A Term Structure of Growth*

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Abstract

We use a new data set on dividend futures 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 show that our growth expectations are important leading indicators of economic growth as measured by GDP growth, consumption growth, and dividend growth. The predictive power of dividend futures outperforms other indicators such as bond yields. We compare the term structures of expected growth before and after the financial crisis and analyze the impact of specific events during the financial crisis. We find that the crisis is accompanied by decreases in both short- and long-term growth expectations for all three regions. The current 10-year nominal growth outlook for the US is substantially higher than that for Europe and Japan.

Keywords: Long and Short-Term Growth Rates, International Economic Outlook

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Expectations about future economic growth are of central importance for the decisions of households, firms, and governments. However, a large empirical literature documents that predicting economic growth, as measured by either GDP growth, consumption growth, or dividend growth, seems challenging.[1] The existing literature has predominantly focused on one-year growth expectations, also because most predictor variables do not have a maturity structure that allows one to uncover expected growth in, for instance, five or ten years from today. So far, arguably the best predictors of future economic activity are variables derived from the term structure of interest rates.

We study a novel data set of dividend futures with maturities up to 10 years across three major world regions: the United States, Europe, and Japan. These data provide expected risk-neutral growth rates of dividends with one-year intervals. We show how to uncover actual dividend growth rates using dividend futures and show that these asset prices are important leading indicators (predictors) of economic growth as measured by GDP growth, consumption growth and dividend growth. The predictive power of dividend futures are superior to alternative measures such as long-term bond yields and the yield spread.

For our analysis, we use a new daily data set between 2002 and 2010 on index dividend futures to uncover risk-adjusted growth expectations over time and across regions. Our main data set comes from several major banks who are important players in the market for dividends, and covers the United States, Europe, and Japan. 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.

The basic structure of a dividend futures contract can be summarized as follows.[2] 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 Eurostoxx 50 index that has been paid out during the 2019 calendar year.[3] Before 2008, index dividend futures and swaps were traded in over-the-counter (OTC) markets. Since

[1] See for instance Campbell and Mankiw (1987), Cochrane (1994), Cochrane and Piazzesi (2005), Lettau and Ludvigson (2005), Cochrane (2008), and Binsbergen and Koijen (2010).

[2] Further details are provided in Section 1.2.

[3] Strictly speaking, it is the dividend amount that is paid on the DJ Eurostoxx 50 index between the third Friday in December in 2018 and the third Friday in December in 2019. Furthermore, in practice only the difference between the two parties is settled, implying that only one payment takes place.

2008, dividend futures are exchange traded for several major indexes in an increasingly liquid market. They are available for every future calendar year with maturities up to ten years.

The term structure of growth rates we present provides a new way of assessing the short-term and long-term influences of specific world events and policy decisions. For example, we can assess how Central Bank monetary policy and government's fiscal policy decisions affect growth expectations of investors across different horizons. As an application of our framework, we study in this paper the time line of the financial crisis and how growth expectations altered as the crisis unfolded. For instance, this allows us to contribute to the debate which event triggered the financial crisis. One view contends that the default of Lehman Brothers was the major event, whereas the alternative view contends that the announcements by (former) policy makers such as Ben Bernanke and Alan Greenspan had a large impact on future growth expectations. Consistent with the second view, we find the largest decline in expected growth rates on the day of a congressional hearing with Alan Greenspan.

More broadly, the term structure we uncover can improve our understanding of the nature of macro-economic shocks. There is a long-standing debate in macro economics and finance to what extent macro-economic shocks are permanent or transitory. Important contributions by Campbell and Mankiw (1987), Campbell and Shiller (1988), and Cochrane (1994) suggest that shocks to dividends and consumption are largely permanent. Such conclusions either follow from higher-order ARMA models or multivariate models of consumption and income, or dividends and asset prices. We enrich the information set to address this question with growth rates implied by dividend growth rates. Our estimates imply a large predictable component in GDP growth, consumption growth, and dividend growth, which suggests that macro-economic shocks may be more transient than implied by estimates based on models not using dividend futures. This has important implications for the design of general equilibrium models that are designed to explain quantities and asset prices.

As expectations about future growth are an important determinant of asset prices, an alternative way to uncover market expectations is to use financial markets data. The level of the stock market over time and across countries is affected by growth prospects of cash flows or dividends and could therefore be informative about such expectations (Campbell and Shiller (1988)). In practice, inferring expected growth rates from aggregate stock market data has turned out to be challenging for several reasons. First, the value of the stock market is influenced by both short and long-term expected growth rates. That is, ceteris paribus, the value of the stock market will go up regardless of whether either short-term or long-term expected growth rates (or both) increase, and a time series model is required when trying to disentangle the two. The mere fact that our data has a maturity structure contains important information about growth rates across different horizons. Second, the valuation and fluctuations of the stock market are not only determined by expected growth rates, but also by time-varying discount rates. This discount rate consists of two parts: a risk free interest rate, which can be observed through the term structure and can therefore be controlled for, and a risk premium component, which is not observable. Empirically, many studies have found that fluctuations of the discount rate seem to dominate when decomposing the variance of stock prices normalized by current dividends (Campbell and Shiller (1988), Cochrane (2008), and Binsbergen and Koijen (2010)).

Most of the stock market literature has either focused on the cross-section of stock returns and cash flows, or on the value of the aggregate stock market, which equals the sum of discounted aggregate cash flows. However, when studying the aggregate market, the individual terms in the sum of discounted dividends, also called dividend strips, provide a wealth of information about growth expectations and discount rates over different horizons. A simple no-arbitrage condition links dividend strip prices to dividend futures prices, requiring a risk-free interest rate as the only additional input. As such, the dividend futures market allows us to break up the index into pieces, and study the properties of the pieces separately. In this paper we focus on studying the risk adjusted growth rates related to each piece and we relate those to the crisis. In Binsbergen, Hueskes, Koijen, and Vrugt (2010) we focus on the return characteristics of dividend strips.

Our paper relates to Binsbergen, Brandt, and Koijen (2010) (BBK hereafter) who use options on the S&P500 index to study the asset pricing properties of short-term dividend strips. Using put-call parity, they uncover the prices of short-term dividend strips with maturities up to three years. They document several return properties for short-term dividend strips in comparison with the aggregate stock market. First, expected returns, volatilities, and Sharpe ratios on short-term strips are on average higher. Second, the slope coefficient (or beta) in the Capital Asset Pricing Model (Sharpe (1964) and Lintner (1965)) of the short-term asset is about 0.5. Third, the CAPM alpha of short-term asset returns is 9% per year, which suggests that the short-term asset has a substantially higher expected return than predicted by the CAPM. Fourth, the prices of the short-term asset are more volatile than their realizations, pointing to excess volatility. Fifth, the returns on the short-term asset are strongly predictable.

For their analysis, BBK use a new dataset on Long-Term Equity Anticipation Securities (LEAPS), which are long-term call and put options, on the S&P500 index. An advantage of using index options is that these derivatives have been exchange-traded since 1996 which allows BBK to study a longer time series. An important disadvantage, however, is that LEAPS have relatively short maturities, up to 3 years. This implies that such contracts can only be used to uncover expected risk-adjusted growth rates for these short maturities. The advantage of our data set is that dividend futures contracts have maturities up to 10 years. In contrast to BBK, who study return properties of dividend strips for the US, we use dividend futures to uncover risk-adjusted expected dividend growth rates across three major regions (the United States, Europe, and Japan).

