The Term Structure of Equity Yields – A Bottom-Up Approach[†]

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Abstract

This paper proposes a novel perspective on the term structure of market equity yields. Instead of using market dividend futures, we aggregate equity yields of individual firms to estimate the market equity yield curve. This approach allows studying the aggregation effect that shapes the market equity yield curve. During the period from 1990 to 2019, we find a positive aggregation effect: companies with high equity yields were expected to grow at higher rates than companies with low equity yields. Thus, high-yield companies were expected to generate an increasing share of total market dividends when expanding the investment time horizon. Under the assumption of flat firm risk premia, this implies an upward-sloping term structure of equity risk premia. Together with the concave bond yield curve, the market equity yield curve was upward-sloping.

JEL Classification: G12

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1. Introduction

The past decade has seen an increasing research interest in the market equity yield curve. Much of the academic debate concentrates around the question whether discount rates of short-term equity are higher or lower than discount rates in the distant future. While the first empirical studies come to the conclusion that market equity yields decrease with the investment time horizon (Binsbergen et al., 2013), more recent studies find evidence for a rather flat (Giglio et al., 2023) or upward-sloping market equity yield curve (Miller, 2020).

This paper revisits this important question by proposing a novel perspective on the market equity yield curve. The starting point of the analysis is the observation that the equity market is not a single entity. Unlike the government bond market, the equity market consists of a large variety of equity shares of thousands of individual companies. Different from the bond yield curve, the market equity yield curve is therefore an aggregate of many different firm-level equity yields.

This study therefore estimates the market equity yield curve by aggregating equity yields of individual firms – the bottom-up approach. By doing so, this is the first study that allows exploring the link between firm-level and market-level equity yields, and thus offers a cross-sectional perspective on the determinants of the market equity yield curve.

We start by estimating equity yields of individual companies. Firm-level equity yields are assumed to consist of the risk-free rate plus a flat firm-specific risk premium. Hence, the equity yield curve for a single stock is equal to the zero-coupon government bond yield curve plus the risk premium. This allows estimating equity yields using the implied cost of equity capital (ICC) approach based on analyst forecasts.[1] Thus, firm-level equity yields are hold-to-maturity expected returns, similar to a bond's yield to maturity, and therefore correspond to the economically important concept of discount rates. In a second

[1] The ICC is the internal rate of return that equates future discounted cash flows per share to the share price, and is widely used in the Finance literature as forward-looking estimate of expected stock returns and equity risk premia of individual companies (Gebhardt et al., 2001) and entire markets (Claus and Thomas, 2001). More recent studies employ the ICC to analyse the shares' risk-return trade-off (Pástor et al., 2008; Chava and Purnanandam, 2010), to test asset pricing models (Lee et al., 2009), to analyse stock price movements (Chen et al., 2013), and to predict market returns (Li et al., 2013).

step, we then dividend-weight firm-level equity yields for all maturities across the market to obtain the market equity yield curve.

Presuming flat firm-specific risk premia is a simplifying assumption, mainly driven by the lack of data of dividend strips with different maturities for all firms traded in the market. While there is a new market of firm-level dividend strips, it is still limited to small set of large firms. Yet, this assumption can serve as a benchmark against which other possible shapes of firm-risk premia might be evaluated. Finally, assuming flat firm-level risk premia is widely adopted in business practice: when doing valuation analysis, practitioners often assume that the risk premium is fixed across horizons.

Assuming flat firm-level risk premia has the additional advantage that it allows studying the composition effects that influence the market equity yield curve. In such a setting, the equity yield curve is shaped by the interplay between dividend growth rates and expected stock returns. To see this, suppose that dividend growth and expected stock returns are positively related. In this case, high-yield companies are expected to contribute an increasing fraction of total market dividends when expanding the investment time horizon. As a result, the market equity yield curve is upward-sloping. If, in contrast, dividend growth and expected stock returns are negatively related, the equity yield curve is downward-sloping. The magnitude of the slope of the equity yield curve is therefore a measure of the aggregation effect. Previous studies on the market equity yield curve are silent on the importance of this aggregation effect on their findings.

During the period from 1990 to 2019, this study finds a positive aggregation effect in the U.S. stock market: dividends of companies with high equity yields were expected to grow, on average, at higher rates than dividends of companies with low equity yields. Since firm-level risk premia are assumed to be flat, the positive aggregation effect implies an upward-sloping term structure of market risk premia. Together with the usual concave shape of the term structure of interest rates, the market equity yield curve was upward-sloping.

The difference in yields between short and long-term equity is with around 2.1% economically meaningful. While most of the upward-sloping equity yield curve is due to an upward-sloping term structure of interest rates, the term structure of equity risk premia contributes about 40 basis points to the yield spread. The term structure of equity yields is pro-cyclical, i.e., upward sloping during normal times, but flat or even slightly downward-sloping just before economic recessions. Thus, despite the simplistic assumption of flat firm-level risk premia, the estimates of the market equity yield curve are realistic and in line with estimates obtained from market-level data (Binsbergen et al., 2013; Bansal et al., 2021; Giglio et al., 2023). Hence, the bottom-up approach is not in conflict with prior empirical evidence, but rather provides some interpretation of the market-level dynamics using firm-level data. Furthermore, the finding of an unconditionally upward-sloping equity yield curve is in agreement with standard asset pricing models, such as the consumption-based model with external habit (Campbell and Cochrane, 1999) or the long-run risk-model (Bansal and Yaron, 2004).

The positive aggregation effect means that the market yield curve is steeper than firm-level yield curves. In turn, this implies a negative disaggregation effect: firm-level estimates are less upward-sloping (or more downward-sloping) than the market. For example, an econometrician observing a flat market equity yield curve cannot infer firm-level yield curves to have the same shape – our results suggest that in such a case firm-level equity yields would be downward-sloping, on average. This observation effectively applies to all estimates of the equity yield curve obtained from market level data.

Do our results unequivocally mean that the unconditional market equity yield curve is upward-sloping? Certainly not, as the aggregate yield curve is obtained under the assumption of flat firm-level risk premia. If firm-level equity risk premia are sufficiently downward-sloping, the aggregate equity yield curve is downward-sloping as well. Yet, additional analyses show that even under reasonable assumptions of downward-sloping firm-level risk premia, the aggregate equity yield curve is still upward-sloping or close to being flat. Only if long-term firm-level equity risk-premia are less than half the magnitude of short-term risk premia, the market yield curve is downward-sloping. Hence, unless firm-level risk premia are much more downward-sloping that previously thought, it seems difficult to support a downward-sloping market equity yield curve. We validate the results by carrying out a series of robustness checks.

Further analysis shows a strong predictive power of the slope of the term structure of equity risk premia for stock returns in both the time-series and the cross-sectional dimension. First, there is a positive association between the slope parameter and future stock market returns for time horizons up to 48 months. Second, we find a negative association between the slope and the size and value factors of stock returns. This means that the predictive power can be explained by higher-than-average returns of large growth companies. We also show how investors might exploit the predictive power of the term structure of equity risk premia to set up profitable investment strategies.

Our paper is different from existing studies (reviewed in section 4.6 in more detail) in some important aspects. By aggregating equity yields of individual firms to estimate the market equity yield curve, this is the first study that allows exploring the link between firm-level and market-level equity yields, and thus offers a cross-sectional perspective on the determinants of the equity yield curve. Furthermore, our equity yield curve estimates are based on explicit dividend and earnings forecasts, allowing to derive a truly ex-ante expected market equity yield curve. We thereby avoid the problems related to estimating expected dividend growth rates from realized asset returns. Also conceptually, using forecasts to derive market equity yields is more convincing as asset prices are solely determined by uncertain future payoffs. In addition, the bottom-up approach allows estimating the term structure of market equity yields for maturities up to 30 years, going beyond the time horizon of 7 years of dividend strips. We can thereby estimate level, slope and curvature parameters of the market equity yield curve, matching the vast empirical works on the term structure of interest rates. Finally, similar to Miller (2020) and Giglio et al. (2023), the analysis extends back to 1990 when market dividend futures were not available, which allows us to cover more boom and recession periods than most previous studies.

The paper proceeds as follows. The next section shows how to aggregate firm-level equity yields to derive the market equity yield curve. Section 3. describes the data set. The estimates of the market equity yield curve are presented and discussed in section 4..

Section 5. shows that the term structure of equity risk premia has informational content for stock returns. Additional robustness tests are presented in section 6.. Section 7. offers some concluding remarks.

2. Market Equity Yields

This section introduces the concept of the market equity yield curve. Then we describe the estimation using the implied cost of equity capital (ICC), followed by a numerical example.

