# 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 construct equity yields, analogous to bond yields. We decompose these yields to obtain a term structure of expected dividend growth rates and a term structure of risk premia, which allows us to decompose the equity risk premium by maturity. We find that both expected dividend growth rates and risk premia exhibit substantial variation over time, particularly for short maturities. In addition to predicting dividend growth, equity yields 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.[1] 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. Our data set is available at a daily frequency with maturities 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.

We show in Section 1 that the equity yield $e_{t,n}$ at time $t$ with maturity $n$ can be written as:

$$\underbrace{e_{t,n}}_{n\text{-year equity yield}} = \underbrace{y_{t,n}}_{n\text{-year bond yield}} + \underbrace{\theta_{t,n}}_{\text{risk premium}} - \underbrace{g_{t,n}}_{\text{expected dividend growth}}. \quad (1)$$

The expression above shows that the equity yield consists of three components. It consists of the nominal bond yield $y_{t,n}$, a maturity-specific risk premium $\theta_{t,n}$ that investors require for holding dividend risk, and the expected dividend growth rate $g_{t,n}$, which represents the average expected dividend growth over the next $n$ periods. Higher discounting increases the yield, whereas higher expected dividend growth lowers the yield.[2]

Dividend assets are generally traded in futures or swap markets, not in spot markets. Spot prices and futures prices are linked through bond prices. Assu ming no-arbitrage, we can replace spot prices with futures prices in our computations to obtain forward equity yields, denoted by $e^f_{t,n}$, which do not depend on the $n$-year bond yield:

$$\underbrace{e^f_{t,n}}_{n\text{-year forward equity yield}} = \underbrace{\theta_{t,n}}_{\text{risk premium}} - \underbrace{g_{t,n}}_{\text{expected dividend growth}}. \quad (2)$$

By definition, forward equity yields must either predict dividend growth rates or excess returns (in excess of bonds) on dividend assets, or both. A high (low) value of the forward

[1]See Singleton (1980), Singleton (1983), Fama and Bliss (1987), Piazzesi (2001), Ang and Piazzesi (2003), Ang and Monika Piazzesi (2006), Cochrane and Piazzesi (2005), Ludvigson and Ng (2009), Duffee (2011), among many others.

[2]There is a straightforward analogy with nominal and real bond yield. The difference between nominal and real bond yields is expected inflation and the inflation risk premium. Similarly, the difference between equity yields and nominal bond yields is expected dividend growth and the dividend risk premium.

equity yield implies that the risk premium is high (low) or that the expected dividend growth rate is low (high). This makes forward equity yields natural candidates to forecast dividend growth across various maturities.

Since the cyclical components of dividends, consumption, and GDP are highly correlated, in particular during severe economic downturns, some of the predictive power of forward equity yields for dividend growth extends to other measures of economic growth, such as consumption growth. To formally assess the value these new predictors add, relative to other predictors, we take the perspective of an economic agent forming beliefs about economic activity using a Bayesian model averaging (BMA) approach. The BMA approach trades off a longer time series (and hence a higher accuracy of the predictive relationship) of other, more commonly-used, predictor variables, against the shorter time series of forward equity yields that appear to predict economic growth well.

Our main findings can be summarized as follows. First, forward equity yields fluctuate strongly over time, for all maturities and for all geographic regions. These fluctuations are due to both expected dividend growth variation and risk premium variation. Particularly during the great recession, 1-year forward equity yields turn strongly positive with values above 40% for the US, and values above 50% for Europe and Japan. We find that for all regions, expected dividend growth rates were low (negative) and risk premia were high during this period.

Second, we find that forward equity yields predict dividend growth rates with high R-squared values. The BMA approach suggests that including two lagged forward equity yields as predictors provides the best forecast of dividend growth, assigning to this model a posterior probability of nearly 90% at the end of our sample. Third, we find that dividend risk premia embedded in equity yields are counter cyclical. Our estimates suggest that the risk premium embedded in the 2-year equity yield increases more during the great recession than the risk premium embedded in the 5-year equity yield. This extends the results in Binsbergen, Brandt, and Koijen (2011) who show that the unconditional risk premium is as high (if not higher) for short-maturity dividend assets than for the aggregate stock market. Finally, we find that equity yields can be useful as predictors of consumption growth even in addition to commonly used predictors. As such, this paper advances our understanding of expected growth rates across three major economic regions as well as our understanding of the dynamics of the equity risk premium.

Given that a large class of macro-finance models would predict that predictable components in growth rates are reflected in bond yields, it may come as a surprise that they are not. One reason for why equity yields may add value in forecasting economic growth, compared to bond yields, is that there may be instabilities in the relationship between bond yields and economic growth. In particular during severe recessions, when bond yields hit the zero lower bond, economic growth expectations become disconnected from bond yields. By contrast, equity yields rise during economic recessions and are unrestricted in sign.

To construct the prices of dividend assets and (forward) 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 (2011) who use options on the S&P500 index (LEAPS) to study the asset return properties of short-term dividend strips. Using put-call parity, they uncover the prices of short-term dividend strips and show that the average return on these assets is at least as high as the average return on the aggregate market. 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 than what we use. A shortcoming of their data, however, is that index options have fairly short maturities. Binsbergen, Brandt, and Koijen (2011) focus on an average maturity of 1.6 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. Finally, we study the implications of equity yields for dividend growth rates as well as returns.

# 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 futures contract 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 $t$ and $g_{t,n}$ as the average per-period expected growth rate of dividends over the next $n$ periods:

$$g_{t,n} = \frac{1}{n} E_t \left[ \ln \left( \frac{D_{t+n}}{D_t} \right) \right]. \tag{3}$$

Then the present value $P_{t,n}$ of $D_{t+n}$ is given by:

$$P_{t,n} = D_t \exp \left( n(g_{t,n} - \mu_{t,n}) \right), \tag{4}$$

which defines the geometric discount rate $\mu_{t,n}$. By splitting the discount rate into the nominal bond yield for period $n$, denoted by $y_{t,n}$, and a risk premium $\theta_{t,n}$ that compensates investors for dividend risk for maturity $n$, we can rewrite equation (4) as:

$$P_{t,n} = D_t \exp \left( n(g_{t,n} - y_{t,n} - \theta_{t,n}) \right). \tag{5}$$

The equity yield at time $t$ with maturity $n$ is then defined as:

$$e_{t,n} \equiv \frac{1}{n} \ln \left( \frac{D_t}{P_{t,n}} \right) = y_{t,n} + \theta_{t,n} - g_{t,n}.$$

The expression above shows that the equity yield consists of three components. It consists of the nominal bond yield $y_{t,n}$, a maturity-specific risk premium $\theta_{t,n}$ that investors require for holding dividend risk, and the expected dividend growth rate $g_{t,n}$, which represents the average expected dividend growth over the next $n$ periods. Ceteris paribus, a higher expected dividend growth rate makes the price $P_{t,n}$ higher compared to the current level of dividends $D_t$. This results in a lower equity yield.[3]

In practice, the contracts we study are quoted not in terms of the "spot" price $P_{t,n}$, but in terms of the futures (or forward) price, which we will denote by $F_{t,n}$. Under no

[3] In the rest of this paper we study log yields and log dividend growth rates. One may be worried that some of our predictability results are driven by time-varying volatility. Our conclusions remain unaltered if instead of geometric yields and growth rates we use arithmetic ones (no logs). The summary statistics and predictive regressions for arithmetic growth rates and yields are included in the appendix.

arbitrage, the spot price and the forward price are linked through the nominal bond yield:[4]

$$F_{t,n} = P_{t,n}\exp(ny_{t,n}). \tag{6}$$

We then define the forward equity yield $e^f_{t,n}$ as:

$$e^f_{t,n} \equiv \frac{1}{n}\ln\left(\frac{D_t}{F_{t,n}}\right) = \theta_{t,n} - g_{t,n}. \tag{7}$$

The forward equity yield is equal to the difference between the risk premium and the expected dividend growth rate. If the forward equity yield is high, this either implies that risk premia are high, or that expected dividend growth rates are low.

Next, we derive the investment strategy that is required to earn the risk premium $\theta_{t,n}$. It can be earned by buying (going long in) the $n$-period forward 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:

$$r^D_{t+n} = \ln\left(\frac{D_{t+n}}{F_{t,n}}\right) = \ln\left(\frac{D_{t+n}}{D_t}\right) + \ln\left(\frac{D_t}{F_{t,n}}\right) \tag{8}$$

Because the forward price is known at time $t$, but paid at time $t+n$, this is a zero-cost strategy, and no money is exchanged at time $t$. The expected return on this strategy is given by:

$$E_t\left[r^D_{t+n}\right] = E_t\left[\ln\left(\frac{D_{t+n}}{D_t}\right) + \ln\left(\frac{D_t}{F_{t,n}}\right)\right] = n\theta_{t,n}.$$

As with all forward and 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 (see for example Binsbergen, Brandt, and Koijen (2011)).[5] Further, $\theta_{t,n}$ is the risk premium earned when the investment horizon is equal to the maturity of the

[4]This no-arbitrage relationship holds for non-dividend paying assets. At first sight this may be confusing, as the focus of the paper is on dividends. 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 6 is the appropriate formula.