The paper proceeds as follows. In Section 1 we show how financial market information can be used to uncover risk-adjusted growth rates. We start in the simplified framework of Gordon (1962), which is a deterministic setting with constant growth rates. We then show how we can use dividend strip prices to uncover the term structure of expected growth in a stochastic setting. In Section 2, we discuss our data set. In Section 3 and 4 we present our main empirical results. In Section 5, we discuss the financial crisis. In Section 6 we discuss the current economic outlook in terms of dividends, for the three regions that we study. Section 7 concludes.

1 Financial Markets and Expected Growth Rates

1.1 The Gordon Growth Model and the Aggregate Market

To illustrate in a simplified framework how financial markets can be used to uncover risk-adjusted growth rates, consider the Gordon growth model, which is a deterministic model. The Gordon growth model states that if dividends grow at a rate g and are discounted at a discount rate μ, the current price of the index S_0, which is the present-value of future dividends $(D_{t+n})_{n=1}^{\infty}$, is given by:

$$S_t = \sum_{n=1}^{\infty} \frac{D_{t+n}}{(1+\mu)^n} = D_t \sum_{n=1}^{\infty} \frac{(1+g)^n}{(1+\mu)^n} = \frac{D_{t+1}}{\mu - g}$$

Now define g^* as:

$$g^* \equiv g - (\mu - r) \tag{1}$$

where r is the interest rate. The difference between μ and r is the so-called risk premium. The growth rate g^* is the difference between the actual growth rate g and the risk premium. As subtracting the risk premium can be seen as a risk adjustment, we will call g^* the risk-adjusted growth rate.

We can rewrite Equation (1) as:

$$g^* = r - \frac{D_{t+1}}{S_t}$$

which shows that the risk-adjusted growth rate g^* can be computed using two observable variables: the interest rate and the dividend yield.

In reality, cash flows (or dividends) are stochastic. Furthermore, there is evidence that both risk premia and expected growth rates are time-varying (Binsbergen and Koijen (2010)). Campbell and Shiller (1988) have extended the Gordon growth model to account for variation in (expected) growth rates and expected returns. In line with the intuition of the Gordon growth model, they show that an increase in stock prices, scaled by the current level of dividends, is either due to higher expected dividend growth rates or lower future discounted rates. However, an important question that then arises is whether this increase is due to a revision in short-term or long-term expectations. When studying the aggregate value of the market, short and long-term expectations about growth rates and returns are all lumped together. One way to address this problem is to specify a VAR-model for returns, dividend growth rates and a set of predictor variables. However, this requires assumptions on the correct specification of the VAR. Furthermore, the parameters of the model have to be estimated. In the remainder of this paper, we use a more direct approach. As year-by-year dividends are traded directly in derivative markets, we can uncover risk-adjusted growth rates from those markets.

1.2 Dividend Futures and Dividend Strips

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 Eurostoxx 50 index that has been paid out between the third Friday in December of 2018 and the third Friday in December of 2019.

Let D_{t+n} denote the stochastic dividend paid out in n years from todays 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:

$$P_{t,n} = \frac{E_t \left[D_{t+n}\right]}{\left(1+\mu_{t,n}\right)^n}. \tag{2}$$

Splitting up the discount rate $\mu_{t,n}$ into the interest rate for period n, denoted by $r_{t,n}$, and the risk premium for period n, denoted by $\theta_{t,n}$, we can rewrite equation (2) as:

$$P_{t,n} = \frac{E_t \left[D_{t+n}\right]}{\left(\left(1+r_{t,n}\right)\left(1+\theta_{t,n}\right)\right)^n}. \tag{3}$$

Further, by defining $g_{t,n}$ as the per-period expected growth rate of dividends over the next n periods, we can rewrite expression 3 as:

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

Finally, define the risk-adjusted growth rate as:

$$g^*_{t,n} = \left(\frac{1+g_{t,n}}{1+\theta_{t,n}}\right) - 1.$$

We can compute $g^*_{t,n}$ using two observables, the price-dividend ratio of dividend strip n and the interest rate for period n:

$$g^*_{t,n} = \left(\frac{P_{t,n}}{D_t}\right)^{\frac{1}{n}} \left(1+r_{t,n}\right) - 1.$$

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 following relationship holds:[4]

$$F_{t,n} = P_{t,n}\left(1+r_{t,n}\right)^n$$

This implies that the risk-adjusted growth rates follow directly from the futures prices:

$$g^*_{t,n} = \left(\frac{F_{t,n}}{D_t}\right)^{\frac{1}{n}} - 1 \tag{4}$$

Finally, note that the growth rate $g^*_{t,n}$ is the per-period growth rate for the next n-years. As

[4]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 do not pay dividends, the formula below is the appropriate formula.

such it represents an average growth rate. However, when considering a 10-year horizon, for example, it may also be interesting to compute the expected growth rate between periods 5 and 10, which we will call the forward growth rate. The forward expected risk-adjusted growth rate between period $n1$ and $n2$ is defined as:

$$f_{t,n1,n2} = \left(\frac{\left(1 + g^*_{t,n2}\right)^{n2}}{\left(1 + g^*_{t,n1}\right)^{n1}} \right)^{\left(\frac{1}{n2-n1}\right)} = \left(\frac{F_{t,n2}}{F_{t,n1}} \right)^{\left(\frac{1}{n2-n1}\right)} \quad (5)$$

2 Data

2.1 Three World Regions

We focus our analysis on three major stock indices representing three world regions: the US, Europe and Japan. For Europe, we focus on 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. For Japan, we focus on the Nikkei 225 index, which is the major stock index for the Tokyo Stock Exchange in Japan. It is comprised of 225 blue chip stocks on the Tokyo Stock Exchange. Finally, for the US we use the S&P500 index. 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.

2.2 Data

Our daily dividend future data comes from BNP Paribas, a major player in the market for dividends, and covers the U.S., Europe and Japan. BNP Paribas provided us with its internal implied dividend database, which it uses firm-wide both as a pricing source and to mark the internal trading books to the market.

The market for dividends is relatively young and started around the turn of the century. With increased trading activities in options, forwards and structured products, the dividend exposure increased on investment banks' balance sheets. By selling structured products to investors which have an implicit long forward position in it (long out-of-the-money call option and/or short out-of-the-money put option), investment banks accumulate significant long dividend positions. However, the hedging is done with the underlying index constituents, which pay ex-ante uncertain dividends. This exposes investment banks to dividend risk, the risk between anticipated and actual dividends, which they prefer to offload to free up capital. Other than investment banks and dealers, hedge funds are important participants in this market. Also, several pension funds are active in the dividend market. For them, dividend futures may be useful tools to match the duration of assets and liabilities, particularly for defined benefit plans that (partially) index pension payments with GDP growth. Most of the trading in dividends occurs over-the-counter (OTC) in the inter-broker market. Since mid 2008, however, exchange traded dividend futures markets have started. First in Europe (SX5E) and later in Japan (NKY).

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.

Index dividend contracts are traded in exposure per (dividend) point. Formally, the pay-off of a contract is the sum of the declared ordinary gross dividends on index constituents that go ex-dividend during the period as stipulated in the contract, which is usually a year. Special or extraordinary dividends are excluded.[5] The decision on in- or exclusion of dividends is guided by the exchange or the index provider. By entering a long dividend swap or future, an investor will receive the actual dividends against the market-implied level at inception of the contract. Contracts are cash-settled at the expiration date and there are no interim cash flows.