2.1 Defining Equity Yields

2.1.1 Equity Yields of Individual Firms

For simplicity, assume that dividends are paid annually. Denote $D^n_{t+\tau}$ the dividend of firm n at the end of year $t+\tau$, and $S^n_{t,\tau}$ the spot price of this dividend payment $S^n_{t,\tau}$ at time t. Then define the annualised equity yield (or yield to maturity) of the dividend strip maturing τ years later as

$$y^n_{t,\tau} = \left(\frac{D^n_{t+\tau}}{S^n_{t,\tau}}\right)^{1/\tau} - 1. \tag{1}$$

The equity yield can be decomposed into the nominal interest rate, $i_{t,\tau}$, and the equity risk premium, $rp^n_{t,\tau}$,[2]

$$y^n_{t,\tau} = i_{t,\tau} + rp^n_{t,\tau} \tag{2}$$

such that

$$rp^n_{t,\tau} = y^n_{t,\tau} - i_{t,\tau}. \tag{3}$$

[2]Bansal et al. (2021) refer to $y^n_{t,\tau}$ as "hold-to-maturity expected return" or "dividend discount rate", and $rp^n_{t,\tau}$ as "hold-to-maturity risk premium". Our definition thus differs from Binsbergen et al. (2013) and Giglio et al. (2023) who define equity yields as hold-to-maturity expected returns less expected dividend growth, $e^n_{t,\tau} = (D^n_t/S^n_{t,\tau})^{1/\tau} - 1$.

The equity yield curve of firm n is the collection of equity yields with maturities up to 30 years, i.e., $y^n_{t,\tau}, \tau \in [1, 30]$. Similarly, the term structure of equity risk premia of firm n is the collection of risk premia with different maturities, i.e., $rp^n_{t,\tau}, \tau \in [1, 30]$.

To estimate an expected equity yield curve for individual firms (see section 2.2.1), one would need the prices of a collection of dividend strips with different maturities for each firm. Yet, such dividend strips are only available for a limited set of large firms.[3]

To circumvent this problem, this paper assumes that a firm's equity yield is given by the risk-free rate plus a flat firm-specific risk premium,

$$y^n_{t,\tau} = i_{t,\tau} + rp^n_t. \tag{4}$$

This means that $rp^n_{t,\tau}$ does not vary with maturity τ at a given point of time t, $rp^n_{t,\tau_k} = rp^n_{t,\tau_l}, \forall k, l$. The assumption of a flat firm-specific risk premium is of course a simplistic assumption. Yet, it is widely adopted in business practice: when doing valuation analysis, practitioners often assume that the risk premium is fixed across horizons. Furthermore, we believe that this assumption serves as a valuable benchmark against which other possible shapes of firm-risk premia can be evaluated.

2.1.2 Market Equity Yields

Building upon firm-level equity yields, we can define market equity yields. Market dividends $D^m_{t+\tau}$ and their spot prices $S^m_{t,\tau}$ are obtained by aggregating firm-level data over all N firms in the market,

$$D^m_{t+\tau} = \sum_{n=1}^{N} D^n_{t+\tau} \quad \text{and} \quad S^m_{t,\tau} = \sum_{n=1}^{N} S^n_{t,\tau}. \tag{5}$$

Market dividends and spot prices then define $y^m_{t,\tau}$, the annualised market equity yield of the market dividends over τ years,

[3]Single-stock dividend futures that give buyers access to dividends over a specific financial year have been introduced on the Eurex stock exchange around 2010 for a few large stocks. These dividend strips have maturities up to 7 years. For most firms, such dividend strips are not traded. In addition, there are concerns about the liquidity of single-stock dividend futures, leading to stale prices. For a detailed discussion see Gormsen and Lazarus (2023).

$$y^m_{t,\tau} = \left(\frac{D^m_{t+\tau}}{S^m_{t,\tau}}\right)^{1/\tau} - 1 \tag{6}$$

Similar to firm-level yields, the market equity yield can be decomposed into nominal interest rates, $i_{t,\tau}$, and the market equity risk premium, $rp^m_{t,\tau}$,

$$y^m_{t,\tau} = i_{t,\tau} + rp^m_{t,\tau} \tag{7}$$

such that

$$rp^m_{t,\tau} = y^m_{t,\tau} - i_{t,\tau}. \tag{8}$$

The market equity yield curve is the collection of market equity yields with different maturities, i.e., $y^m_{t,\tau}, \tau \in [1, 30]$, and the term structure of market equity risk premia is the collection of risk premia, i.e., $rp^m_{t,\tau}, \tau \in [1, 30]$.

Although each firm is assumed to have a flat equity risk premium rp^n_t, the market equity yield curve is not flat since companies with different risk premia differ in their dividend growth rates. The weight of each company therefore changes as the time horizon expands, generating different aggregated market risk premia for each maturity. On top of this term structure of market risk premia, the bond yield curve has to be added, generating a highly complex dynamics of the market equity yield curve.

To see the interplay between risk premia and dividends, rearrange equation (6):

$$\frac{1}{(1+y^m_{t,\tau})^\tau} = \frac{S^m_{t,\tau}}{D^m_{t+\tau}} = \frac{1}{D^m_{t+\tau}} \sum_{n=1}^{N} S^n_{t,\tau} \tag{9}$$

$$= \frac{1}{D^m_{t+\tau}} \sum_{n=1}^{N} \frac{D^n_{t+\tau}}{(1+i_{t,\tau}+rp^n_t)^\tau} = \sum_{n=1}^{N} \frac{w^n_{t,\tau}}{(1+i_{t,\tau}+rp^n_t)^\tau}, \tag{10}$$

where $w^n_{t,\tau}$ is the weight of a firm's dividends out of total market dividends at time $t+\tau$. For example, if companies with increasing dividend weights have high risk premia, the market yield curve is upward-sloping (even if the bond yield curve is flat). In contrast, a negative relation between dividend growth and firm risk premia generates a downward-sloping equity yield curve.

Thus, the assumption of flat firm risk premia allows studying the composition effects that shape the market equity yield curve: the shape of the aggregate term structure of risk premia is a measure of the aggregation effect.

2.2 Estimation

2.2.1 Equity Yields of Individual Firms

Under the assumption that firm-level risk premia are flat, expected equity yields $y^n_{t,\tau}$ can be calculated using the ICC approach. The ICC is usually defined as the internal rate of return that equates future discounted cash flows per share to the share price. Different from the standard ICC literature, we follow Claus and Thomas (2001) and decompose a firm's implied cost of capital into the risk-free rate and a firm-specific risk-premium, see equation (4).

The ICC methodology builds on Gebhardt et al. (2001). We use equity analyst earnings forecasts as proxy of the firms' expected cash flows. Similar to Griffin (1976), Elton et al. (1981) and Park and Stice (2000), we presume that analyst forecasts reflect the average investor's expectation. Relying on analyst forecasts to proxy for expected cash flows makes sure that the yield curve estimates are entirely forward-looking. In addition, there is evidence that earnings expectations provided by analysts are significantly better than a random walk or autoregressive processes, especially over the short horizon (Bradshaw et al., 2012). Together with the assumption of market efficiency, the ICC approach allows deriving an unbiased estimate of a firm's expected risk premium.

We follow Gebhardt et al. (2001) and employ the residual income model (RIM) to estimate the ICC. The RIM expresses the value of a company by its book value of equity capital plus the discounted residual income from future business. Let B_t denote the book value of equity per share at the end of year t, I_t the earnings (income) per share in year

t, and roe_t the return on equity.[4] Then the residual income per share R_t is defined as

$$R_t = I_t - y_t(B_{t-1}) = (roe_t - y_t)B_{t-1}. \tag{11}$$

The price of a share P_t is

$$P_t = B_t + \sum_{\tau=1}^{\infty} \frac{E_t[R_{t+\tau}]}{(1+y_{t,\tau})^{\tau}} = B_t + \sum_{\tau=1}^{\infty} \frac{froe_{t+\tau} - y_{t,\tau}}{(1+y_{t,\tau})^{\tau}} B_{t+\tau-1} \ . \tag{12}$$

where $froe_{t+\tau}$ denotes the forecasted return on equity at time $t+\tau$. As earnings forecasts are not available beyond a certain horizon, it is necessary make assumptions in the long run when implementing the model in practice. Gebhardt et al. (2001) propose a three-stage implementation. Denote $\overline{roe}$ the long-term return on equity and decompose the equity yield into $y_{t,\tau} = i_{t,\tau} + rp_t$. Then the price of a share is

$$\begin{aligned} P_t \;\; = \;\; & B_t + \sum_{\tau=1}^{5} \frac{froe_{t+\tau} - (i_{t,\tau} + rp_t)}{(1 + i_{t,\tau} + rp_t)^{\tau}} B_{t+\tau-1} \quad \textit{(Explicit forecasts)} \\ & + \sum_{\tau=6}^{T} \frac{froe_{t+\tau} - (i_{t,\tau} + rp_t)}{(1 + i_{t,\tau} + rp_t)^{\tau}} B_{t+\tau-1} \quad \textit{(Transition period)} \\ & + \frac{\overline{roe} - (i_{t,T} + rp_t)}{(i_{t,T} + rp_t)(1 + i_{t,T} + rp_t)^{T-1}} B_{t+T-1}. \quad \textit{(Terminal value)} \end{aligned} \tag{13}$$

In the first stage up to year five, future earnings are directly obtained from equity analysts. In the transition period, the company's return on equity is presumed to geometrically converge to a long-term industry average. This assumption is rooted in the idea that permanent competition will not allow any company to generate higher returns than their peers in the long run, at least not in expectation. To ensure a smooth market equity yield curve in the long end, we depart from the original model by Gebhardt et al. (2001) and use a longer transition period of 25 years.[5]

The term structure equity yields is obtained by solving the residual income model (13)

[4] For brevity, the firm superscript n is dropped in this subsection.