[5]In addition, Binsbergen, Brandt, and Koijen (2011) report simple returns, not log returns.

futures contract $n$. 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.[6]

The current size of the exchange-traded dividend futures 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 futures contract on the DJ Eurostoxx 50 was $1.7 billion. The open interest in the Dec 2011 contract was $2.5 billion. 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.[7] 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 is 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 numerator in equation (7). For example, if we want to compute the equity yields on October 15th 2010, we use as the numerator 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 dividend futures price as the current dividend level refer to a whole year of dividends.

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[6]Exchange-traded dividend futures are also available for the FTSE 100 index in the United Kingdom, the HSI and HSCEI indices in Hong Kong, for the AEX index in the Netherlands, and for Russian energy companies. Finally, individual stock dividend futures are also available for all constituents of the Eurostoxx 50 index and 13 UK underlyings.

[7]Over time, the share of special dividends as a fraction of total dividends, has decreased and is negligible for the sample period that we consider, see DeAngelo, DeAngelo, and Skinner (2000).

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

The forward 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 yields for four different horizons: 1, 2, 5, and 7 years. The graph shows that between 2003 and 2007, short-maturity yields were lower than long-maturity yields. During the financial crisis this pattern reversed and short-maturity yields sharply increased compared to long-maturity yields. However, long-maturity yields also increased substantially during this period. This implies that expected growth rates went down and/or risk premia went up, both for the short run and the long run.

The 1-year forward equity yield for the S&P500 index displays a double peak, the first occurring on December 15th 2008 and the second occurring on March 4th of 2009, with values of 29.3% and 35.5%, respectively. During this sample period, the S&P 500 index level 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. On March 4th, the 2-, 5-, and 7-year yields have values of 29.6%, 10.6% and 6.9% respectively. Finally, a very steep increase in the 1-year rate occurred in October 2008 when the rate increased from 6.6% on October 1st to 28.0% 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 yields increase further between October 30th 2008 and November 20th 2008 when the index dropped another 22% from 968.8 to 752.44, but short-maturity yields, stay roughly constant. This suggests that during the month of October 2008 predominantly short-term expectations were adjusted downwards, whereas in November, financial market participants realized that the financial crisis was going to last a long time.

### 2.2.2 Equity yields of the Eurostoxx 50 Index

In Figure 2, we plot the forward equity yields for the Eurostoxx 50 index. As before, the four lines in each graph represent four horizons: 1, 2, 5, and 7 years. The peak of the 1-year yield occurs on March 30th 2009 with a yield of 53.4%. Similar to the S&P 500 index, the peak of the 1-year yield occurred after the trough of the index level, 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 yield. As with the S&P500 index, there is one particular period of a very steep increase for the 1-year yield. Between October 1st and October 24th 2008 this yield increased from 8.8% to 50.5%.

### 2.2.3 Equity yields of the Nikkei 225

In Figure 3, we plot the forward equity yields for the Nikkei 225 index. The peak of the 1-year yield occurs on March 25th 2009 with a value of 58.5%. The index reached its trough on March 10th 2009 with an index level of 7055.0, which (like the other two indices) is before the 1-year yield reached its peak.

Between October 1st and October 30th 2008, the 1-year yield increased from 5.6% to 29.6%. Apart from this steep increase, there is no particular period over which the yield increased abruptly and the yield drifts upward gradually to its peak of 58.5%. There is also a marked increase by the end of the sample as a consequence of the earthquake and tsunami in March 2011 as further discussed in Section 6.3.

### 2.2.4 Summary statistics of the forward equity yields for all three markets

We report in Table 1 the summary statistics of the forward equity yields for all three indices and for all ten maturities. The average 1-year yield is highest for Europe (2.4%) and lowest for Japan (-3.6%). The average 1-year yield for the US is -2.8%. The average 7-year yield is -2.5% for the US, -2.4% for Japan and 0.7% for Europe.

The volatilities of the yields decline monotonically with maturity for all three indices, similar to bond yields (see for instance Dai and Singleton (2003)). The volatility of yields is highest for Japan and lowest for the US at all maturities. Further, over this sample period the yields are positively skewed, which is induced by the large positive 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). For real yields[8] and credit spreads, we use data from 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.

[8] See http://www.federalreserve.gov/econresdata/researchdata.htm.

# 3 Dividend Growth Predictability and Risk Premia

In this section we explore to what extent forward equity yields can be used to predict realized 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 forward equity yields are equal to the difference between a risk premium component and expected dividend growth rates, they are natural candidates to predict dividend growth. In Section 3.2 we use a Bayesian Model Averaging (BMA) approach to compare the performance of forward equity yields to a set of linear prediction models that are commonly used in the empirical literature to predict economic growth. Once we obtain a time series of expected dividend growth from one or more prediction models, it is then straightforward to back out the risk premium component, see equation (7).

## 3.1 Dividend Growth Predictability and Equity Yields

We first run a set of univariate regressions to explore the predictability of dividend growth by forward equity yields. 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 run the following regressions for $n = 1, .., 5$:

$$\Delta d_{t+12} = \alpha_n - \beta_n e^f_{t,n} + \varepsilon_{d,t+12}, \tag{9}$$

where:

$$\Delta d_{t+12} \equiv \ln\left(\frac{\sum_{i=1}^{12} D_{t+i}}{\sum_{i=1}^{12} D_{t-12+i}}\right). \tag{10}$$

The realized growth rate $\Delta d_{t+12}$ is based on the summed dividends within the year, which is also the measure of aggregate annual dividends the futures contract is based upon.[9] We regress the growth rates on $-e^f_{t,n}$ so that if the risk premium on the 1-year equity yield is constant, the regression slope $\beta_1 = 1$. Put differently, a deviation of $\beta_1$ from 1 implies that the risk premium embedded in the 1-year forward equity yield is time-varying.

[9]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.

The results are presented in the second through fourth column of Table 2. The first column reports the point estimate. The second column reports the Hansen and Hodrick (1980) standard errors. The final column reports the R-squared value. We find that all forward 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 rates are strongly predictable, at least during this sample period. The R-squared value of the regression monotonically decrease with the maturity of the yields.

Second, we find that the absolute size of the predictive coefficients is decreasing 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 zero and one-period expected dividend growth is an AR(1) process with autoregressive coefficient $\rho$, then it is straightforward to show that:

$$\beta_n \simeq \frac{n(1-\rho)}{1-\rho^n}. \tag{11}$$

This expression directly implies $\beta_1 = 1$, as discussed before. We can also solve for $\rho$ for $n = 5$ given $\beta_5 = 1.9$. This corresponds to an annual autoregressive coefficient of $\rho = 0.67$. This illustrates how the cross-section of predictive coefficients can be informative about the persistence of $g_{t,n}$.

Because we use log dividend growth rates and log yields, one may be worried that some of our predictability results are driven by time-varying volatility. Our conclusions remain unaltered if instead of geometric yields and growth rates we use arithmetic ones (no logs). The summary statistics and predictive regressions for arithmetic growth rates and yields are included in the appendix.

## 3.2 Bayesian Model Averaging

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.[10] To formally assess the value forward 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

[10]See Stock and Watson (1989), Stock and Watson (2000), Stock and Watson (2003), Ang and Monika Piazzesi (2006), Faust, Gilchrist, Wright, and Zakrajsek (2011) and many others.

in time using a Bayesian model averaging (BMA) approach.[11] 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 time series of forward equity yields that appear to predict growth well.

We will explore bivariate regressions. The main reason to include two (or more) yields is that forward 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 yield. If the risk premium variation across yields of different maturities is correlated, putting multiple yields in the regression will improve the forecasting power.[12]

We follow Fernandez, Ley, and Steel (2001) and Wright (2008) and the references therein, and consider a set of $k$ linear models $M_1, ...M_k$. We will predominantly focus on models with two forecasting variables. Let the $i^{th}$ linear model be given by:

$$\Delta d_{t+12} = \beta_i z_{i,t} + \varepsilon_{d,t+12}, \tag{12}$$

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:

$$\pi(M_i|X_s) = \frac{\pi(X_s|M_i)\,\pi(M_i)}{\sum_{i=1}^{k}\pi(X_s|M_i)\,\pi(M_i)}. \tag{13}$$

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

$$\pi(M_i) = \frac{1}{k}. \tag{14}$$

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

[11]See among others Min and Zellner (1993), Fernandez, Ley, and Steel (2001), Cremers (2002) and Wright (2008).

[12]See also Fama (1984) for exchange rates and Stambaugh (1988) and Cochrane and Piazzesi (2005) for bonds.