2.3 Interest Rates

The US interest rates are calculated from a collection of continuously-compounded zero-coupon interest rates at various maturities and provided by IvyDB (OptionMetrics). This zero curve is derived from LIBOR rates from the British Bankers Association (BBA) and settlement prices of Chicago Mercantile Exchange (CME) Eurodollar futures. For a given futures contract (or dividend strip), the appropriate interest rate corresponds to the zero-coupon rate that has a maturity equal to the options expiration date. We obtain these by linearly interpolating between the two closest zero-coupon rates on the zero curve.

[5] Over time, the share of special dividends as fraction of total dividends, has decreased and is negligible for the sample period that we consider.

2.4 Dividends

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 Datastream to obtain the same objects for the DJ Eurostoxx50 index and the Nikkei 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 (4). For example, if we want to compute the risk-adjusted growth rates 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.

2.5 Financial Crisis Timeline

We obtain detailed data on the timeline of the financial crisis from the St. Louis Fed.[6]. We also use an alternative timeline of the crisis as provided by the New York Fed.[7] These two data sources help us to resolve the question which events most affected investors' short and long-term expectations during the financial crisis.

3 Summary Statistics of Growth Rates

3.1 Risk Adjusted Expected Growth: S&P 500

The risk-adjusted expected growth rates for the S&P 500 index between October 2002 and October 2010 are plotted in Figure 1. The four lines (in color) in each graph represent the expected risk-adjusted growth rates for four horizons: 1, 2 ,5 and 10 years. The graph shows that between 2003 and 2007, short-term growth rates were higher than long-term growth rates. During the financial crisis this pattern reversed and short-term growth rates plummeted compared to long-term growth rates. However, long-term growth rates also decreased substantially.

The 1-year risk-adjusted expected growth rate for the S&P500 index shows a double dip, the first occurring on December 4th 2008 and the second occurring on March 12th of 2009, with values of -34.3% and -37.2% respectively. The S&P 500 index level also

[6]See also http://timeline.stlouisfed.org/index.cfm?p=timeline
[7]See http://www.ny.frb.org/research/global_economy/Crisis_Timeline.pdf

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. Both these index level troughs occur before the troughs of the 1-year expected risk adjusted growth rate. The 2,5 and 10 year risk-adjusted expected growth rates do not exhibit a double dip pattern. The trough of the 2-year rate occurs on March 12th 2009. The troughs of the 5 and 10-year rates coincide with the second trough of the index level and occur on March 5th 2009. Finally, a very steep decline in the one-year rate occurred between August 18th and October 31st 2008 when the rate dropped from -5.7% to -31.5%. Note that the latter number is close to the first trough of -34.3%. Interestingly, the S&P 500 index level during this period only dropped from 1266.7 on August 18th to 968.8 on October 31st, which is substantially higher than its two troughs of 752.44 and 682.55. This suggests that even though on October 31st 2008 short-term growth expectations had been revised downwards, long-run growth expectations had not yet been adjusted. Long-run growth risk-adjusted expectations were further revised downwards between October 31st 2008 and November 20th 2008 when the index dropped another 22% from 968.8 to 752.44.

In Figure 2 we plot the risk adjusted expected forward growth rates, denoted by $f_{t,n1,n2}$, for maturities between 1 and 2 years (so $n_1 = 1$ and $n_2 = 2$), 2 and 5 years (so $n_1 = 2$ and $n_2 = 5$) and 5 and 10 years (so $n_1 = 5$ and $n_2 = 10$). Interestingly, forward growth rates between 2 and 5 years and 5 and 10 years did not decrease during the crisis but increased instead, which suggests that market participants priced in a recovery after the initial steep decline. However, the increase in the 5-10 year forward rate is not sufficient to make up for the one-year expected decline. This can easily be seen from the 10-year growth rate in Figure 1, which decreased during the crisis. If the decline in the one-year expected growth rate would have been fully offset by higher expected growth in years 5-10, the 10-year expected growth rate, which is the average growth rate over the next ten years, would have stayed constant.

3.2 Risk Adjusted Expected Growth: Eurostoxx 50 Index

In Figure 3 we plot the risk-adjusted expected growth rate for the Dow Jones Eurostoxx 50 index. As before, the four lines (in color) in each graph represent the expected risk-adjusted growth rates for four horizons: 1,2,5 and 10 years. The trough of the one-year rate occurs on May 4th 2009 with an expected risk-adjusted growth rate of -44.5%. 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 DJ 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 September 30th and October 23rd 2008 the one-year expected risk-adjusted growth rate decreased from -7.9% to -39.8%. In Figure 4 we plot the expected risk-adjusted forward rates. Similar to the expected forward growth rates of the S&P500 index, forward rates between 2 and 5 years and 5 and 10 years did not decrease during the crisis but increased instead.

3.3 Risk Adjusted Expected Growth: Nikkei 225

In Figure 5 we plot the risk-adjusted expected growth rate for the Nikkei 225 index. The trough of the one-year rate occurs on March 25th 2009 with an expected risk-adjusted growth rate of -46.8%. 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 3 and October 30th 2008, the one-year growth rate decreased from -6.2% to -17.6%. 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 -46.8%.

In Figure 6 we plot the forward rates. As for the S&P500 index, forward rates between 2 and 5 years and 5 and 10 years did not decrease during the crisis but increased instead.

3.4 Summary Statistics

In Table 1 we report the summary statistics of the growth rates for all three indexes and for all ten maturities. The average growth 1-year rate is highest for Japan (9%) and lowest for Europe (0.2%). The average 1-year rate for the US is 2.5%. The average 10-year rate is the highest for the US (2.1%) and lowest for Europe (-0.2%). The average 10-year rate for Japan is 1.2%.

The volatilities of the growth rates decrease monotonically with the maturity for all three indexes, reminiscent of bond yields. The volatility of growth rates is highest for Japan and lowest for the US at all maturities. Further, over this sample period the rates are negatively skewed, which is induced by the large negative numbers during the financial crisis.

4 Predictability of dividend and consumption growth

In this section, we study the predictability of dividend and consumption growth by equity yields. We follow a long tradition in macro-finance using yield based variables to forecast either returns or cash flows. Examples include Fama (1984) and Lustig, Roussanov, and Verdelhan (2010) for currency markets, Fama and Bliss (1987), and Campbell and Shiller (1991), and Cochrane and Piazzesi (2005) for bond markets, and Campbell and Shiller (1988), Cochrane (1991), and Binsbergen and Koijen (2010) for the aggregate stock market.

We first focus on the predictability of dividend growth. 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. For each index, we consider regressions of the form:

$$\log\left(\sum_{i=1}^{12} D_{t+12+i}\right) - \log\left(\sum_{i=1}^{12} D_{t+i}\right) = \alpha_n + \beta_n g^*_{t,n} + \varepsilon^D_{t+24}, \tag{6}$$

where D_t denotes the dividend in month t. The summed dividends within the year measure the annual aggregate dividend.[8]

We use either the 1-year, ..., 5-year equity yields to predict dividend growth, that is, $n = 1, \ldots, 5$. If the risk premium on short-term dividend strips is constant, then it holds that $\beta_1 = 1$. The evidence in Binsbergen, Brandt, and Koijen (2010) suggests, however, that the risk premium tends to fluctuate over time, which may induce a deviation from one. However, annual dividend growth reached a minimum -23% for the S&P500, -35% for the Eurostoxx 50, and -32% for the Nikkei 225. This unusual shift in growth rates, as so far anticipated, may help us uncover cash-flow predictability. In addition, how the predictive coefficient is affected also depends on the correlation between expected returns and expected growth rates.