[5] The results are robust to shortening the transition period.

for the (horizon-dependent) internal rate of return $y_{t,\tau} = i_{t,\tau} + rp_t$, given the share price and earnings estimates. Since the RIM is generally monotone in rp_t, the solution can be found by iteration. The risk premium is then the difference between the term structure equity yields and the term structure of interest rates, $rp_t = y_{t,\tau} - i_{t,\tau}$. For a detailed description of the implementation of the residual income model, see appendix A.

2.2.2 The Market Equity Yield Curve

To estimate the market equity yield curve, we first have to obtain annual dividend forecasts $D^n_{t+\tau}$ for each firm up to 30 years into the future. Dividend forecasts per share for the first 5 years are again obtained from equity analysts. If no dividend forecasts are available, we compute dividend forecasts using projected payout ratios. After year 5, dividend forecasts are inferred from forecasted returns on equity and payout ratios used when estimating the firms' risk premia. Finally, a firm's total annual dividend forecasts are computed by multiplying forecasted dividends per share with the current number of shares outstanding. For more details, see appendix A.

We rearrange equation (1) into

$$S^n_{t,\tau} = \frac{D^n_{t+\tau}}{(1 + y^n_{t,\tau})^\tau}, \tag{14}$$

to calculate the spot prices $S^n_{t,\tau}$ of the annual forecasted dividends using the firms' equity yields derived in the previous section as discount rate. Then dividend forecasts and their present values are aggregated – for each maturity – over the entire market, see equation (5). The market equity yield $y^m_{t,\tau}$ with maturity τ is obtained using equation (7). The term structure of market risk premia is given by (8).

This aggregation procedure ensures that the market equity yield accurately reflects the (annual) expected returns an investor hopes to achieve by buying the market portfolio. It comes, however, at a drawback, as the aggregated market equity yield curve is dominated by larger companies that account for a significant fraction of forecasted dividends.

As alternative measure, we also estimate an equal-weight market equity yield curve.

In this version, we adjust dividend forecasts by the firms' current market capitalization. More precisely, we divide a firm's forecasted dividends $D^n_{t,\tau}$ by its fraction of the market capitalization of all firms (M^n_t/M^m_t):

$$\tilde{D}^n_{t,\tau} = \frac{M^m_t}{M^n_t} D^n_{t,\tau} \tag{15}$$

Using the adjusted dividend forecasts $\tilde{D}^n_{t,\tau}$ before applying the aggregation procedure described above puts all companies on an equal footing.[6]

2.2.3 Assumptions and Limitations

To summarize, the main assumptions of the empirical strategy are: (i) firm-level risk premia are estimated using the ICC approach, (ii) firm-level risk premia are flat, (iii) future cash flows are taken from analyst forecasts, and (iv) the firms' growth rates are assumed to converge to an industry-specific average. These assumptions have partly some important implications (and possibly limitations) for the results.

While using the ICC to estimate firm-level risk premia is standard in the literature, section 4.2 suggests that this methodology generates an upward trend in risk premia caused by the decline in interest rates over the sample period. Furthermore, it does not allow for substantial business cycle variations in the risk premium.

Assuming firm-level risk-premia to be flat is another key assumption. However, section 4.4 considers the case of downward-sloping risk premia. If firm-level risk premia are sufficiently downward-sloping, the aggregate equity yield curve is downward sloping as well. Yet, for realistic slope parameters, it is difficult to support a downward-sloping market equity yield curve.

Next, section 6.1 discusses the problems with taking future cash flows from analyst forecasts, and uses regression-based forecasts instead. This approach generates different

[6] Another possibility is to adjust the firms' weight such that their forecasted dividends are of equal size. Yet, this raises the question which years' dividend forecast to use. One-year ahead dividends are zero for many firms, and thus not suitable. Long-term dividend forecasts are highly uncertain. Using the firms' market capitalisation is therefore a compromise, as it captures the sum of all discounted expected dividends.

term structures of equity risk premia, but once adding the term structure of interest rates, the market equity yield curve is upward-sloping. In addition, section 6.2 shows that defining equity yields on earnings instead of dividends generates similar results.

Finally, section 4.1 discusses the implications of assuming long-term growth rates to be industry-specific (Gebhardt et al., 2001). When assuming that all companies converge to economy-wide averages instead, the term structure of market equity risk premia is equally upward-sloping, but flat in the long-run.

To conclude, although the results of the paper depend on certain key assumptions, multiple robustness checks show that the results are unlikely to be completely overturned, i.e., obtaining a significantly negative slope of the equity yield curve.

2.3 A Numerical Example

Assume the market consists of two firms, k and l. Both firms are forecasted to pay next year a dividend of $D^k_{t+1} = D^l_{t+1} = 10$ each, such that market dividends are $D^m_{t+1} = 20$. While firm k is not forecasted any dividend growth, dividends of firm l are forcasted to grow at 15% per year forever. Hence, forecasted dividends in year 2 are $D^k_{t+2} = 10$ and $D^l_{t+2} = 11.5$, with market dividends in year 2 equal $D^m_{t+2} = 21.5$.

Firm k has a low cost of capital of $y^k_t = 5\%$ forever, while firm l has a high cost of capital with $y^l_t = 20\%$ forever. Assuming for simplicity an interest rate of 0% for all maturities, the discount rates equal the firms' risk premia. Using the constant growth formula, both firms have a market price of $P^k_t = P^l_t = 200$.

Using the cost of capital to discount future dividends, one can obtain the present values (i.e., spot prices) for all dividends $S^n_{t,\tau}$, see table 1.

Table 1: Example with 2 firms

	Firm k	Firm l	Market m (firm $k+l$)	Market discount rate $y^m_{t,\tau}$
g	0%	15%		
y_t	5%	20%		
P_t	200	200		
D_{t+1}	10.00	10.00	20.00	12.00%
$S_{t,1}$	9.52	8.33	17.86	
D_{t+2}	10.00	11.50	21.50	12.27%
$S_{t,2}$	9.07	7.99	17.06	

Aggregating the spot prices of future dividends over the market gives the price of total market dividends for both years, $S^m_{t,1} = 17.86$ and $S^m_{t,2} = 17.06$. Given the forecasted market dividend payments D^m_{t+1} and D^m_{t+2}, is it possible to calculate the (annualised) discount rate for market dividends: $y^m_{t,1} = 12.00\%$ and $y^m_{t,2} = 12.27\%$. That is, a two-year market dividend claim has a higher expected return than a one-year market dividend claim – the equity yield curve is upward-sloping.

This result is contingent on the assumption that firm l with the higher cost of capital is assumed to grow at a faster rate than firm k ($y_l > y_k$ and $g_l > g_k$): the weight of firm l's dividends of total market dividends increases from year 1 to year 2. Given that firm l has a higher expected return, the market equity yield increases. If, however, dividend growth and cost of capital are negatively correlated (e.g., $y_k > y_l$ and $g_k < g_l$), the equity yield curve is downward-sloping.

Finally, there are two conditions that result in flat market yield curves. First, if firms have the same cost of capital ($y_k = y_l$) but different growth rates ($g_k \neq g_l$), the relative weight of total market dividends changes, but the market yield is flat. Second, if firms have the same growth rate ($g_k = g_l$) but different costs of capital ($y_k \neq y_l$), the relative weight of market dividends remains constant, such that the market yield is equally flat.

3. Data and Descriptive Statistics

3.1 Data

This study estimates the U.S. equity yield curve each month from January 1990 to May 2019. Equity analyst earnings and dividend forecasts as well as long-term earnings growth forecasts are taken from IBES. We use the mean of all analyst forecasts, which are published on the third Thursday of each calendar month. To make sure that the equity yield curve estimates are based on publicly available information, we use share price data as of the same day, provided by CRSP. Fundamental company data, such as book value of equity, are obtained from Compustat. In the final sample, we use all observations for which there are enough data to estimate the firms' implied equity risk premia, including financial companies. To remove the impact of outliers, we keep only observations with risk premium estimates between 0.01% and 50%. Data for the U.S. term structure of interest rates, i.e., the zero-coupon spot yield curve, are taken from the Federal Reserve Board, using the methodology by Gürkaynak et al. (2007).[7]

3.2 Summary Statistics

Table 2 reports the summary statistics of the individual firm data. The mean equity risk premium is 6.5%, similar to Lee et al. (2009). Together with the average yield of ten-year government bonds of 4.6% over this period, this means an equal-weight expected return on equities of 11.1%, similar to Claus and Thomas (2001). The average firm size of the sample is at around USD 4,600 million in terms of market value, and at around USD 1,650 in terms of book value. The mean B/M ratio is at 0.63. More detailed summary statistics of firm-level data can be found in appendix B.