$1/\sigma$. Finally, motivated by the fact that we use overlapping data, we use an MA-structure for $\varepsilon_t$:

$$\operatorname{cov}\left(\varepsilon_t, \varepsilon_{t-j}\right) = \sigma^2 \frac{h-j}{h}, \tag{15}$$

where $h$ measures the amount of overlap in the data, that is, $h = 12$ for monthly data, and $h = 4$ for quarterly data (Wright (2008)). Under these assumptions, the likelihood of the data up until time $s$, denoted by $X_s$, given the model, is given by:

$$\pi\left(X_s | M_i\right) = \frac{\Gamma(s/2)}{\sqrt[2]{\pi}} (1+\phi)^{-p/2} H_i^{-s/h}, \tag{16}$$

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

$$H_i^2 = \Delta d' \Delta d - \Delta d' z_i (z_i' z_i)^{-1} z_i' \Delta d \frac{\phi}{1+\phi}, \tag{17}$$

where $\Delta d \equiv (\Delta d_1, ..., \Delta d_s)'$ 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. 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 forward equity yields when predicting dividend growth. Put differently, this assumption works against the model with forward 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 ($i = 1$) uses two forward equity yields as the predictors: the 2-year ($n = 2$) and the 5-year ($n = 5$) yields:

$$z_{1,t} = \left[ e_{t,2}^f \;\; e_{t,5}^f \right]'. \tag{18}$$

The second model ($i = 2$) has two bond yields (the 2-year and the 5-year bond yield):

$$z_{2,t} = \left[ y_{t,2} \quad y_{t,5} \right]' . \tag{19}$$

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 forward equity yields, the data starts in October 2002, indicated by the vertical black line. Even though for forward 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, forward equity yields do receive the penalty for 2 regressors, despite the fact that for all subsamples before 2002 no data is available.[13] 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 4. 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 two forward 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 forward 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 forward equity yields. The investor knows that one of these two models is the true model. The results are presented in Figure 5. The vertical line shows the point at which data for forward equity yields becomes available (October 2002). Because the penalty parameter $p$ is set to a value of 2 for the model with two forward 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 forward equity yields model to the left of the vertical line. However, as soon as data for forward equity yields becomes available, this model quickly takes over. At the end of our sample the posterior

[13] As before, this assumption works against the model with forward equity yields. Relaxing this assumption would make our findings stronger.

probability of the model with two forward 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 forward equity yields, will choose the latter.

### 3.3 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 two forward 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 very small compared to the forward equity yield specification, it seems reasonable to proceed with just forward equity yields.[14]

Let $x$ denote the vector of the 2-year and 5-year equity yields:

$$x_t = \begin{bmatrix} e^f_{t,2} & e^f_{t,5} \end{bmatrix}'. \tag{20}$$

Our model for expected dividend growth is then given by:

$$g_{t,n} = E_t\left(\Delta d_{t+12}\right) = \psi_0 + \psi_1' x_t, \tag{21}$$

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 forward equity yields relate to expected growth rates and the risk premium component as follows:

$$e^f_{t,n} \equiv \theta_{t,n} - g_{t,n}. \tag{22}$$

Rewriting this equation we find:

$$\theta_{t,n} = e^f_{t,n} + g_{t,n}. \tag{23}$$

To compute $n$-year risk premia (where $n > 1$), we need $n$-year growth expectations $g_{t,n}$. To compute these expectations, we model the time-series dynamics of forward equity

[14] 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 forward equity yields, any estimate of expected dividend growth can be combined with the yields to arrive at an estimate of the risk premium.

yields as a first-order vector autoregressive (VAR) model:

$$x_{t+1} = \mu + \Gamma x_t + \varepsilon_{t+1}. \tag{24}$$

The monthly VAR model implies an annual VAR model:

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

where:

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

As before, we estimate the parameters using OLS.

Using the joint dynamics for dividend growth from (21) and the forward equity yields (24), we can compute the conditional expectation of 1-year dividend growth as:

$$\begin{aligned} E_t \left( \Delta d_{t+12} \right) &= \psi_0 + \psi_1' x_t \\ &\equiv \gamma_{0(1)} + \gamma_{1(1)}' x_t. \end{aligned}$$

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

$$\begin{aligned} E_t \left( \Delta d_{t+12n} \right) &= E_t \left( \psi_0 + \psi_1' x_{t+12(n-1)} \right) \\ &= \psi_0 + \psi_1' \left( \left[ \sum_{i=0}^{n-2} \Gamma_A^i \right] \mu_A + \Gamma_A^{(n-1)} x_t \right) \equiv \gamma_{0(n)} + \gamma_{1(n)}' x_t. \end{aligned}$$

The forward equity yield can now be written as:

$$\begin{aligned} e_{t,n}^f &= \theta_{t,n} - g_{t,n} \\ &= \theta_{t,n} - \frac{1}{n} \sum_{i=1}^{n} \left( \gamma_{0(n)} + \gamma_{1(n)}' x_t \right). \end{aligned}$$

We observe the left-hand side, $e_{t,n}^f$, and we estimate the second term on the right-hand side using the VAR. This results in an estimate for the risk premium, $\theta_{t,n}$ for all maturities $n$.

The results are presented in the top panel of Figure of 6, 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 about same and equal to 2.8% per year for the 2-year yield and 3.1% per year for the 5-year yield.[15]

We find that the risk premium estimates fluctuate substantially over time. In fact, the estimates imply that the short-term risk premium component fluctuates more than the longer-maturity component.[16] 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 (2011) already suggest that the risk premium component on the short-maturity dividend claims is on average higher than on the long-maturity dividend claims.[17] 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 7, we decompose the 2-year forward 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.

### 3.4 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 we find for the S&P500 index. The univariate predictability results are presented in panels B and C of Table 2. As is the case for the S&P 500 index, dividend growth seems strongly predictable, with R-squared values above 60%. The risk premia, shown in the second and third panel of figure 6, vary strongly over time and are always positive. The average value of the risk premia is

[15]The number for the 2-year (annualized) risk premium is lower than the annualized average simple monthly returns on 1.5 year dividend strips reported in Binsbergen, Brandt and Koijen (2011). This difference can be explained as follows. First, because $\theta_{t,n}$ is a geometric risk premia (logs), there is a Jensen term that makes the average simple return higher. Secondly, the risk premium $\theta_{t,n}$ does not include the bond risk premium. The average simple excess return on two-year bonds equals 9bp per month over this sample period, which in annualized terms adds up to more than a percent. To further explore the difference, we compute the simple monthly return on a return strategy where we go long in the 2-year dividend futures contract, hold this contract for a year (when the maturity of the futures has decreased from 2 years to 1 year) and then go long in the new 2-year dividend futures contract until we reach the end of our sample. As argued before, because we are investing in futures contracts, this return is already an excess return in excess of bonds. We find that the average excess return on this strategy over this sample period is 71 basis points per month, consistent with the results in Binsbergen, Brandt and Koijen (2011).

[16]The 2-year risk premium turns somewhat negative during the period 2006-2007. 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).

[17]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).

high and higher than for the US. For Europe the average risk premium is 9.1% for the 2-year contract and 8.5% for the 5-year contract. For Japan, the average risk premium is 6.1% for the 2-year contract and 5.6% for the 5-year 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 yields into expected growth rates and risk premia is presented in the middle and bottom panels of Figure 7. As for the S&P 500 index, forward equity yields seem to vary both due to risk premium fluctuations as well as due to variation in expected dividend growth.

# 4 Consumption Growth

## 4.1 Dividends, Consumption and GNP

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 8 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 9. 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.

## 4.2 Univariate Regressions

The previous results show that our newly-constructed data set of forward equity yields is useful in forecasting future dividend growth. We now extend these results for the US and show that S&P500 forward 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:

$$\Delta c_{t+4} = \ln\left(\frac{\sum_{i=1}^{4} C_{t+i}}{\sum_{i=1}^{4} C_{t-4+i}}\right), \tag{25}$$

where $C_t$ is real quarterly consumption of nondurables and services. We run the regressions:

$$\Delta c_{t+4} = \alpha_n - \beta_n e^f_{t,n} + \varepsilon_{c,t+4}, \tag{26}$$

We present the results in Panel A of Table 3. The structure of the table is the same in Table 2. Consistent with our results for dividend growth predictability, we uncover predictability of 1-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 yields are less exposed to fluctuations in short-term expected growth rates.

As a point of reference, we use in Panel B of Table 3 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 forward equity yields as reported in Panel A. In Panel C, we show that even using real bond yields, we do not uncover strong predictability. Even though the yield spread is statistically significant, the R-squared values are low.

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 equity 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 as 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 (and forward equity yields) are not subject do these concerns. Equity yields rise during recessions and are unrestricted in their sign.