The results are presented in Table 2. Panel A reports the results for the S&P500, Panel B for Eurostoxx 50, and Panel C for the Nikkei 225. The first column reports the point estimate. The second column reports the Newey-West test statistics using 12 lags. 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 very high,

[8] We follow Fama and French (1988) and sum all dividends within the year. Alternatively, we can reinvest dividends at the 1-month T-bill as in Binsbergen and Koijen (2010). We obtain very similar results for both reinvestment policies.

suggesting that dividend growth rates, at least during this sample period, are strongly predictable.

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 ρ, then it is straightforward to show that:

$$\beta_n \simeq \frac{n(1-\rho)}{1-\rho^n}. \tag{7}$$

This expression directly implies $\beta_1 = 1$, as discussed before. We can also solve for ρ for $n = 5$ given $\beta_5 = 2$. This corresponds to an annual autoregressive coefficient of $\rho = 0.64$.[9]

The previous results show that our newly-constructed data is useful in forecasting future dividend growth. We now extend these results for the S&P500 data and show that equity yields also predict consumption growth. We study the same forecasting regressions as before:

$$\log\left(\sum_{i=1}^{12} C_{t+12+i}\right) - \log\left(\sum_{i=1}^{12} C_{t+i}\right) = \gamma_n + \delta_n g^*_{t,n} + \varepsilon^C_{t+24}, \tag{8}$$

where C_t is now monthly consumption.[10]

We present the results in Table 3. The structure of the table is the same in Table 2. Consistent with our results for dividend growth predictability, we uncover strong 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 expected growth rates.

5 Dividend Growth 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

[9]This calculation approximately results in the persistence of the risk-neutral growth rate if the persistence of expected returns and expected growth rates is identical.

[10]We use Personal consumption expenditures (PCE) from Table 2.8.5. of the Bureau of Economic Analysis.

long-term growth rates (or both). Our main focus is on the S&P500 index.

5.1 November 2007

Between October 31st and November 29th 2007, the one-year risk-adjusted expected growth rate for the S&P500 index decreased from 8.6% to -1.3%. The 5-year rate dropped from 5.6% to 3.6%, the 10-year rate dropped from 4.1% to 3.0% and the index value changed from 1549.4 to 1469.7, a drop of 5%. During this period 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.[11] 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."

5.2 August 2008

Two large drops in growth rates occur on August 18th and 19th of 2008. The 1-year growth rate changes from -6.9% on August 17th to -11.3% on August 18th, to -15.2% on August 19th. Several important economic releases occurred around these dates. In addition to the PPI numbers, on August 19th 2008 the statistics on Building Permits and New Housing Starts were released and both numbers were lower than consensus forecasts.

5.3 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 rate was -14.1% on September 1st and -15.1% on September 30th, and the volatility of the rate was relatively low. For the US, most of the drop in short- and long-term expectations occurred in October. Growth

[11] See "The Big Short" by Michael Lewis.

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 rate dropped from -3.3% to -8%, and the 10-year rate dropped from -0.8% to -1.8%. For Japan, the 1-year rate dropped from 7.9% to -3.8% and the 10-year rate dropped from -0.2% to -2%.

5.4 October 2008

During the month October the 1-year rate dropped from -17.5% on October 1st to -31.5% on October 31st. Over the same period, the 2-year rate dropped from -9.4% to -17.3%, the 5-year rate dropped from -2.8% to -6.3%, and the 10-year rate dropped from -1.1% to -2.6%. In the list below we list the major events that happened during that month and we report on each event date the 1, 5 and 10 year risk-adjusted expected growth rates.

- October 3: 1-year = -15.3%, 5-year = -2.9%, 10-year = -1.5%
  - Wells Fargo announces a competing proposal to purchase Wachovia Corporation that does not require assistance from the FDIC.
  - Congress passes and President Bush signs into law the Emergency Economic Stabilization Act of 2008 (Public Law 110-343), which establishes the $700 billion Troubled Asset Relief Program (TARP).
- October 6: 1-year = -15.4%, 5-year = -3.1%, 10-year = -2.1%
  - The Federal Reserve Board announce that the Fed will pay interest on depository institutions required and excess reserve balances at an average of the federal funds target rate less 10 basis points on required reserves and less 75 basis points on excess reserves.
- October 7: 1-year = -14.5%, 5-year = -3.0%, 10-year = -2.5%
  - The Federal Reserve Board announces the creation of the Commercial Paper Funding Facility (CPFF), which will provide a liquidity backstop to U.S. issuers of commercial paper through a special purpose vehicle that will purchase three-month unsecured and asset-backed commercial paper directly from eligible issuers.
  - The FDIC announces an increase in deposit insurance coverage to $250,000 per depositor as authorized by the Emergency Economic Stabilization Act of 2008.

- October 8: 1-year = -16.2%, 5-year = -4.2%, 10-year = -2.6%
  - The Federal Reserve Board authorizes the Federal Reserve Bank of New York to borrow up to $37.8 billion in investment-grade, fixed-income securities from American International Group (AIG) in return for cash collateral.
  - The FOMC votes to reduce its target for the federal funds rate 50 basis points to 1.50 percent. The Federal Reserve Board votes to reduce the primary credit rate 50 basis points to 1.75 percent.
- October 12: Non-trading day
  - The Federal Reserve Board announces its approval of an application by Wells Fargo & Co. to acquire Wachovia Corporation.
- October 13: 1-year = -19.4%, 5-year = -4.0%, 10-year = -2.0%
  - The FOMC increases existing swap lines with foreign central banks. The Bank of England, European Central Bank, and Swiss National Bank announce that they will conduct tenders of U.S. dollar funding at 7-, 28-, and 84-day maturities at fixed interest rates.
- October 14: 1-year = -19.4%, 5-year = -4.0%, 10-year = -2.0%
  - The Federal Reserve announces additional details of the Commercial Paper Funding Facility (CPFF).
  - The FOMC increases its swap line with the Bank of Japan.
  - U.S. Treasury Department announces the Troubled Asset Relief Program (TARP) that will purchase capital in financial institutions under the authority of the Emergency Economic Stabilization Act of 2008. The U.S. Treasury will make available $250 billion of capital to U.S. financial institutions. This facility will allow banking organizations to apply for a preferred stock investment by the U.S. Treasury. Nine large financial organizations announce their intention to subscribe to the facility in an aggregate amount of $125 billion.
  - The FDIC creates a new Temporary Liquidity Guarantee Program to guarantee the senior debt of all FDIC-insured institutions and their holding companies, as well as deposits in non-interest-bearing deposit transaction through June 30, 2009.
  - 9 Large Banks agree to capital injection from the Treasury.