Panel B reports the correlation statistics. In line with the literature on the value premium, there is a strong positive association between the B/M ratio and equity risk premia – value stocks have on average higher expected returns (Graham and Dodd, 1934;

[7] The results are robust to using median instead of mean analyst forecasts, and not trimming the risk premium estimates.

Basu, 1983). Furthermore, there is a slightly negative association between firm size (as measured by both book and market value of equity) and equity risk premia, confirming that small firms have higher expected returns (Banz, 1981).

Table 2: Summary statistics: Firm data

Panel A: Descriptive statistics

	Mean	Std. dev.	25% centile	50% centile	75% centile
Equity risk premium (rp_t^i)	6.48%	3.47%	4.35%	6.01%	7.94%
Market value of equity (in mn USD)	4,622	21,003	158	563	2,151
Book value of equity (in mn USD)	1,646	7,736	78	241	851
B/M ratio	0.63	0.87	0.28	0.48	0.76

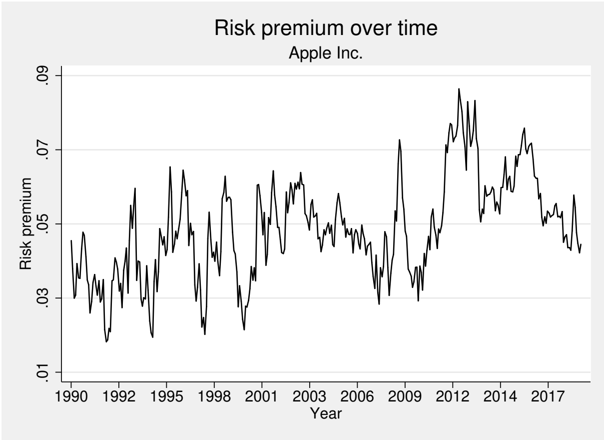
Panel B: Correlation statistics

	Risk premium	Market value	Book value	B/M ratio
Equity risk premium (rp_t^i)	1.000			
Market value of equity	-0.070***	1.000		
Book value of equity	-0.047**	0.816***	1.000	
B/M ratio	0.371***	-0.097***	-0.010	1.000

The table presents the summary statistics of the individual firm data. Panel A presents the mean, standard deviation, and quartiles of the firms' equity risk premia (rp_t^i), market value of equity, book value of equity, and the B/M ratio. Panel B presents the time-series averages of the linear correlation statistics, with standard errors being adjusted following Newey and West (1987) using 24 lags. The sample period is from January 1990 to May 2019. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively. Observations: 802,670.

Figure 1 plots the estimated risk premium exemplarily for Apple Inc. over time. The Great Financial Crisis 2007/09 is clearly visible, as there is a marked spike in the firm's risk premium. Also, following the death of Apple's founder and long-term CEO Steve Jobs in October 2011, Apple was perceived considerably more risky as the company's ability to continue its success story was questioned.

Figure 1: Risk premium of Apple Inc. (1990-2019)



4. Main Results

4.1 The Term Structure of Market Equity Yields

This section presents the estimates of the unconditional term structure of spot market equity yields obtained from the bottom-up approach. Table 3 presents the risk-free rate, market risk premium, and market equity yield (in percent) for selected maturities. Panel A presents the value-weighted aggregate market equity yields; panel B presents the equal-weighted market equity yields. The table also reports the slopes of the term structures, calculated as the difference in yields with maturities of 10 years and 1 year, following the convention of the spot bond yield curve. In addition, the table reports average yields over all maturities.

Table 3: Term structure of market equity yields

Panel A: Value-weighted market equity yields

	Maturity (τ) 1 year	5 years	10 years	20 years	30 years	Slope	All maturities
Risk-free rate ($i_{t,\tau}$)	3.09	4.01	4.73	5.24	5.23	1.64***	4.79
Risk premium ($rp^m_{t,\tau}$)	5.71	5.66	6.12	6.78	7.39	0.41***	6.48
Equity yield ($y^m_{t,\tau}$)	8.80	9.68	10.86	12.02	12.63	2.05***	11.27

Panel B: Equal-weighted market equity yields

	Maturity (τ) 1 year	5 years	10 years	20 years	30 years	Slope	All maturities
Risk-free rate ($i_{t,\tau}$)	3.09	4.01	4.73	5.24	5.23	1.64***	4.79
Risk premium ($rp^m_{t,\tau}$)	6.15	6.86	7.58	8.01	8.43	1.43***	7.67
Equity yield ($y^m_{t,\tau}$)	9.23	10.87	12.31	13.26	13.67	3.08***	12.46

The table presents the time-series averages of the monthly risk-free rate ($i_{t,\tau}$), market risk premium ($rp^m_{t,\tau}$), and market equity yield ($y^m_{t,\tau}$) for different maturities (in percent). Panel A presents the value-weighted aggregate market equity yields; panel B presents the equal-weighted aggregate market equity yields. The slope parameter is calculated as the difference in the 10-year and the 1-year yield. Statistical significance of the slope parameter is estimated using a t-test, with standard errors being adjusted following Newey and West (1987) using 24 lags. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively. The sample period is from January 1990 to May 2019.

Panel A shows that value-weighted market equity yields average at around 11.3% over the sample period. Short-term equity yields are considerably lower, reaching around 8.8%, while long-term yields with a maturity of 30 years are higher, at around 12.6%. Hence, equity yields increase with maturity. This can also be seen from the positive average slope parameter of 2.1%.

The market equity yield can be decomposed into nominal interest rates and the market risk premium. The risk-free rate contributes around 4.8% to the equity yield, while the risk premium accounts for another 6.5% – not very different from Li et al. (2013) that estimate a risk premium of 7.1% for the 1977-2010 period.

The equity yield curve is upward-sloping because both interest rates and the market equity risk premium are increasing with time to maturity. Most of the slope of the equity yield curve is due to the upward-sloping U.S. government bond yield curve. Yet, the term structure of equity risk premia also contributes 0.4% to the slope.

Equal-weighted market equity yields follow a similar pattern, see panel B. Since small companies have higher risk premia (Fama and French, 1993), market equity yields are higher than the value-weighted aggregate, which is dominated by large companies. The slope parameter is with 3.1% also considerably higher.

Figure 2 plots the time-series averages of the term structure of market equity risk premia, the term structure of interest rates, and the market equity yield curve. The graphs nicely illustrate the results conveyed in the table. The market equity yield curves are upward-sloping, on average. Most of the positive slope of the market equity yield curve can be explained by the upward-sloping term structure of interest rates, which exhibits is usual concave shape. The term structure of equity risk premia is also upward-sloping on average, albeit less so.

The value-weighted equity yield curve shows a small kink after year 5, the beginning of the transition period. This kink can be explained by the influence of large technology stocks in the years after 2010. Since the value-weighted approach is dominated by large companies, their large growth forecasts considerably shape the equity yield curve at the long end. In contrast, the equal-weighted equity yield curve is smooth.

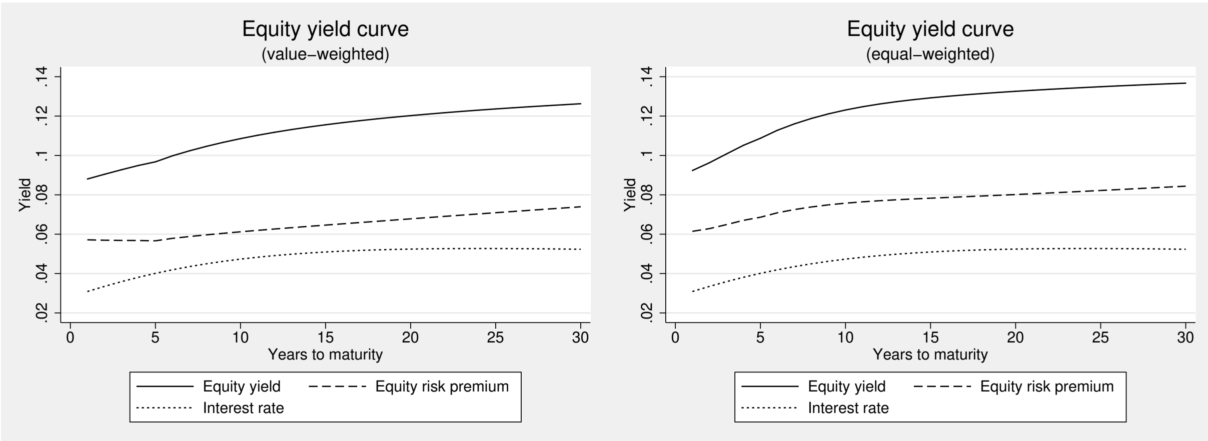
Note that the term structure of equity risk premia is upward-sloping even at the long end for maturities over 20 years. This result is driven by the assumption that the firms' returns on equity converge to the long-term industry average (see section 2.2.1). Thus, even in the long-run, some differences in expected return and firm growth persist. When assuming that all companies converge to economy-wide averages, the term structure of market equity risk premia is equally upward-sloping, but flat in the long-run.[8]

Taken together, the bottom-up approach produces an upward-sloping equity yield curve. While most of the upward-sloping equity yield curve is due to an upward-sloping term structure of interest rates, the term structure of equity risk premia is increasing with the time to maturity as well. Most of the dynamics of the yield curve are at the short-end

[8]See Fairfield et al. (2009) and Schröder and Yim (2018) for some discussion.

of the curve, i.e., for maturities up to 10 years. For longer maturities, the equity yield curve is rather flat.