### 4.3 Bayesian Model Averaging

We then apply the BMA approach to consumption growth. We use the exact same setup as in Section 3.2, but now use consumption growth as the left-hand-side variable. As before, we take a conservative approach with respect to forward 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 forward equity yields. That is, we perform the thought experiment where an agent has to choose in real time between a model in which consumption growth is unpredictable, and a model where consumption growth is predictable by two forward equity yields. The investor knows that one of these two models is the true model. The results are presented in Figure 10. As before, the vertical black line shows the point at which data for forward equity yields becomes available (2002). Because the penalty parameter $p$ is set to a value of 2 for the model with forward 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 forward equity yields model before 2002. However, as soon as data for forward equity yields becomes available, this model takes over. At the end of our sample the posterior probability of the model with two forward equity yields increases from 0.33 to 0.60, and the random walk model changes from a probability of 0.67 to 0.40. Note that this change is not as large as the change for dividend growth in the previous section, but it does suggest that forward 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 11. 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 forward equity yields model is the correct one decreases to as low as 4.9%. After 2002, when data for forward equity yields becomes available this probability more than doubles to 12.8%. It thereby outperforms both the model with two 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 forward 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 in 2011.

# 5 Do Equity Yields Contain Other Information Than Bond Yields?

To assess whether forward 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 forward equity yields on these principal components.[18] 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 capture d 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-squared 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-squared values, never exceeding 5%. When we include the first two principal components of real yields and the first two principal components of nominal yields in one regression (four regressors), the R-squared values jump up to 75% for the 1-year forward equity yield, and 60% for the 5-year forward equity yield. This still leaves a substantial fraction of the variation in forward equity yields that is unexplained by the term structure of interest rates.

To further assess the relation between bond yields and forward equity yields, Table 5 describes the correlations between the first two principal components of forward equity yields, the first two principal components of nominal bond yields and the first two principal components of real bond yields. We find that the first principal component of forward equity yields seem generally negatively correlated with nominal bond yields, but positively correlated with real yields, both in levels as in innovations.

[18] An advantage of using principal components is that they are less sensitive to measurement error than individual yields.

# 6 Applications

## 6.1 Economic Outlook Around the World

We now use the framework we develop in Section 3.3 to compute longer-term growth expectations. As before, instead of using a single equity yield, we use two forward equity yields with maturities equal to 2 and 5 years, respectively. As argued before, 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).[19]

In Figure 12, 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.

In Figures 13 and 14 we plot the term structures of forward equity yields and expected dividend growth rates on March 31st 2011 for all three regions. The term structure of equity yields and expected growth for the US and Europe are downward sloping, suggesting that dividends are expected to grow faster in the short run than the long run, presumably as a consequence of the recovery of the steep decline in dividends in 2008 and 2009. Due to the earthquake in Japan, the term structure of expected growth in Japan is upward sloping, implying that dividends are expected to grow slower in the short run than in the long run. Just before the earthquake this term structure was also downward sloping.

## 6.2 Growth Expectations and the Financial Crisis

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

### 6.2.1 November 2007

Between October 31st and November 30th 2007, the 1-year forward equity yield for the S&P500 index increased from -9.0% to -2.6%. The 5-year yield increased from -5.4% to

[19]Other examples include Croce, Lettau, and Ludvigson (2009) and Bekaert, Engstrom, and Xing (2009).

-3.6%, the 10-year equity yield increased from -4.1% to -3.2% and the index value changed from 1549.4 to 1469.7, a drop of 5%. During this period the following important economic 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.[20] By the end of that day, Citigroup shares had dropped 8%, and four days later, Citigroup CEO Chuck Prince resigned. Second, on October 31st, the FOMC lowered the target rate by 25bp to 4.5%. Third, November 2nd the Fed approved the Basel II accord. Fourth, 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."

### 6.2.2 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, forward equity yields for the US did not change all that much in September for all maturities. As an illustration, the 1-year yield was 6.4% on September 1st and 6.3% 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 increased from 4.0% to 8.2%, and the 10-year yield increased from 0.8% to 1.8%. For Japan, the 1-year yield increased from -5.4% to 4.7% and the 10-year yield increased from -2.0% to -0.1%.

### 6.2.3 October 2008

During the month of October 2008, the 1-year yield in the US increased from 6.6% on October 1st to 26.0% on October 31st. Over the same period, the 2-year yield increased from 3.5% to 16.2%, the 5-year yield increased from 0.5% to 4.8%, and the 10-year rate increased from 0.1% to 1.4%. Several major events happen during this time period. Interestingly, we find that the one of the largest drops in the 1-year equity yield occurred shortly after former Federal Reserve chairman Alan Greenspan testified before the House

[20] See "The Big Short" (Lewis (2010)).

Committee of Government Oversight and Reform.

### 6.3 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. Equity yields for all maturities increased each day from Monday the 14th to Thursday the 17th of March, to recover slightly on the joint G-7 intervention on Friday the 18th. The 1-year equity yield increased from -3.3% to 6.9% in the first four days, to rebound to 5.2% on Friday March 18th (the G-7 intervention). Similarly, the 2-year equity yield dropped from -1.4% to 4.8% to settle at 4.3%. Even the 7-year equity yield changed from -0.1% to 2.3% and eventually settled at 1.9% on the 18th. This indicates that financial markets expected a long-lasting influence on the Japanese economy. The US and Europe were much less affected by the Japanese situation, which illustrates that financial markets view these events as largely Japan-specific, rather than having an impact on global growth.

The equity yields for Europe seem largely unaltered by the events. During this period, the short-term yields of the US slightly lowered, but the long-term yields are unaffected. It is unclear whether this can be attributed to the crisis in Japan.

## 7 Conclusion

We use a new data set on traded dividends of three major stock indices with maturities up to 10 years 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. 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.

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| Maturity in years | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **S&P500 Index (Oct 2002 - Mar 2011)** | | | | | | | |
| Mean | -0.0281 | -0.0258 | -0.0266 | -0.0269 | -0.0265 | -0.0258 | -0.0254 |
| Stdev | 0.1026 | 0.0807 | 0.0578 | 0.0467 | 0.0398 | 0.0352 | 0.0323 |
| Median | -0.0620 | -0.0510 | -0.0408 | -0.0384 | -0.0336 | -0.0293 | -0.0248 |
| Min | -0.1601 | -0.1297 | -0.1293 | -0.1074 | -0.1019 | -0.0960 | -0.0891 |
| Max | 0.3547 | 0.2956 | 0.1896 | 0.1360 | 0.1055 | 0.0840 | 0.0695 |
| **DJ Eurostoxx 50 Index (Oct 2002 - Mar 2011)** | | | | | | | |
| mean | 0.0238 | 0.0303 | 0.0206 | 0.0148 | 0.0108 | 0.0097 | 0.0073 |
| stdev | 0.1619 | 0.1432 | 0.1005 | 0.0759 | 0.0606 | 0.0509 | 0.0434 |
| median | -0.0206 | 0.0038 | 0.0032 | 0.0077 | 0.0083 | 0.0098 | 0.0092 |
| min | -0.2389 | -0.1923 | -0.1510 | -0.1252 | -0.1088 | -0.1001 | -0.0862 |
| max | 0.5412 | 0.5467 | 0.3742 | 0.2772 | 0.2185 | 0.1792 | 0.1497 |
| **Nikkei 225 Index (Jan 2003 - Mar 2011)** | | | | | | | |
| mean | -0.0356 | -0.0234 | -0.0237 | -0.0245 | -0.0250 | -0.0247 | -0.0242 |
| stdev | 0.1854 | 0.1543 | 0.1134 | 0.0902 | 0.0753 | 0.0646 | 0.0559 |
| median | -0.0368 | -0.0253 | -0.0182 | -0.0129 | -0.0100 | -0.0091 | -0.0095 |
| min | -0.2979 | -0.2267 | -0.1936 | -0.1674 | -0.1493 | -0.1316 | -0.1161 |
| max | 0.5850 | 0.5356 | 0.3670 | 0.2621 | 0.1997 | 0.1576 | 0.1285 |

Table 1: Summary statistics forward equity yields

| | S&P500 | | | EuroStoxx 50 | | | Nikkei 225 | | |
|---|---|---|---|---|---|---|---|---|---|
| $n$ | $\beta_n$ | t-statistic | $R^2$ | $\beta_n$ | t-statistic | $R^2$ | $\beta_n$ | t-statistic | $R^2$ |
| 1 | 0.88 | 7.36 | 76% | 0.93 | 8.28 | 73% | 0.63 | 5.16 | 65% |
| 2 | 1.09 | 5.87 | 70% | 1.01 | 7.55 | 69% | 0.76 | 5.63 | 65% |
| 3 | 1.40 | 5.29 | 60% | 1.44 | 7.42 | 69% | 1.03 | 5.72 | 64% |
| 4 | 1.66 | 4.75 | 54% | 1.87 | 7.10 | 66% | 1.29 | 5.61 | 63% |
| 5 | 1.86 | 4.16 | 48% | 2.29 | 6.78 | 62% | 1.53 | 5.45 | 62% |

Table 2: Predictability of annual dividend growth by forward equity yields, using univariate regressions with one forward equity yield of maturity $n$ on the right-hand side. The t-statistics are computed using Hansen Hodrick (1980) standard errors.