- October 16: 1-year = -19.7%, 5-year = -4.2%, 10-year = -2.5%
  - Tier 1 capital definition is changed to include stock purchased by Treasury.
- October 21: 1-year = -20.8%, 5-year = -4.6%, 10-year = -3.0%
  - The Federal Reserve Board announces creation of the Money Market Investor Funding Facility (MMIFF). Under the facility, the Federal Reserve Bank of New York provides senior secured funding to a series of special purpose vehicles to facilitate the purchase of assets from eligible investors, such as U.S. money market mutual funds. Among the assets the facility will purchase are U.S. dollar-denominated certificates of deposit and commercial paper issued by highly rated financial institutions with a maturity of 90 days or less.
- October 22: 1-year = -22.1%, 5-year = -5.2%, 10-year = -3.6%
  - The Federal Reserve Board announces that it will alter the formula used to determine the interest rate paid to depository institutions on excess reserve balances. The new rate will be set equal to the lowest FOMC target rate in effect during the reserve maintenance period less 35 basis points.
- October 23: 1-year=-28.4%, 5-year=-6.3%, 10-year=-3.2%
  - Former Federal Reserve chairman Alan Greenspan testifies before the House Committee of Government Oversight and Reform
- October 24: 1-year = -28.5%, 5-year = -6.6%, 10-year = -3.4%
  - PNC Financial Services Group Inc. purchases National City Corporation, creating the fifth largest U.S. bank.
- October 28: 1-year = -28.3%, 5-year = -6.2%, 10-year = -2.5%
  - The U.S. Treasury Department purchases a total of $125 billion in preferred stock in nine U.S. banks under the Capital Purchase Program.
  - The FOMC and Reserve Bank of New Zealand establish a $15 billion swap line.
- October 29: 1-year = -28.0%, 5-year = -6.3%, 10-year = -2.6%
  - The FOMC votes to reduce its target for the federal funds rate 50 basis points to 1.00 percent. The Federal Reserve Board reduces the primary credit rate 50 basis points to 1.25 percent.

- The FOMC also establishes swap lines with the Banco Central do Brasil, Banco de Mexico, Bank of Korea, and the Monetary Authority of Singapore for up to $30 billion each.
- The International Monetary Fund (IMF) announces the creation of a short-term liquidity facility for market-access countries.

As can be seen from this overview, one of the largest drops in the one-year expected growth rate occurred on October 23rd when former Federal Reserve chairman Alan Greenspan testifies before the House Committee of Government Oversight and Reform. This led to a decrease in the 1-year growth rate from -24.7% to -32.0%, the 2-year growth rate decreased from -14.6% to -17.5% and the 3-year growth rate decreased from -9.5% to -10.9%. The 4 to 8-year growth rates also decreased slightly. Finally, the 9-year and 10-year rates increased slightly, from -3.2% to -3.0% and from -3.6% to -3.2% respectively. So even though short-term growth rates were revised downwards substantially, there was also good news, in the sense that market participants adjusted downward their beliefs about the long-term negative impact of the crisis.

6 The Economic Outlook around the World

In Figures 7 and 8, we plot the 2-year and 10-year risk adjusted expected growth rates for all three regions. This graph reveals several interesting facts. First, the troughs of the financial crisis were more severe for Japan and Europe than for the US. This is the case both for the 2-year as for the 10-year rate. Secondly, as of October 13th 2010, both the 2-year and the 10-year risk adjusted expected growth rate for the US are substantially higher than for Europe and Japan. The 2-year rate for the US is 7.8% compared to 2.5% for Japan and -0.6% for Europe. The 10-year rate is 4.3% for the US, compared to -1% for Japan and -0.2% for Europe. The three term structures on October 13th 2010 are plotted in Figure 9.

When interpreting these numbers one has to be careful and several caveats need to be considered. One potential explanation is simply that the growth outlook of the US is much higher than that of Europe and Japan, both for the short horizon and the long horizon. However, two alternative (not mutually exclusive) interpretations need to be considered. First of all, we are looking at risk-adjusted growth rates, not at actual growth rates. As such, an alternative interpretation is that the current risk premium in Europe and Japan is higher than in the US both for the 2-year and the 10-year horizon. Finally, it is important to note that these are nominal growth forecasts. The third interpretation is that expected inflation in the US is substantially higher than the expected inflation in Europe and Japan for both horizons. A casual look at bond markets suggests that this last interpretation alone, seems implausible. Of course, it is possible that a combination of all three interpretations is what is driving our empirical findings and future research should be dedicated in entangling these three components: growth, risk premia and inflation.

7 Conclusion

We use a new data set on dividend futures with maturities up to 10 years to uncover the term structure of risk-adjusted expected dividend growth across three major regions around the world: the US, Europe and Japan. We compare the term structures of growth before and after the financial crisis and analyze the impact of specific events during the financial crisis. We find that the crisis is accompanied by decreases in both short- and long-term growth expectations for all three regions. The current risk-adjusted 10-year nominal growth outlook for the US is substantially higher than that for Europe and Japan.

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Maturity in years	1	2	3	4	5	6	7	8	9	10
S&P500 Index (Oct 2002 - Oct 2010)										
Mean	0.0248	0.0230	0.0212	0.0217	0.0222	0.0215	0.0209	0.0205	0.0210	0.0212
Stdev	0.1284	0.0904	0.0624	0.0507	0.0439	0.0389	0.0349	0.0315	0.0295	0.0280
Median	0.0659	0.0506	0.0416	0.0330	0.0308	0.0296	0.0259	0.0232	0.0209	0.0205
Min	-0.3717	-0.2946	-0.1929	-0.1466	-0.1217	-0.1037	-0.0902	-0.0763	-0.0646	-0.0526
Max	0.1876	0.1458	0.1039	0.1065	0.1032	0.0934	0.0853	0.0783	0.0768	0.0740
DJ Eurostoxx 50 Index (Oct 2002 - Oct 2010)										
Mean	0.0020	-0.0169	-0.0134	-0.0097	-0.0070	-0.0068	-0.0045	-0.0025	-0.0010	-0.0021
Stdev	0.1647	0.1333	0.0954	0.0729	0.0590	0.0496	0.0429	0.0381	0.0339	0.0288
Median	0.0359	0.0136	0.0052	0.0006	0.0008	-0.0066	-0.0036	0.0014	0.0022	0.0026
Min	-0.4452	-0.4321	-0.3197	-0.2442	-0.1946	-0.1586	-0.1342	-0.1170	-0.1030	-0.0920
Max	0.3374	0.2783	0.1931	0.1478	0.1229	0.1063	0.0914	0.0814	0.0751	0.0621
Nikkei 225 Index (Jan 2003 - Oct 2010)										
Mean	0.0900	0.0525	0.0429	0.0386	0.0353	0.0326	0.0298	0.0266	0.0209	0.0116
Stdev	0.2116	0.1592	0.1196	0.0969	0.0814	0.0696	0.0599	0.0511	0.0409	0.0325
Median	0.0712	0.0349	0.0239	0.0183	0.0159	0.0148	0.0148	0.0151	0.0155	0.0103
Min	-0.4680	-0.4318	-0.3261	-0.2504	-0.2014	-0.1670	-0.1415	-0.1218	-0.1051	-0.0854
Max	0.4402	0.3066	0.2548	0.2165	0.1815	0.1557	0.1319	0.1087	0.0935	0.0727

Table 1: Summary Statistics Risk Adjusted Expected Growth Rates

Panel A: S&P500

n	β_n	t-statistic	R-squared
1	0.75	19.79	88%
2	1.05	15.78	84%
3	1.51	17.76	80%
4	1.78	10.56	72%
5	2.00	7.89	68%