Figure 2: Average market equity yield curve (1990-2019)



The graphs plot the time-series averages of the term structure of market equity risk premia ($rp^m_{t,\tau}$), the term structure of interest rates ($i_{t,\tau}$), and the market equity yield curve ($y^m_{t,\tau}$) of the United States from January 1990 to May 2019. The graph on the left shows the value-weighted market equity yield curve; the graph on the right shows the equal-weighted market equity yield curve.

Recall that these results are obtained assuming individual equity yield curves to consist of a flat risk premium over the term structure of interest rates. The shape of the market equity yield curve is thus not driven by the term structure of firm-level equity risk premia: If all companies were predicted to grow at the same rate, the market term structure of equity risk premia would be flat (see section 2.3).

The finding of an upward-sloping term structure of market equity risk premia therefore results from a positive relation between expected returns and projected dividend growth rates (see also appendix B). Thus, the weight of companies with high expected returns is expected to increase with the investment time horizon. The slope of the term structure of market equity risk premia thus measures the aggregation effect that drives the market-level term structure of equity risk premia. A positive slope means that the aggregation effect is positive.

This result mirrors prior empirical evidence by Schröder and Esterer (2016) that present a positive association between forecasted cash flow growth and expected stock returns when estimating the cash-flow duration for a large cross-section of firms. More recently, Gormsen and Lazarus (2023) present a negative relation between expected growth rates and ex-post observable (excess) returns. Since there are potentially many reasons for our results to differ from Gormsen and Lazarus (2023), appendix C presents a detailed analysis that reconciles the results of both studies. The main reason for the difference in results is that Gormsen and Lazarus (2023) examine 10 value-weighted portfolios. Since the correlation between firm size and (expected) returns declines with the firms' predicted growth, using value-weight portfolios increases (decreases) excess returns of portfolios with low (high) expected growth rates.

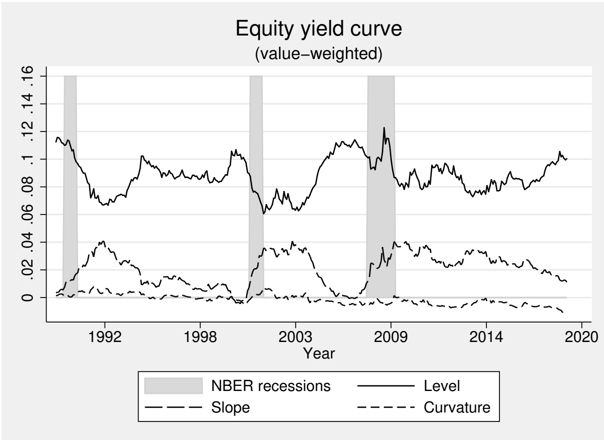
4.2 The Equity Yield Curve Over Time

Figure 3 presents estimates of the level, slope and curvature of the market equity yield curve over time. The level is measured as the short end of the equity yield curve, which corresponds to the 1-year market equity yield. The slope is calculated as the spread between 10-year and 1-year market equity yields. Following the convention of the bond yield curve, the curvature parameter is calculated as the spread of the 5-year market equity yield over the average of the 1-year and 10-year yields (butterfly spread).[9]

The chart shows considerable variation in the equity yield curve over time. The level of the equity yield curve moves in the interval between 6% and 12%. Matching the term structure of interest rates, it declines during economic recessions. In the sample period, it reaches an all-time low in December 2001, just after the end of the recession in the early 2000s. Its highest level is reached in November 2008, at the peak of the Great Financial Crisis 2007/09.

[9]This section presents the results obtained from the value-weighted market equity yield curve. Using the equal-weighted yield curve results in qualitatively similar estimates.

Figure 3: Level, slope and curvature parameters of the U.S. equity yield curve



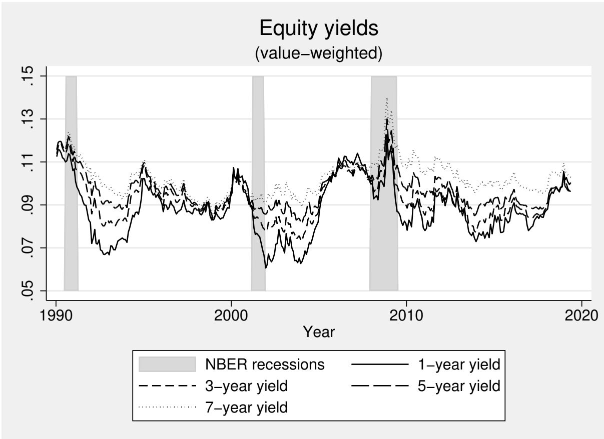
The graph plots the level, slope and curvature parameters of the market equity yield curve of United States from January 1990 to May 2019. NBER recessions are marked in grey.

The slope parameter follows an inverse pattern of the level, increasing during times of economic recessions, i.e., the slope is pro-cyclical. It moves in a narrow interval between 0% and 4%. Since level and slope add up to the 10-year yield, this indicates that (1) most changes in the market equity yield curve occur at the short end, and (2) expected returns of long-horizon equity are relatively stable over time. Indeed, with the exception of the Great Financial Crisis, 10-year equity yields have moved in a narrow interval between 9% and 12% in the sample period. As such, the stability of long-term equity yields is not surprising as long-term interest rates and market risk premia are more stable than their short-term counterparts.

Finally, there is not a lot of curvature in the equity yield curve – effectively implying that the market equity yield curve is more a line than a curve, which can be captured sufficiently well by the level and slope parameters.

Figure 4 plots the market equity yields for maturities of 1, 3, 5, and 7 years over time. This chart confirms some of the patterns identified before, notably the alternating slopes of the equity yield curve: while most of the time, long-term equity yields are higher than short-term yields, there are also periods with flat and downward-sloping yield curves, especially before economic recessions.

Figure 4: Dynamics of the U.S. equity yield curve for different maturities



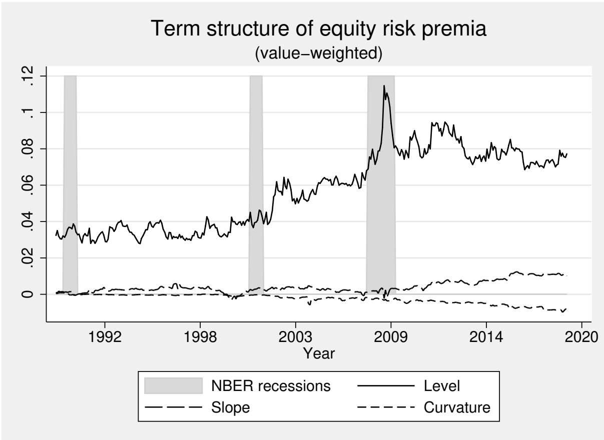
The graph plots the U.S. market equity yields for maturities of 1, 3, 5, and 7 years from January 1990 to May 2019. NBER recessions are marked in grey.

To better understand the dynamics of equity yield curve, figure 5 presents the level, slope and curvature parameters of the term structure of equity risk premia. The figure shows that the level of the market equity risk premium increased over time. While it is below 4% in the 1990s, it reaches 8% and more in the 2010s.

To some extent, this upward trend can be explained by the decline in nominal interest rates. Risk premia are not directly observable, but are obtained by subtracting the term structure of interest rates from the equity yield, see equation (8). While long-term equity yields are rather stable, as mentioned before, 10-year interest rates have substantially declined from 9% to 4% from 1990 to 2019. As a result, the risk premium increased – a pattern similar to Li et al. (2013).

The market equity risk premium attained its peak of almost 12% during the Great Financial Crisis. In this time of high economic uncertainty, the risk premium was very high, resulting in low equity prices. Apart from the Financial Crisis, there is little business cycle variation in equity risk premia. Since the underlying firm-level risk premia are assumed flat, they capture risk premia over all maturities in one estimate. As a result, this approach is less suitable in capturing short-term business cycle fluctuations of risk premia also at the market level.

