph displays the posterior probabilities of five predictive models of annual consumption growth, using monthly data. The first four models all have two predictor variables \((p = 2)\). The first model uses two equity yields (2-year and 5-year) to predict consumption growth, the second model uses two bond yields, the third model has the 2-year bond yield and the credit spread, and the fourth model uses the dividend yield and the credit spread. The fifth model has no predictor variables \((p = 0)\), which implies a random walk for consumption.
Figure 13: 2-year and 5-year expected dividend growth across regions

The graph displays the expected growth rate $g_{t,n}$ for $n = 2$ and 5 years for $t$ varying between January 14th 2003 and April 8th 2011 for three regions: the US (as represented by the S&P500 Index), Europe (as represented by the DJ Eurostoxx 50 index), and Japan (as represented by the Nikkei 225 index).