Panel A: Consumption growth predictability by equity yields

| n | Estimate | t-statistic | $R^2$ |
|---|---|---|---|
| 1 | 0.10 | 5.12 | 40.4% |
| 2 | 0.12 | 5.54 | 38.0% |
| 3 | 0.16 | 4.68 | 30.5% |
| 4 | 0.18 | 3.73 | 25.7% |
| 5 | 0.19 | 3.10 | 21.2% |

Panel B: Consumption growth predictability by nominal bond yields

| | Estimate | t-statistic | $R^2$ |
|---|---|---|---|
| 1-year | 0.19 | 0.90 | 3.9% |
| 5-year | 0.65 | 1.83 | 14.1% |
| 5-1-year | 0.04 | 0.09 | 0.0% |

Panel C: Consumption growth predictability by real bond yields

| | Estimate | t-statistic | $R^2$ |
|---|---|---|---|
| 2-year | -0.21 | -1.12 | 2.3% |
| 5-year | -0.22 | -0.58 | 0.8% |
| 5-2-year | 0.79 | 2.11 | 7.8% |

Table 3: Predictability of consumption growth by forward equity yields (Panel A), nominal bond yields (Panel B) and real bond yields (Panel C) using quarterly observations between December 2002 and March 2011. The t-statistics are computed using Hansen Hodrick (1980) standard errors.

| Maturity | n=1 | n=2 | n=3 | n=4 | n=5 |
|---|---|---|---|---|---|
| Right hand side variables | | | | | |
| PC1 nominal bonds | 0.297 | 0.291 | 0.336 | 0.366 | 0.369 |
| PC1 + PC2 nominal bonds | 0.311 | 0.306 | 0.335 | 0.366 | 0.370 |
| PC1 real bonds | 0.037 | 0.027 | 0.005 | 0.000 | 0.001 |
| PC1 + PC2 real bonds | 0.062 | 0.052 | 0.016 | 0.005 | 0.005 |
| PC1 + PC2 nominal and PC1 + PC2 real bonds | 0.751 | 0.697 | 0.650 | 0.637 | 0.600 |

Table 4: R-squared values of contemporaneous regressions of forward 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.

**Correlations**

**Panel A: Levels**

| | PC1 Eq | PC2 Eq | PC1 Nom B. | PC2 Nom B. | PC1 Real B. | PC2 Real B. |
|---|---|---|---|---|---|---|
| PC1 Equity | 1 | 0 | -0.56 | -0.09 | 0.14 | -0.14 |
| PC2 Equity | | 1 | -0.19 | 0.36 | -0.51 | 0.22 |
| PC1 Nom Bonds | | | 1 | 0 | 0.58 | 0.33 |
| PC2 Nom Bonds | | | | 1 | -0.24 | 0.82 |
| PC1 Real Bonds | | | | | 1 | 0 |
| PC2 Real Bonds | | | | | | 1 |

**Panel B: Innovations**

| | PC1 Eq | PC2 Eq | PC1 Nom B. | PC2 Nom B. | PC1 Real B. | PC2 Real B. |
|---|---|---|---|---|---|---|
| PC1 Equity | 1 | -0.02 | -0.40 | -0.23 | 0.38 | -0.12 |
| PC2 Equity | | 1 | 0.02 | -0.03 | -0.28 | -0.05 |
| PC1 Nom Bonds | | | 1 | 0.72 | 0.20 | 0.62 |
| PC2 Nom Bonds | | | | 1 | 0.20 | 0.72 |
| PC1 Real Bonds | | | | | 1 | 0.02 |
| PC2 Real Bonds | | | | | | 1 |

Table 5: Correlations between principal components. The second principal components are picked in terms of their sign such that they are comparable to a yield curve slope. The Panel A describes correlations in levels, and Panel B describes the correlation in innovations of a VAR(1) model of all six variables.

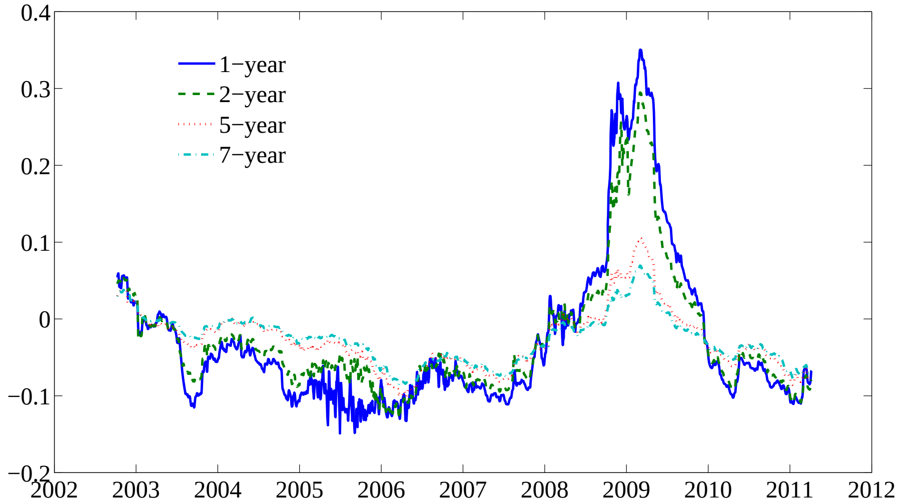



**Figure 1: Forward equity yields: S&P500 Index**
The graph displays the equity yields $e^f_{t,n}$ for $n = 1, 2, 5,$ and 7 years for $t$ varying between October 7th 2002 and April 8th 2011.

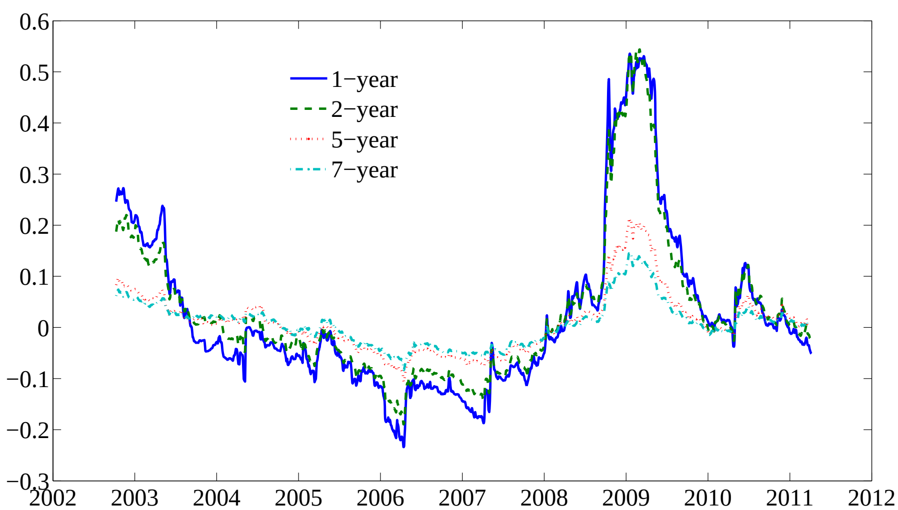



**Figure 2: Forward equity yields: DJ Eurostoxx 50 Index**
The graph displays the equity yields $e^f_{t,n}$ for $n = 1, 2, 5,$ and 7 years for $t$ varying between October 7th 2002 and April 8th 2011.

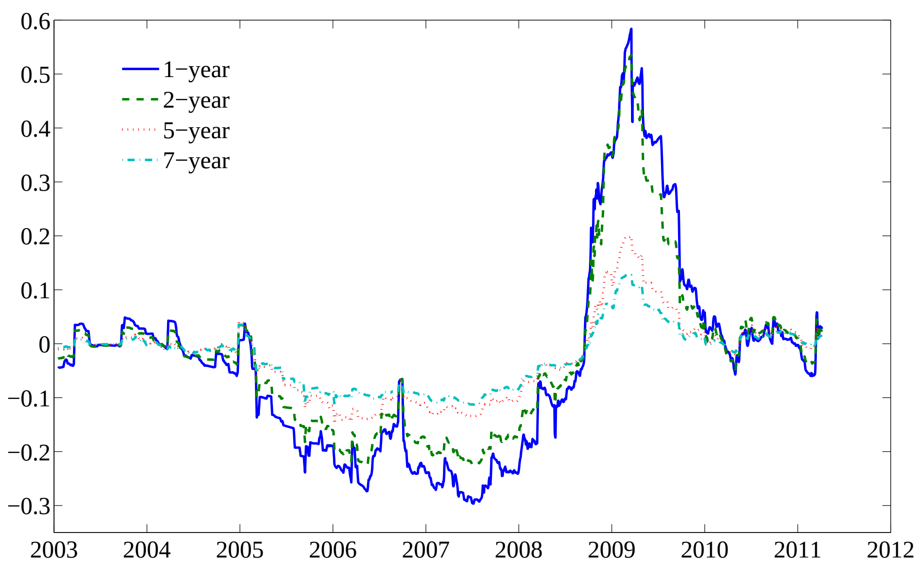



**Figure 3: Forward equity yields: Nikkei 225 Index**
The graph displays the equity yields $e^f_{t,n}$ for $n = 1, 2, 5$, and 7 years for $t$ varying between October 7th 2002 and April 8th 2011.