Figure 5: Level, slope and curvature of the U.S. term structure of equity risk premia



The graph plots the level, slope and curvature parameters of the term structure of equity risk premia of United States from January 1990 to May 2019. NBER recessions are marked in grey.

The average slope of the term structure of the market equity risk premia, capturing the aggregation effect, is not very steep. In fact, until the Great Financial Crises, the slope is close to flat. Only from 2009 onwards, the slope is consistently positive, reaching more than one percentage point. Yet, it shows some pattern of cyclicality: in each of the recessions, the slope of the term structure of risk premia is negative at some point, i.e., the term structure of risk premia is inverted. A time-varying aggregation effect means that investors constantly revise their growth forecasts of high-risk relative to low-risk companies, resulting in a more or less pronounced slope of the term structure of equity risk premia. This pattern will be analysed in section 5. in more detail.

Taken together, the figure confirms that it is not only the dynamics of the risk-free rate that generates fluctuations in the equity yield curve, but highlights the importance of changes in the term structure of equity risk premia.

4.3 Sub-samples

This section analyses the term structure of equity risk premia for different stages of the business cycle as well as for selected sub-samples of firms.[10]

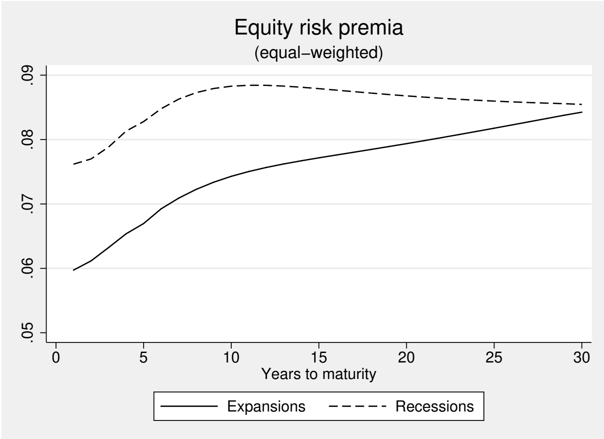
Figure 6 plots the term structure of market risk premia separately for economic expansions and recessions. In line with the theoretical prediction of standard asset pricing theory (Campbell and Cochrane, 1999), equity risk premia are significantly higher during economic recessions relative to expansions. Up to a maturity of about 10 years, there is a parallel shift with equity risk premia being 1.5% higher during recessions. However, the difference between risk premia disappears at the long end of the curve. This is intuitive, as the long-term equity risk premia should not be influenced by short-term economic circumstances.

Figure 7 plots the term structure of market equity risk premia for different sub-samples of firms. Mirroring Fama and French (1993), value firms and small firms have higher equity risk premia than growth firms and large firms.[11] While the term structure of market equity risk premia is upward-sloping for all sets of firms, the slope is highest for growth stocks, with a difference between short-term and long-term yields of about 3%.

[10] This section presents the results obtained from the equal-weighted equity risk premia, as this specification shows more pronounced differences across the various sub samples. The results are qualitatively similar for the value-weighted term structure of equity risk premia.

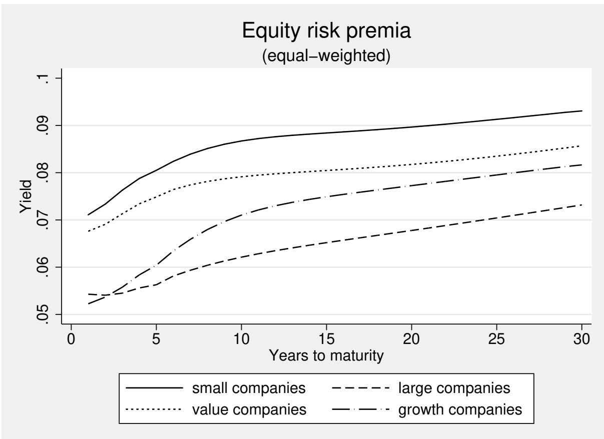
[11] This study follows Fama and French (1993) and defines growth stocks as stocks with low book-to-market ratios, and value stocks as stocks with high book-to-market ratios.

Figure 6: The term structure of equity risk premia and the business cycle



The graph plots the term structure of market equity risk premia of United States from January 1990 to May 2019 for different stages of the business cycle. Business cycle data is obtained from the NBER.

Figure 7: Term structure of equity risk premia by sub-samples



The graph plots the term structure of market equity risk premia of United States from January 1990 to May 2019 for selected sub-samples. The breakpoint between small/large and value/growth stocks is the rolling monthly median market capitalization and B/M ratio of all companies in the sample.

4.4 Downward-sloping Firm-level Risk Premia

As observed before, the positive aggregation effect it is driven by the empirical finding of a positive association between expected returns and dividend growth. It is thus independent of any assumption on firm-level risk premia. Instead of flat equity risk premia, as used so far, different assumptions or data for firm-level equity yields could be considered. If a full data set of dividend futures for all firms was available, one could possibly obtain different shapes of the market equity yield curve, but the positive aggregation effect will be the same. Callen and Lyle (2020), for example, show that firm-level equity yields are increasing with the time to maturity, on average. Combining this insight with our findings would suggest that the slope of the market equity yield curve is even greater than our calculations.

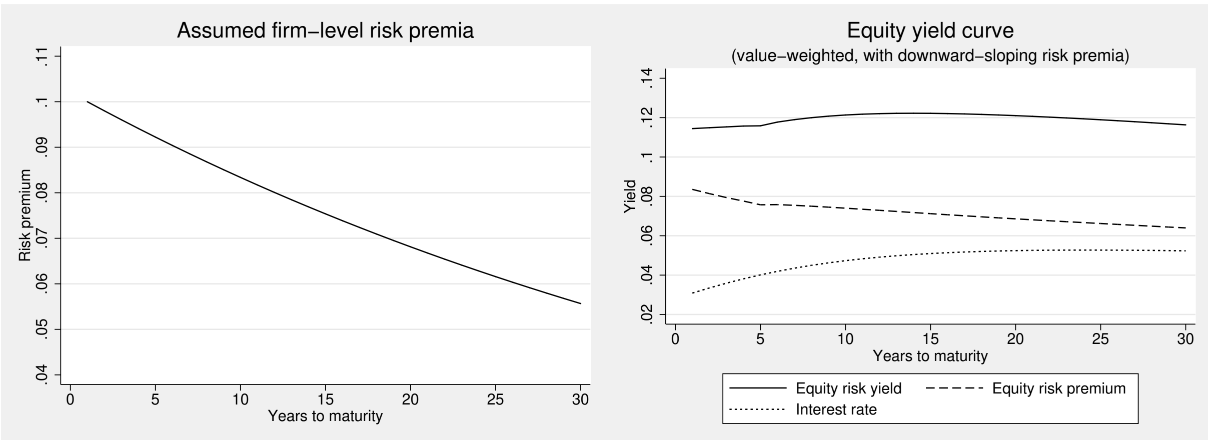
The argument behind the aggregation effect can also be reversed. Every estimated (or exogenously specified) shape of the market equity yield curve has some direct implications for the pricing of individual, firm-specific dividend payments. A positive aggregation effect implies a negative disaggregation effect – individual yield curves are less upward-sloping (or more downward-sloping) than those of the market. Previous empirical studies on the market equity yield curve that document a positive slope, e.g., Miller (2020) or Bansal et al. (2021), would then be consistent with flat firm-level equity risk-premia, exactly matching the underlying assumption of our study.

This means that if firm-level equity risk premia are sufficiently downward-sloping, the aggregate equity yield curve is downward sloping as well – despite a positive correlation of the firms' expected returns and growth rates. To see this, this section derives an approximate bound for the slope of firm-level risk premia, below which the market equity yield is downward sloping. This lower bound is obtained by re-estimating the market equity yield curve under the assumption that firm-level equity risk premia are downward-sloping such that the market equity yield curve is flat.

Suppose that risk premia decline geometrically by 2% each year going into the future. For a company, e.g., with a short-term, 1-year risk premium of 10%, the two-year ahead risk premium is only 9.8%, and so on. As a consequence, the long-term 30-year equity risk premium is just around half of the short-term risk premium, which corresponds to a considerable negative slope of firm-level equity yields. This pattern is illustrated in the graph on the left side of figure 8.

Such a pattern of firm-level risk premia can also be obtained when replacing the assumption of flat firm-level risk premia with flat equity yields, i.e., $y^n_{t,\tau_k} = y^n_{t,\tau_l}, \forall k, l$. Although this assumption does not seem very realistic at the firm level, the term structure of firm-level risk premia is then $rp^n_t = y^n_t - i_{t,\tau}$. Given the usual concave term structure of interest rates, firm-level risk premia are downward-sloping.