Panel B: Eurostoxx 50

n	β_n	t-statistic	R-squared
1	0.99	12.67	78%
2	1.13	12.47	71%
3	1.55	12.38	69%
4	1.96	11.59	64%
5	2.35	10.21	60%

Panel C: Nikkei 225

n	β_n	t-statistic	R-squared
1	0.67	11.49	77%
2	0.88	13.61	78%
3	1.17	12.86	76%
4	1.43	11.10	74%
5	1.69	9.98	73%

Table 2: Predictability of dividend growth by equity yields

	γ_n	t-statistic	R-squared
1	0.14	8.59	73%
2	0.20	7.83	69%
3	0.28	8.26	63%
4	0.33	6.76	55%
5	0.37	5.57	51%

Table 3: Predictability of consumption growth by equity yields

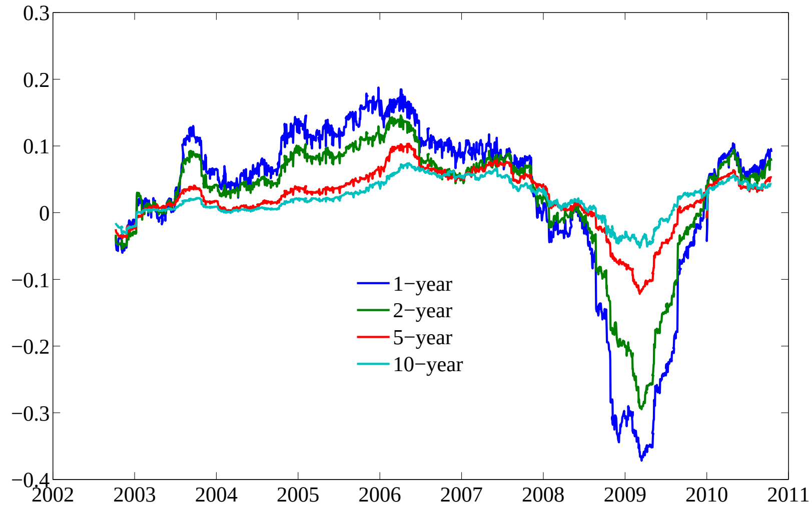

Figure 1: Risk-Adjusted Expected Growth Rates: S&P500 Index
The graph displays the risk-adjusted expected dividend growth rate $g^*_{t,n}$ for $n = 1, 2, 5, 10$ years for t varying between October 7th 2002 and October 13th 2010.

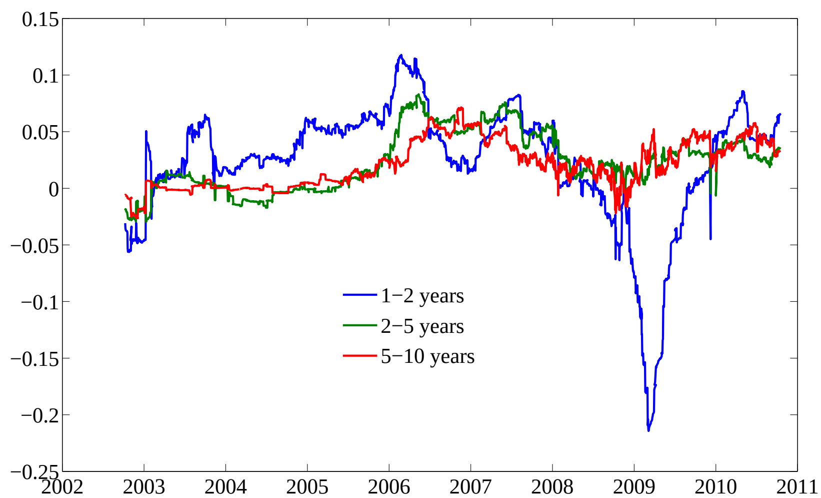

Figure 2: Risk-Adjusted Expected Forward Rates: S&P500 Index
The graph displays the risk-adjusted expected forward growth rate $f_{t,n1,n2}$ for $n1 = 1, 2$ and 5 years and $n2 = 2, 5$ and 10 years.

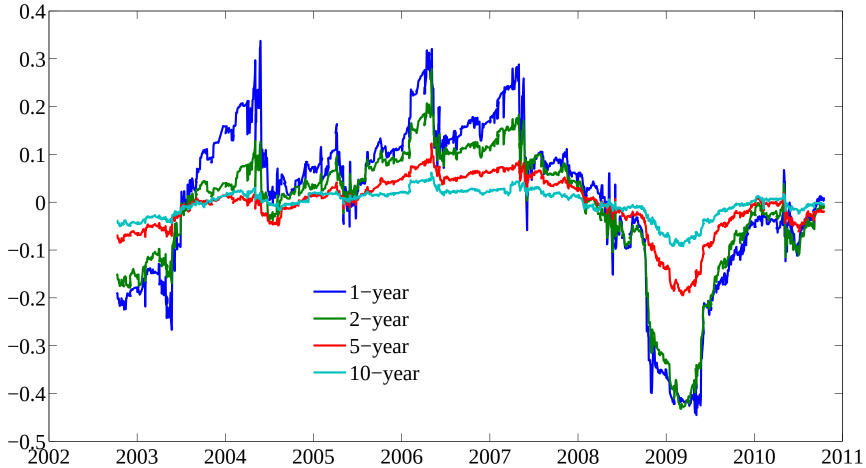

Figure 3: Risk-Adjusted Expected Growth Rates: DJ Eurostoxx 50 Index
The graph displays the risk-adjusted expected dividend growth rate $g^*_{t,n}$ for $n = 1, 2, 5$ and 10 years for t varying between October 7th 2002 and October 13th 2010.

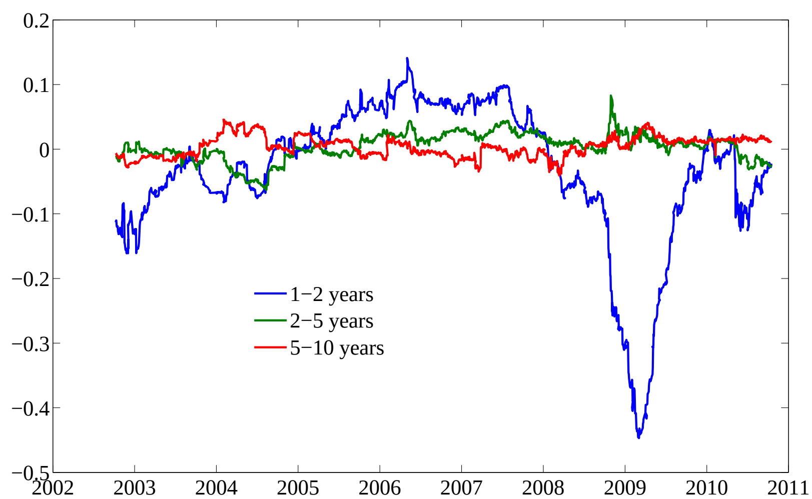

Figure 4: Risk-Adjusted Expected Forward Rates: DJ Eurostoxx 50 Index
The graph displays the risk-adjusted expected forward growth rate $f_{t,n1,n2}$ for $n1 = 1, 2$ and 5 years and $n2 = 2, 5$ and 10 years.