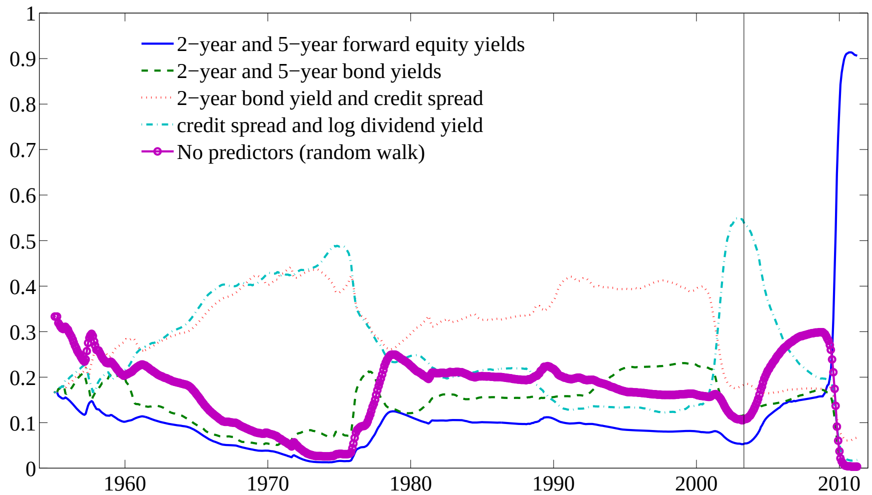



**Figure 4: Posterior probabilities of the Bayesian model averaging approach: Dividends** The graph displays the posterior probabilities of five predictive models of annual dividend growth, using monthly data. The first four models all have two predictor variables ($p = 2$). The first model uses two 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.

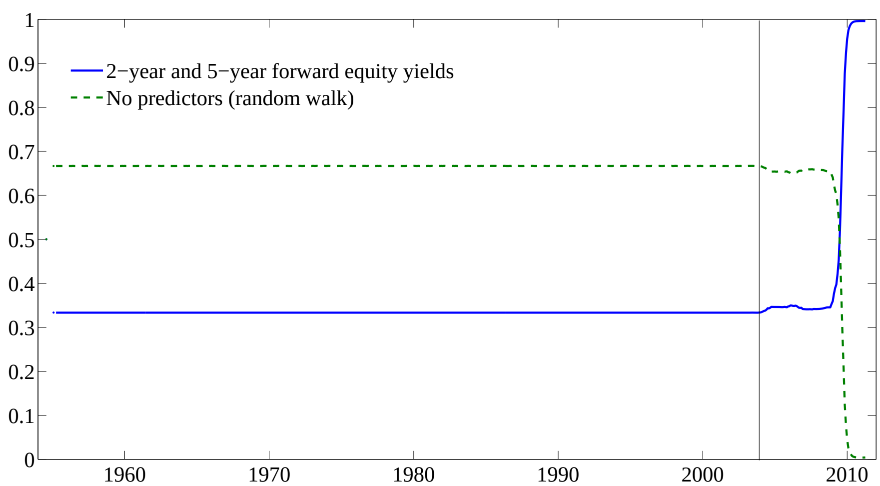



**Figure 5: Posterior probabilities of the Bayesian model averaging approach: Dividends** The graph displays the posterior probabilities of two predictive models of annual dividend growth, using monthly data. The first model uses two equity yields (2-year and 5-year) to predict dividend growth ($p = 2$). The second model has no predictor variables ($p = 0$), which implies a random walk for dividends.

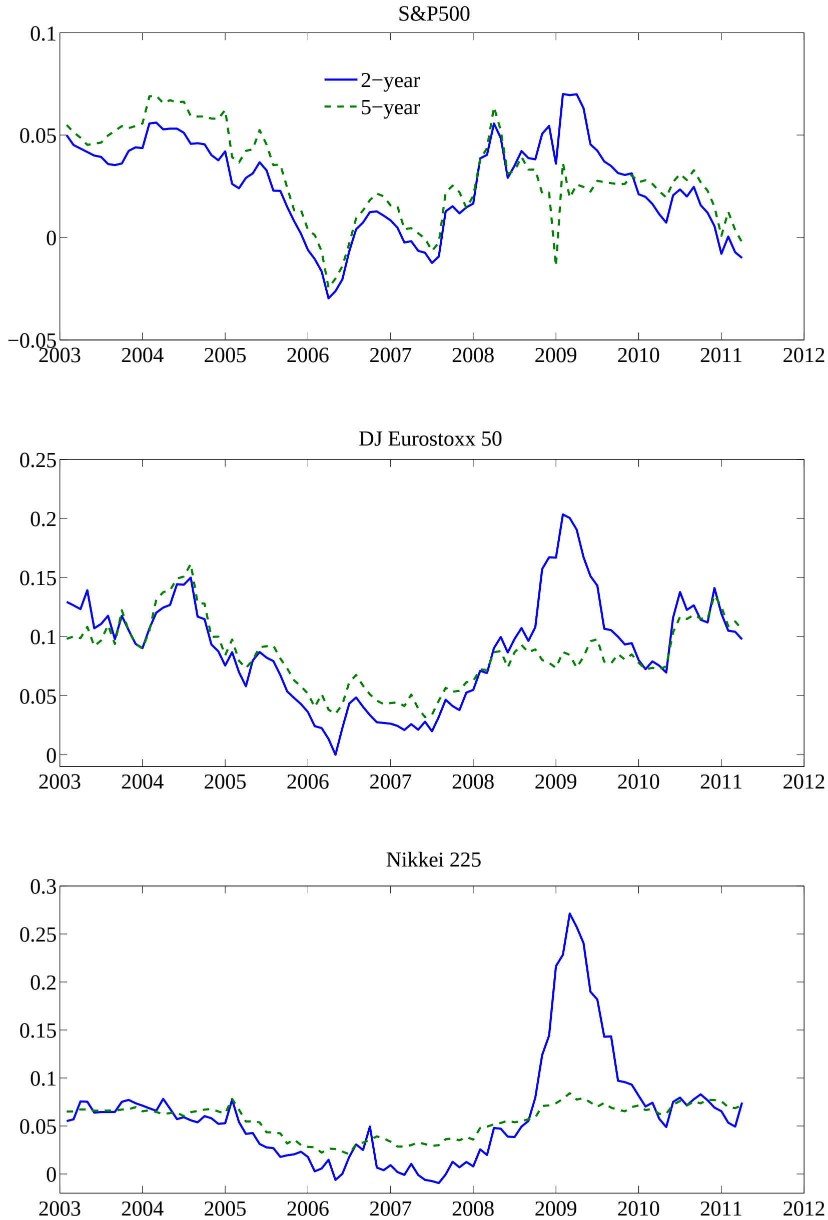



**Figure 6: Risk-premium dynamics across maturities**
The graph displays the risk premium component for the 2-, and 5-year forward equity yields for all three regions.