Figure 8: Equity yield curve with downward-sloping risk premia



The graph on the left plots the term structure of firm-level equity risk premia under the assumption that the risk premium declines by 2% each year, exemplarily for a firm that has a short-term risk premium of 10%. The graph on the right plots the resulting (value-weighted) time-series averages of the term structure of market equity risk premia, the term structure of interest rates, and the market equity yield curve.

The graph on the right side of figure 8 then shows the aggregate market equity yield curve derived from such firm-level equity yields. The market equity risk premium is now downward-sloping, but much less than the firm-level risk premia. When adding the term structure of interest rates, the resulting equity yield curve is close to flat. Hence, unless firm-level risk premia are much more downward-sloping than previously thought, it seems difficult to support a downward-sloping market equity yield curve.

4.5 Entry and Exit

The market equity yield curve is obtained by aggregating future dividend payments and expected returns of existing companies over the market. This approach therefore implicitly assumes that there is no change in the market composition. Yet, new companies continuously enter the market, while others leave the market. If there is a systematic difference between entering and exiting firms in terms of expected returns, then the equity yield curve estimates are biased. For example, if entering firms have lower expected returns than the market average (and investors correctly anticipate this pattern), expected future market returns are lower than if there is no change in the market composition.[12]

Table 4 shows that the time-series average of market-cap weighted risk premia of entering firms (post-entry) is with 6.4% of equal magnitude as the risk premia of exiting firms (pre-exit). In contrast, risk premia of continuing firms are with around 5.6% the lowest. The table further suggests that these higher risk premia can be explained by size and value effects (Fama and French, 1993). Additional analysis shows that the times-series averages of risk premia of entering and exiting firms are not significantly different from each other.

Table 4: Characteristics of the firms entering, continuing, and exiting the market

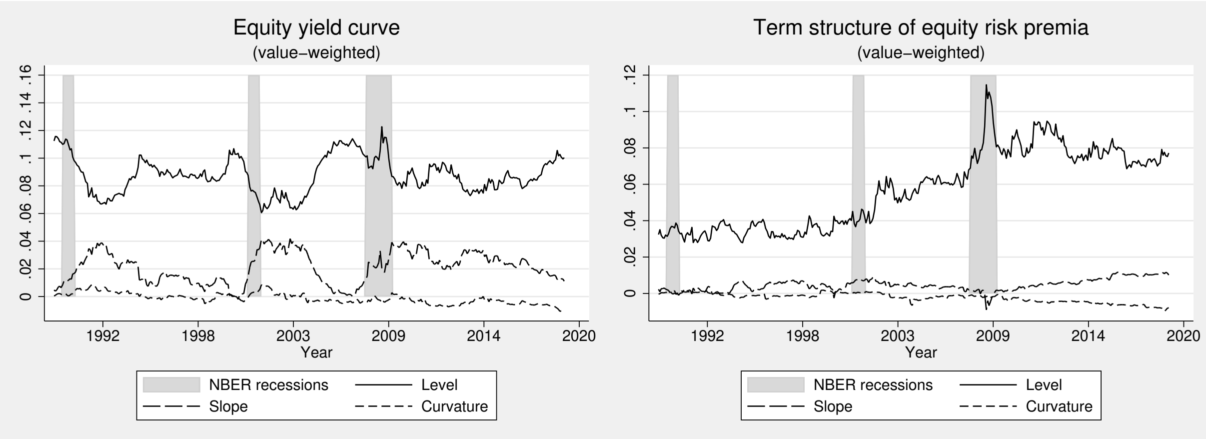
Firm type	Number	Risk premia	Firm size (in mn)	B/M ratio
Entering firms	24.7	6.36%	1,646	0.55
Continuing firms	2229.3	5.63%	4,585	0.36
Exiting firms	23.7	6.40%	821	0.72

This table presents the monthly times-series average characteristics of the firms entering (post-entry), continuing, and exiting (pre-exit) the market. Risk premia and B/M ratio are market-capitalization weighted averages. The sample period is from January 1990 to May 2019.

[12] Some literature points in this direction. Baker and Wurgler (2002) and Ritter and Welch (2002) show that newly public firms tend to have relatively low book-to-market ratios and low expected returns.

As a second test, figure 9 presents an estimate of the equity yield curve that assumes perfect foresight of all future additions and deletions of the data sample.

Figure 9: Equity yield curve assuming perfect foresight



This figure presents the level, slope and curvature parameters of the equity yield curve assuming perfect foresight of future additions and deletions of the data sample. The chart on the left presents the equity yield curve; the chart on the right the term structure of equity risk premia.

The two figures are very similar to the baseline analysis presented in figures 3 and 5. Taken together, these two analyses suggests that anticipated changes in the stock market composition are unlikely to have a significant impact on the equity yield curve estimates.

4.6 Relation to the Literature

4.6.1 Market-level Equity Yields

Despite the simplistic assumption of flat firm-level risk premia, the estimates of the aggregate market equity yield curve are largely in line with prior empirical studies. Most of these studies are based on prices of index dividend futures. Binsbergen et al. (2013) estimate the term structure of forward equity yields with maturities up to 7 years, which they define as the annualised ratio of current index dividends over the forward price of the future index dividends. They find that forward equity yields are on average upward-sloping, as well as pro-cyclical: downward sloping during the Great Recession, but upward-sloping otherwise. They also econometrically decompose the forward equity yield into risk premia and expected dividend growth rates. They find that the slope of the term structure of risk premia is positive and inverted in the Great Recession – similar to the results of this study.

Bansal et al. (2021) build on Binsbergen et al. (2013), using a longer data sample. They not only confirm the results by Binsbergen et al. (2013), but they also report results for the economically more important concept of equity yields as defined in this paper (called ‘hold-to-maturity expected returns’ in Bansal et al. (2021)). To that end, they econometrically forecast dividend growth, similar to Binsbergen et al. (2013). Similar to the findings of this study, they report a positive unconditional slope of both the equity yield curve and the term structure of equity risk premia. In addition, they show that both measures are pro-cyclical – again similar to the results of the present study.

More recently, Giglio et al. (2023) estimate an affine model of equity prices, dividends and returns, which allows them to price dividend strips. This approach is elegant as it allows extracting the equity term structure using only equity price data (and the term structure of interest rates). Therefore, they can extend the time-series of term structure estimates back to the time when index dividend futures were not available.

To validate their approach, their first compare their estimates for the Bansal et al. (2021) sample when index dividend futures are available, before then extending the analysis starting in the 70s. In this longer sample, they find that the forward yield curve is mildly upward-sloping on average, but inverting in all recessions. This finding is again qualitative similar to the results of this paper. Different from this paper, however, the sample average is not significantly positive. Yet, it is important to recall that the forward yields reported by Giglio et al. (2023) are different to the (hold-to-maturity) equity yields reported in this paper, such that they are not directly comparable.[13]

[13]Forward equity yields (Binsbergen et al., 2013) are defined as $f^m_{t,\tau} = rp^m_{t,\tau} - g^m_{t,\tau}$, where $g^m_{t,\tau}$ is the

Following Binsbergen et al. (2013) and Bansal et al. (2021), Giglio et al. (2023) also report equity risk premium estimates. They find that the 5-year market risk premium decreases from 5-10% in the 70s/80s to values close to 0% around the year 2000. After that, the risk premium is essentially flat, with the exception of the Great Financial Crisis. The results of this paper match the upward trend in the 2000s, but not the decline before and after, presumably because of the effect of changes in long-term interest rates on the risk premium estimates.

Finally, Miller (2020) uses replication and no-arbitrage pricing to estimate the term structure of equity risk premia for maturities up to 5 years. For the period from 1950 to 2014, he finds that the term structure is unconditionally upward-sloping.

From a theoretical perspective, our estimates are in line with standard asset pricing models. Consumption-based models with external habit à la Campbell and Cochrane (1999) and the long-run risk-model (Bansal and Yaron, 2004) produce an unconditionally upward-sloping term structure of equity risk premia. The rare disasters model by Gabaix (2012) implies a flat term structure of equity risk premia. If taking the stance that the average term structure of equity risk premia is close to flat, our results could also sustain this asset pricing model. Since we also document a pro-cyclical variation of the slope parameter, the Bansal and Yaron (2004) model is closest to our empirical findings, see Gormsen (2021).[14]

4.6.2 Firm-level Equity Yields

The baseline assumption of flat firm-level equity yields is mainly driven by the lack of firm-level dividend strips. There are, however, a few studies that aim at estimating firm-level expected returns for different maturities. Callen and Lyle (2020) find that the firm-level term structure of risk premia is increasing with maturity, with the exception of the Great Financial Crisis 2007/09. Since their empirical tests rely on the availability of

growth rate of dividends from t to $t + \tau$.