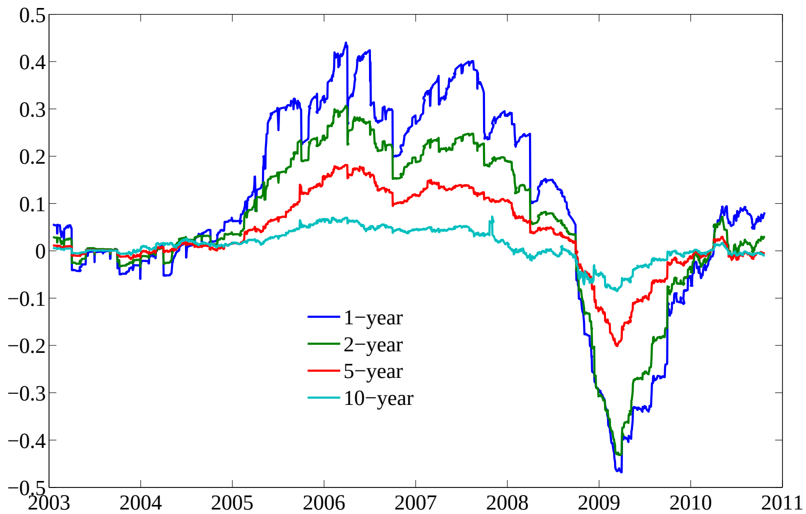

Figure 5: Risk-Adjusted Expected Growth Rates: Nikkei 225 Index
The graph displays the risk-adjusted expected dividend growth rate $g^*_{t,n}$ for $n = 1, 2, 5$ and 10 years for t varying between October 7th 2002 and October 13th 2010.

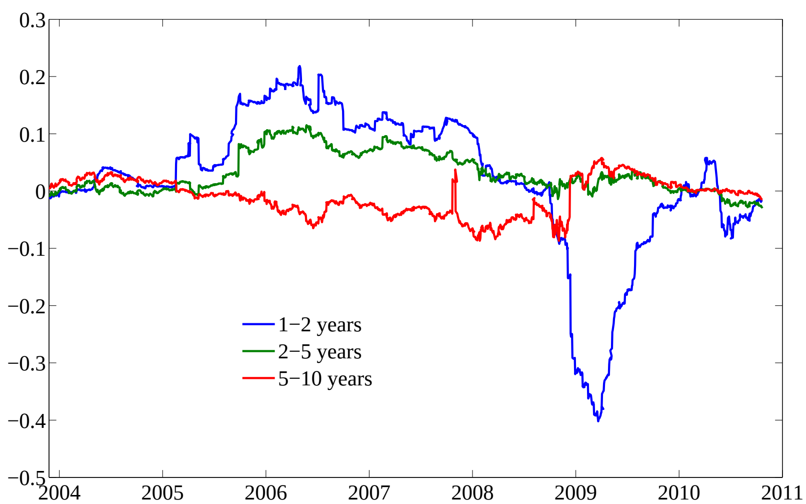

Figure 6: Risk-Adjusted Expected Forward Rates: Nikkei 225 Index
The graph displays the risk-adjusted expected forward growth rate $f_{t,n1,n2}$ for $n1 = 1, 2$ and 5 years and $n2 = 2, 5$ and 10 years.

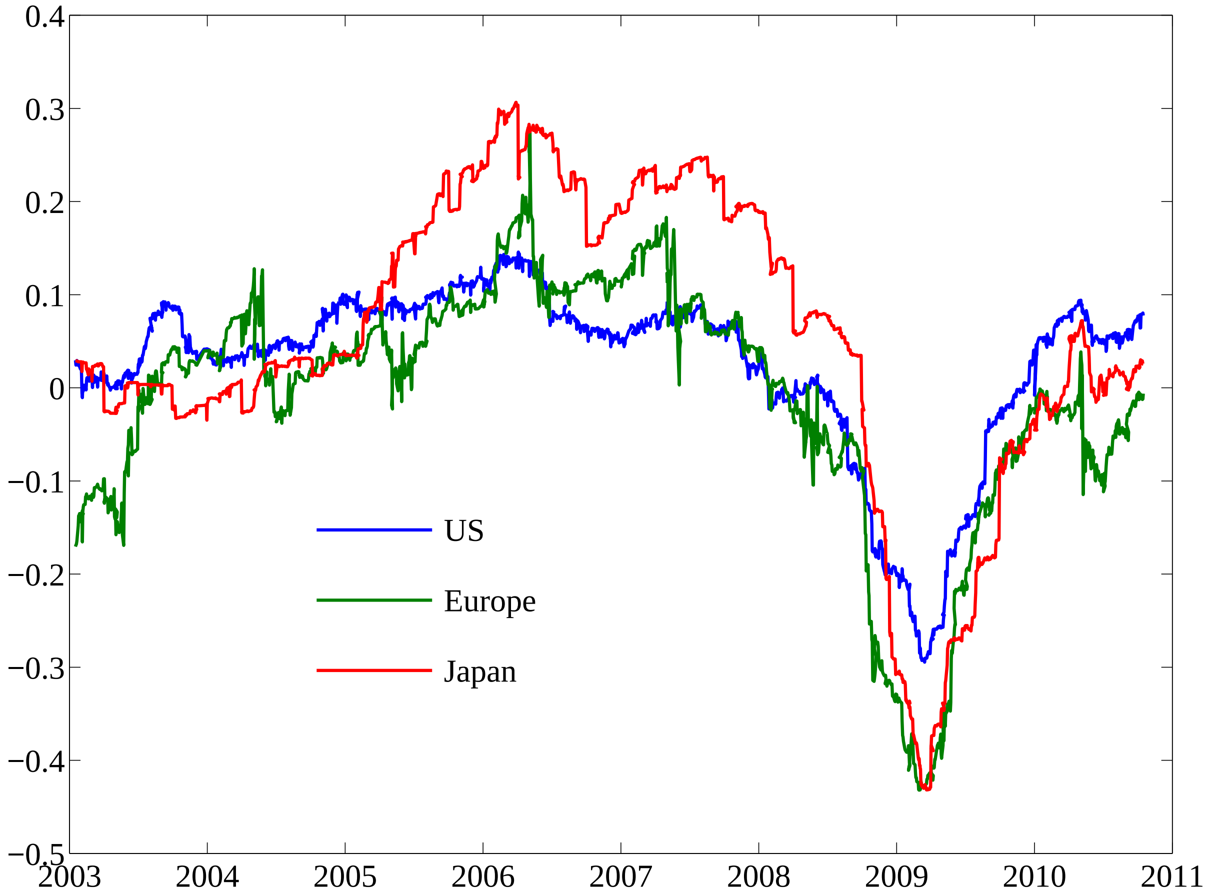

Figure 7: 2-Year Risk-Adjusted Expected Growth Rates Across Regions
The graph displays the risk-adjusted expected dividend growth rate $g^*_{t,n}$ for $n = 2$ years for t varying between January 14th 2003 and October 13th 2010 for three regions: the US (as represented by the S&P500 Index), Europe (as represented by the DJ Eurostoxx 50 index) and Japan (as represented by the Nikkei 225 index).