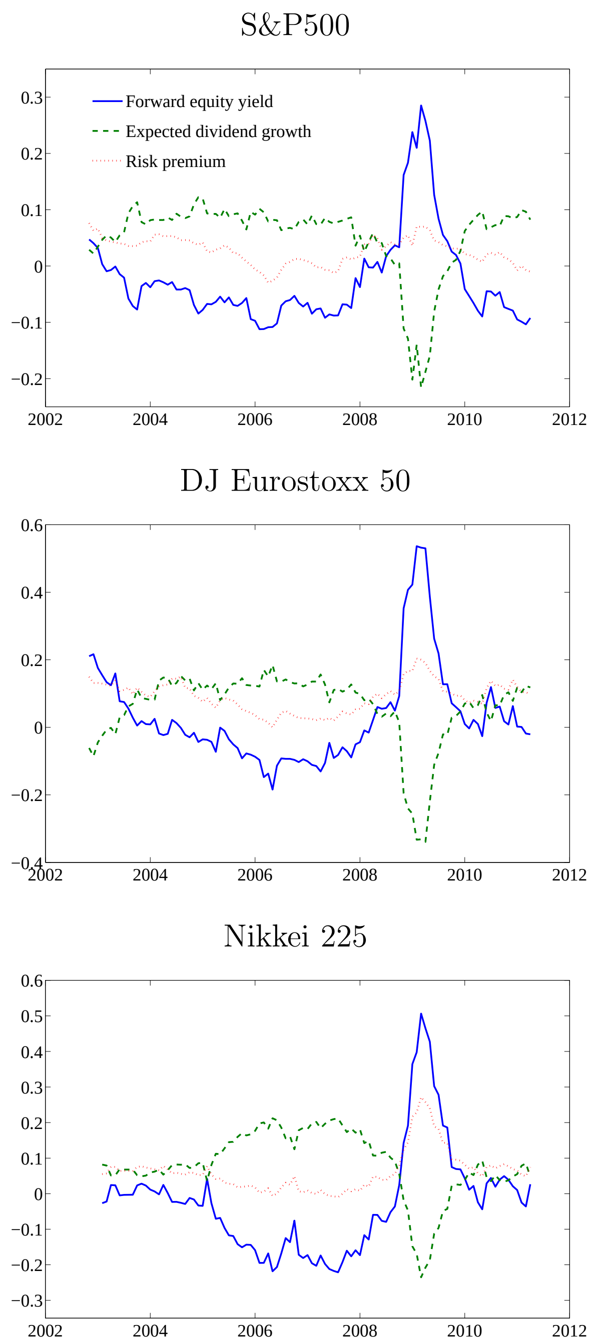



**Figure 7: Decomposition of 2-year forward equity yields**
The top panel decomposes the 2-year forward equity yield of the S&P 500 index into expected dividend growth $g_{t,2}$ and the risk premium component $\theta_{t,2}$. The middle and bottom panel show the same decompositions but for the DJ Eurostoxx 50 and the Nikkei 225.

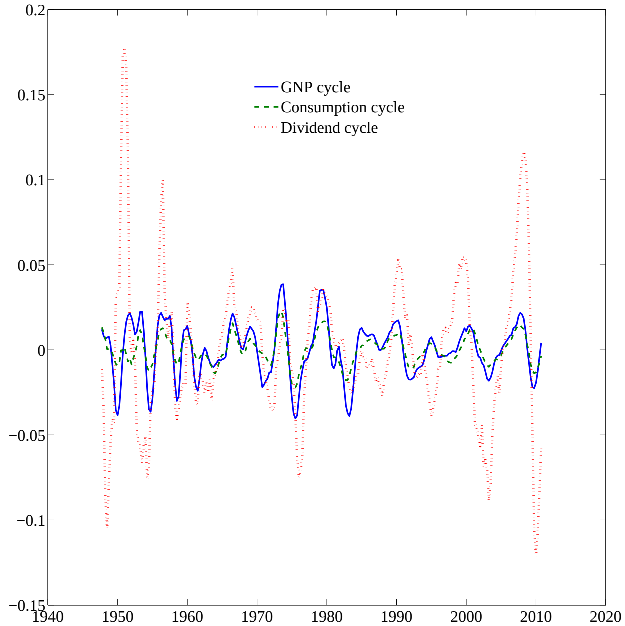



**Figure 8: Cyclical components of GNP, consumption, and dividends**
The graph displays the cyclical residue of Hodrick-Prescott filtered series for real GNP, real consumption (nondurables and services) and dividends.

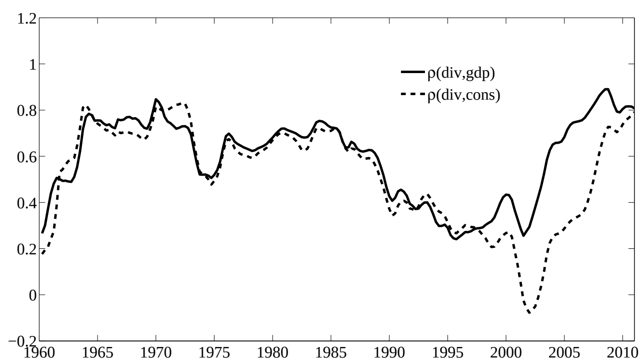



**Figure 9: Rolling correlations between the cyclical components of consumption, GNP, and dividends**
The graph displays the rolling correlation between the cyclical residue of Hodrick-Prescott filtered series for real GNP, real consumption (nondurables and services) and dividends. We use a 10-year window to construct the correlations.

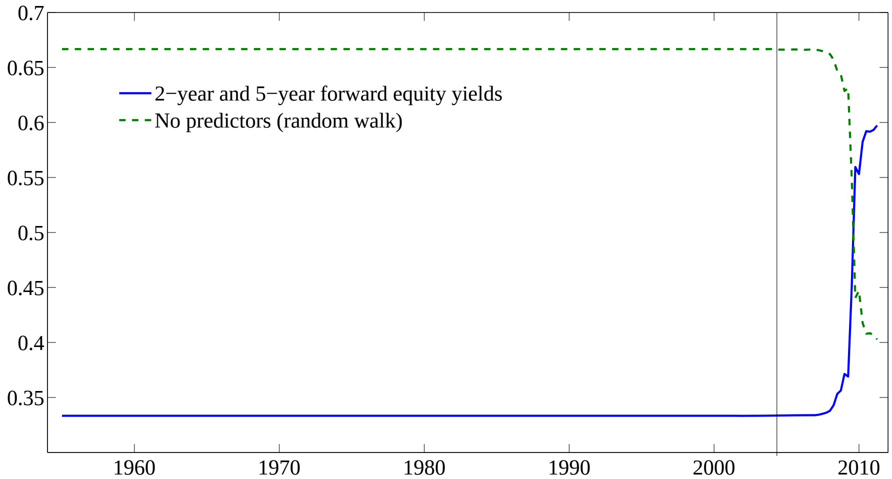



**Figure 10: Posterior probabilities of the Bayesian model averaging approach: Consumption** The graph displays the posterior probabilities of two predictive models of annual consumption growth, using monthly data. The first model uses two forward equity yields (2-year and 5-year) to predict dividend growth ($p = 2$). The second model has no predictor variables ($p = 0$), which implies a random walk for consumption.

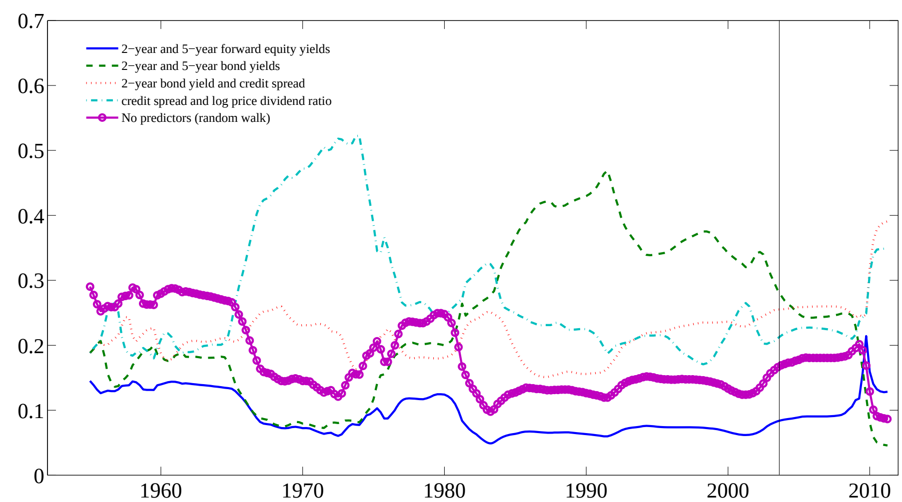
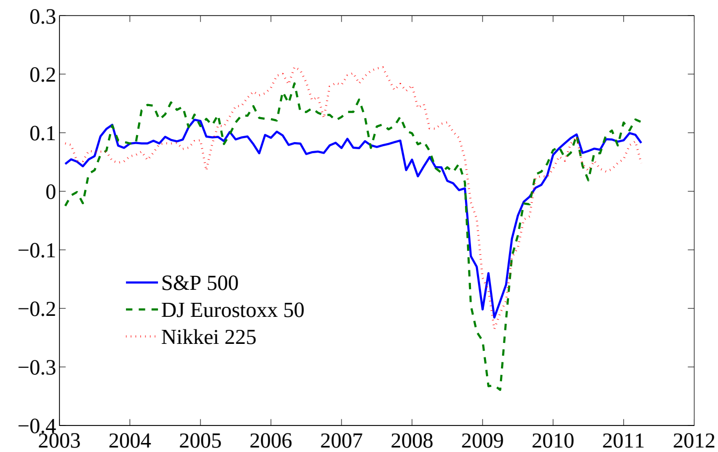



**Figure 11: Posterior probabilities of the Bayesian model averaging approach: Consumption** The graph displays the posterior probabilities of five predictive models of annual consumption growth, using monthly data. The first four models all have two predictor variables ($p = 2$). The first model uses two forward 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.



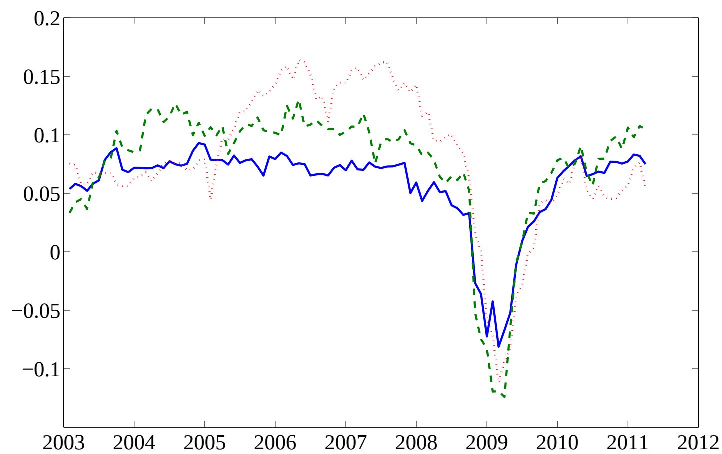




**Figure 12: 2-year and 5-year expected dividend growth across regions**
The graph displays the expected growth rate $g_{t,n}$ for $n = 2$ and 5 years for $t$ varying between January 14th 2003 and April 8th 2011 for three regions: the US (as represented by the S&P500 Index), Europe (as represented by the DJ Eurostoxx 50 index), and Japan (as represented by the Nikkei 225 index).

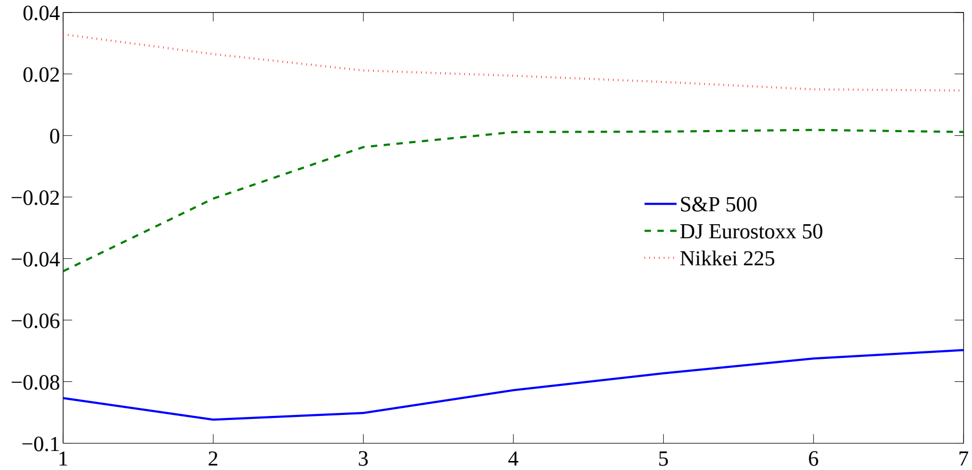



**Figure 13: Term Structure of Forward Equity Yields on March 31st 2011 Across Regions.**

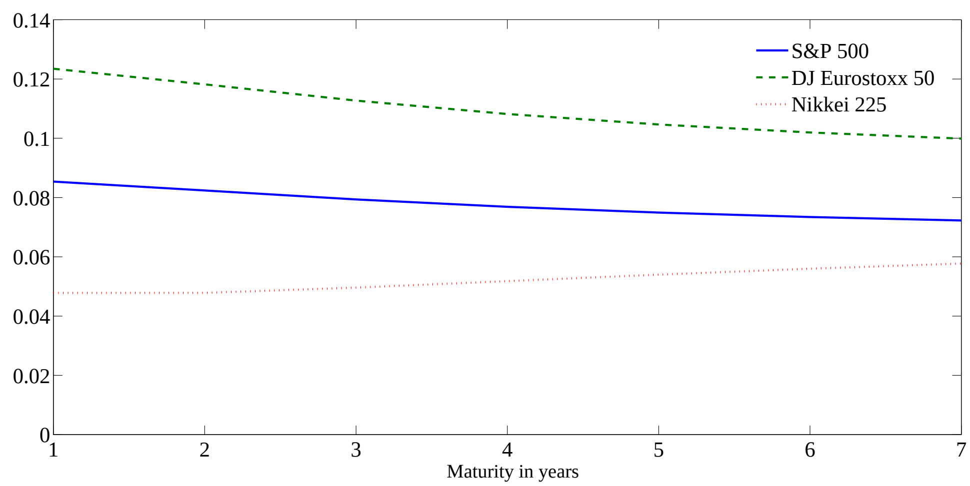



**Figure 14: Term Structure of Forward Equity Yields on March 31st 2011 Across Regions.**

# A APPENDIX NOT FOR PUBLICATION

## A.1 Arithmetic vs geometric returns and growth rates

As noted in the main text, we also compute summary statistics for arithmetic forward equity yields, defined as $\exp(e^f_{t,n}) - 1$. The results are summarized in Table 6.

| Maturity in years | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **S&P500 Index (Oct 2002 - Mar 2011)** | | | | | | | |
| Mean | -0.0224 | -0.0223 | -0.0248 | -0.0256 | -0.0254 | -0.0248 | -0.0246 |
| Stdev | 0.1110 | 0.0856 | 0.0589 | 0.0468 | 0.0395 | 0.0348 | 0.0317 |
| Median | -0.0603 | -0.0499 | -0.0400 | -0.0378 | -0.0330 | -0.0289 | -0.0245 |
| Min | -0.1480 | -0.1216 | -0.1213 | -0.1019 | -0.0969 | -0.0915 | -0.0852 |
| Max | 0.4258 | 0.3439 | 0.2088 | 0.1457 | 0.1113 | 0.0877 | 0.0720 |
| **DJ Eurostoxx 50 Index (Oct 2002 - Mar 2011)** | | | | | | | |
| mean | 0.0385 | 0.0421 | 0.0261 | 0.0178 | 0.0127 | 0.0110 | 0.0083 |
| stdev | 0.1898 | 0.1698 | 0.1115 | 0.0811 | 0.0635 | 0.0527 | 0.0446 |
| median | -0.0208 | 0.0032 | 0.0031 | 0.0074 | 0.0083 | 0.0098 | 0.0093 |
| min | -0.2125 | -0.1749 | -0.1402 | -0.1176 | -0.1031 | -0.0952 | -0.0826 |
| max | 0.7181 | 0.7275 | 0.4538 | 0.3195 | 0.2442 | 0.1962 | 0.1615 |
| **Nikkei 225 Index (Jan 2003 - Mar 2011)** | | | | | | | |
| mean | -0.0171 | -0.0105 | -0.0168 | -0.0201 | -0.0219 | -0.0223 | -0.0223 |
| stdev | 0.2038 | 0.1715 | 0.1190 | 0.0915 | 0.0751 | 0.0639 | 0.0551 |
| median | -0.0361 | -0.0250 | -0.0180 | -0.0129 | -0.0100 | -0.0090 | -0.0095 |
| min | -0.2576 | -0.2028 | -0.1760 | -0.1541 | -0.1386 | -0.1233 | -0.1096 |
| max | 0.7950 | 0.7084 | 0.4434 | 0.2996 | 0.2210 | 0.1707 | 0.1371 |

Table 6: Summary statistics forward equity yields using arithmetic (as opposed to geometric) yields.

Finally, in Table 7 we report predictive regression results of arithmetic dividend growth rates on lagged arithmetic forward equity yields:

$$\exp\left(\Delta d_{t+12}\right) = \alpha_n + \beta_n \exp(-e^f_{t,n}) + \varepsilon_{d,t+12}. \tag{27}$$

| | S&P500 | | | EuroStoxx 50 | | | Nikkei 225 | | |
|---|---|---|---|---|---|---|---|---|---|
| $n$ | $\beta_n$ | t-statistic | $R^2$ | $\beta_n$ | t-statistic | $R^2$ | $\beta_n$ | t-statistic | $R^2$ |
| 1 | 0.91 | 7.52 | 75% | 1.04 | 8.01 | 74% | 0.67 | 5.06 | 65% |
| 2 | 1.11 | 5.84 | 68% | 1.15 | 7.24 | 70% | 0.83 | 5.56 | 65% |
| 3 | 1.36 | 5.02 | 57% | 1.55 | 6.93 | 68% | 1.08 | 5.66 | 64% |
| 4 | 1.59 | 4.45 | 51% | 1.95 | 6.47 | 64% | 1.32 | 5.56 | 64% |
| 5 | 1.75 | 3.90 | 45% | 2.29 | 6.13 | 61% | 1.56 | 5.43 | 63% |

Table 7: Predictability of annual dividend growth (arithmetic) by lagged forward equity yields, using univariate regressions with one forward equity yield of maturity $n$ on the right-hand side. We use arithmetic growth rates and yields. The t-statistics are computed using Hansen Hodrick (1980) standard errors.