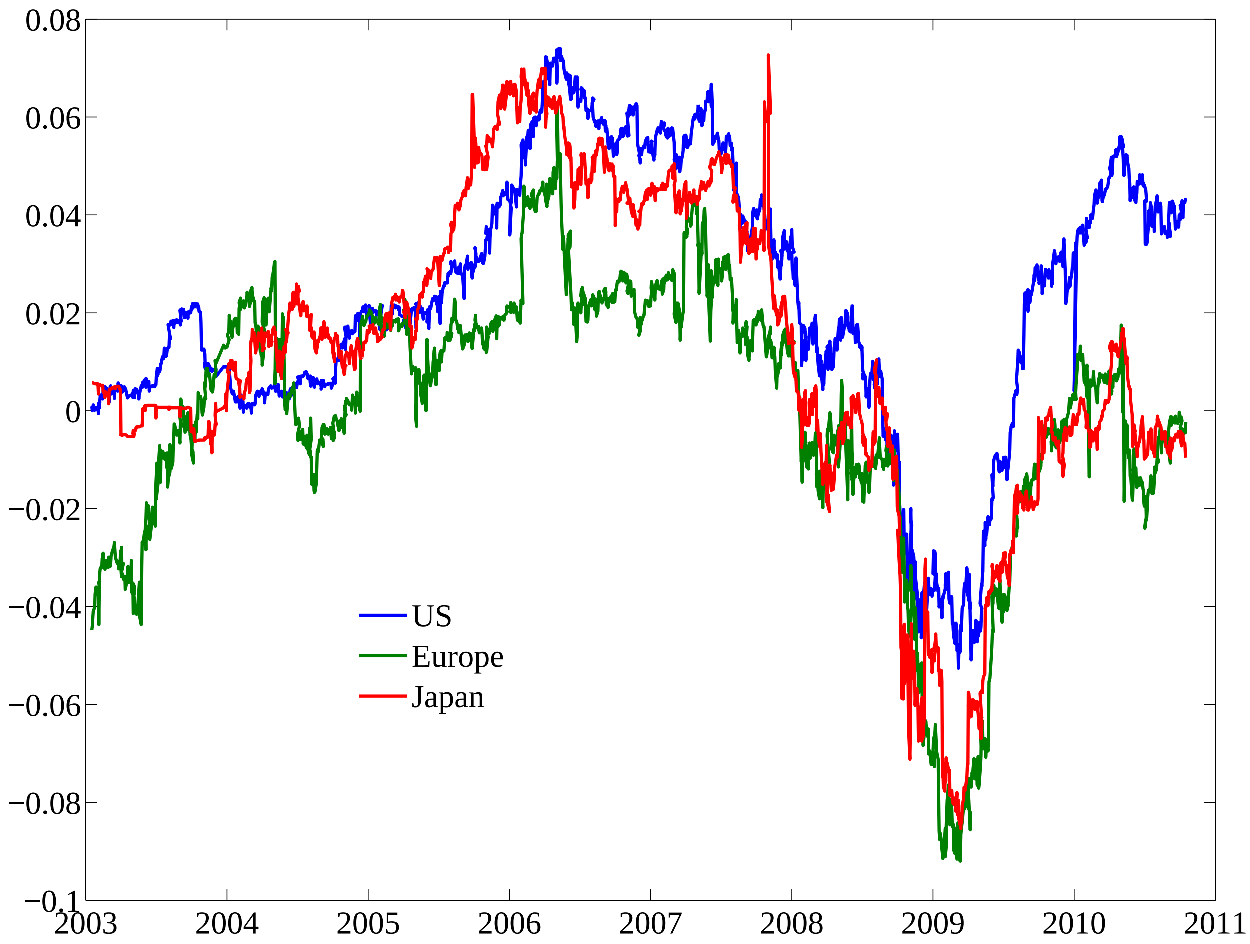

Figure 8: 10-Year Risk-Adjusted Expected Growth Rates Across Regions
The graph displays the risk-adjusted expected dividend growth rate $g^*_{t,n}$ for $n = 10$ years for t varying between January 14th 2003 and October 13th 2010 for three regions: the US (as represented by the S&P500 Index), Europe (as represented by the DJ Eurostoxx 50 index) and Japan (as represented by the Nikkei 225 index).

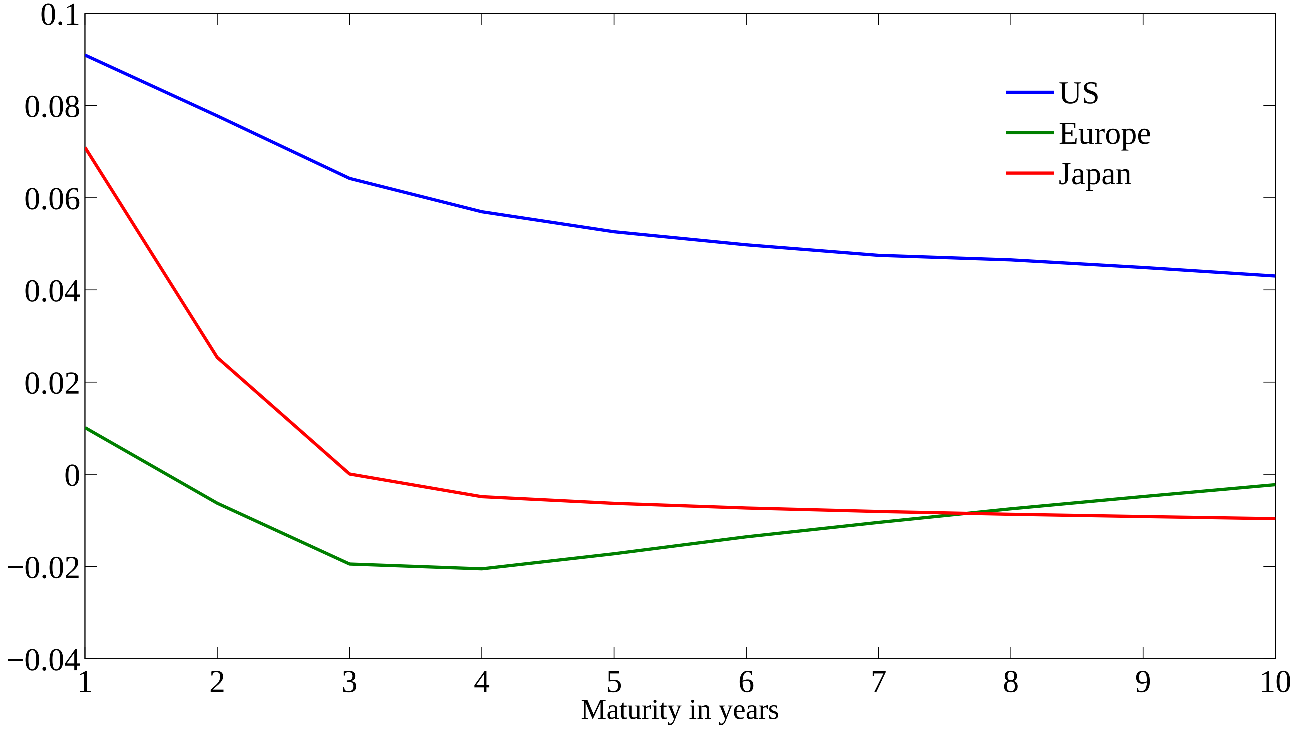

Figure 9: Term Structure of Growth on October 13th 2010

The graph displays the risk-adjusted expected dividend growth rate $g^*_{t,n}$ for $n = 1, .., 10$ years for t equals October 13th 2010 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).