[14]For good overviews of these models, see Binsbergen et al. (2012), Binsbergen and Koijen (2017), or Gormsen (2021). It should be noted, however, that the models are based on a single dividend growth process, and therefore do not allow for a distinction between firm-level and market-level equity yield curves.

put and call options, they can however only estimate the term structure for maturities up to 24 months. Gormsen and Lazarus (2023) use prices of exchange-traded single-stock dividend futures estimate expected returns of a small set of firms for up to 4 years into the future. They find that the CAPM alpha of expected returns decreases in maturity. Finally, Giglio et al. (2023) estimate the term structure of risk premia for different sets of actively managed portfolios, such as value versus growth portfolios, or small versus large firms. Their results suggest, among others, that the SMB portfolio has a downward-sloping term structure, while the HML portfolio has an upward-sloping term structure. Yet, Giglio et al. (2023) do not provide empirical evidence for single stocks.

4.6.3 Equity Duration

The evidence of an upward-sloping equity yield curve challenges the duration-biased explanation of the value premium by Lettau and Wachter (2007, 2011). In their attempt to explain the value premium by differences in the firms' cash-flow timing, they assume a downward-sloping equity yield curve. Since in their model, the term structure of interest rates is constant and flat, this assumption implies a downward-sloping term structure of equity risk premia. Under the premise that value stocks are short-term stocks, a downward-sloping term structure of equity risk premia can explain the value premium.[15] The upward-sloping term structure of market equity risk premia presented earlier questions this assumption.

However, an upward-sloping equity yield curve does not contradict the findings of the empirical equity duration literature. These studies document a negative relation between the firms' *equity duration* and (expected) stock returns.[16] Inspired by the seminal paper by Dechow et al. (2004), these papers transfer the idea of bond duration to equity shares. Bond duration, however, uses the bond price as input variable. A low price implies a high yield to maturity (corresponding to high risk), which automatically translates in a

[15] A series of recent papers motivates the assumption of a downward-sloping term structure of equity risk premia. See, e.g., Belo et al. (2015), Croce et al. (2015), Mafre (2017), or Ai et al. (2018).

[16] See, for example, Schröder and Esterer (2016), Weber (2018), Goncalves (2021), Binsbergen (2021), Chen (2022), or Chen and Li (2023). The duration concepts proposed in these papers differ from each other, but most of their underlying ideas are very similar.

short bond duration. When transferring the concept to equities, the same mechanism holds true, generating a negative relation between (expected) returns and duration by construction. For example, when using the Gordon (1962) growth model to price equities, Leibowitz et al. (1989) show that equity duration is given as

$$DUR_t = \frac{1}{y_t - g_t}. \tag{16}$$

The higher expected returns y_t, the shorter is the equity duration. Equity duration therefore combines risk considerations (y_t) and cash flow timing (as captured by the cash flow growth rate g_t) in one single parameter. It is not an unambiguous measures of cash flow timing (Hansen et al., 2008), and therefore does not allow for any conclusion about the relation between the timing and pricing of equity cash flows, i.e., the equity yield curve.

4.6.4 Cash-flow Duration

In contrast, cash-flow duration (Da, 2009) allows for some conclusion about the term structure of equity yields. Cash-flow duration measures the weighted average time until a firm's dividend payments are received. Since it does not rely on price information, it can be considered a non-linear transformation of future cash flow or dividend growth rates. Using different empirical approaches, these studies come to different conclusions about the relation between cash-flow growth and firm risk premia, the focal point of this study. Looking at historical data, Da (2009) finds no significant relation between ex-post cash-flow duration and historical portfolio excess returns. More recently, Gormsen and Lazarus (2023) suggest a hump-shaped relation between future cash-flow duration and portfolio excess returns. Long-term equity has slightly lower excess returns than short-term equity, but the relation is not significant. Finally, Schröder and Esterer (2016) adopt an entirely forward-looking approach, similar to this paper. They find a significantly positive relation between forecasted cash-flow duration and expected stock returns.

5. Term Structure of Market Risk Premia and Stock Returns

This section tests the informational content, and thus validity, of the estimated term structure of equity risk premia by analysing its relation to stock market returns.

5.1 Predictive Regressions

In a first step, we estimate time-series regressions of the three Fama and French (1993) factor returns on the level, slope, and curvature parameters of the term structure of equity risk premia.[17]

The market factor ($RM - RF$) captures the time-series dimension of stock returns. High expected market risk premia should be followed by high subsequent actual market returns. Hence, we expect the level of equity risk premia to predict the market factor. In addition, a positive slope is a sign that market risk premia are expected to increase. Therefore, we also expect the slope parameter to predict stock market returns.

The size (SMB) and value (HML) factors capture some of the cross-sectional variation in stock returns, as they measure the relative performance of different subsets of equity shares. Since the slope of the term structure of equity risk premia reflects cross-sectional differences in the firms' expected risk premia and growth rates, it should be related to the two Fama and French (1993) factors. As the term structure of equity risk premia is dividend-weighted, its shape is mainly driven by large companies. A positive slope of the market risk premium therefore not only means that companies with high equity risk are predicted to grow faster than the market average, but that these companies have to be large as well. Hence, we expect a negative relation between the slope parameter and the size factor. The slope of the term structure of equity risk premia should also have some predictive power for the value factor: To the extent that growth stocks are long-duration assets, a positive slope implies that growth stocks have higher expected returns than value

[17]Since the Fama and French (1993) factors are value-weighted, this section is based on value-weighted market equity yield curve estimates.

stocks. Thus we expect a negative relation between the slope parameter and the value factor.

To test these hypotheses, we use multi-period univariate predictive regressions (Fama and French, 1988, 1989) for time horizons up to 48 months:

$$r_{t,t+k} = \alpha + \beta X_t + \varepsilon_{t,t+k}, \tag{17}$$

where $r_{t,t+k}$ captures the annualised factor returns from t to $t+k$ (k indicating months), and X_t denotes the term structure parameters. For factor returns of more than one month we use overlapping observations, and adjust standard errors for serial correlation (Newey and West, 1987).

Panel A of table 5 presents the predictive power of the three term structure parameters for the market excess return. As conjectured, the table shows a positive relation between the level of market risk premia and subsequent market excess returns. Yet, the relation is not statistically significant. To some extent, the weak predictive power of the level parameter might be explained by the absence of short-term business cycle fluctuations in equity risk premia, as discussed earlier (section 4.2). Another explanation is the increase in risk premia over the sample period, caused by the decline in interest rates.

The panel also shows a strongly positive and significant relation between the slope parameter and the market factor. This suggests that the risk-premium spread is equally a good empirical proxy for time-varying equity risk, in line with Callen and Lyle (2020). Similarly, Viceira (2012) show a positive relation between the yield spread and bond returns. Finally, there is no relation between the curvature parameter and the market factor.

Panel B confirms a negative association between the slope parameter and returns of the size factor SMB. A negative association with the size factor means that in times of a positive term structure of equity risk premia, the size effect is reversed: large companies provide higher average returns than small companies. Finally, and also in line with the conjecture, panel C shows a significant relation between the value factor HML and the

Table 5: Prediction of Fama and French (1993) factors

Panel A: Market factor ($RM - RF$)

		Level		Slope		Curvature	
Factor returns	# Lags	$\hat{\beta}$	t-stat.	$\hat{\beta}$	t-stat.	$\hat{\beta}$	t-stat.
1 month	2	0.70	(0.46)	10.48	(1.51)	-6.26	(-0.65)
6 months	9	1.16	(0.98)	13.25**	(2.13)	-7.03	(-1.02)
12 months	18	1.01	(0.90)	12.75*	(1.82)	-6.41	(-0.86)
24 months	36	1.32	(1.15)	13.91**	(2.01)	-8.01	(-1.15)
36 months	54	1.26	(1.08)	14.15**	(2.38)	-10.61	(-1.48)
48 months	72	1.33	(1.20)	10.55**	(2.30)	-9.59	(-1.34)

Panel B: Size factor (SMB)

		Level		Slope		Curvature	
Factor returns	# Lags	$\hat{\beta}$	t-stat.	$\hat{\beta}$	t-stat.	$\hat{\beta}$	t-stat.
1 month	2	0.40	(0.44)	-3.28	(-0.45)	0.05	(0.01)
6 months	9	0.50	(0.70)	-3.31	(-0.89)	2.50	(0.44)
12 months	18	0.28	(0.45)	-5.30**	(-2.04)	4.50	(0.95)
24 months	36	0.14	(0.22)	-5.61***	(-2.75)	3.87	(0.89)
36 months	54	-0.11	(-0.17)	-5.67**	(-2.40)	3.94	(0.89)
48 months	72	-0.23	(-0.40)	-5.48**	(-2.08)	4.12	(1.02)

Panel C: Value factor (HML)

		Level		Slope		Curvature	
Factor returns	# Lags	$\hat{\beta}$	t-stat.	$\hat{\beta}$	t-stat.	$\hat{\beta}$	t-stat.
1 month	2	-1.67	(-1.45)	-6.81	(-0.93)	11.64	(1.55)
6 months	9	-1.27	(-1.25)	-9.60	(-1.26)	11.81	(1.63)
12 months	18	-1.49	(-1.52)	-13.99*	(-1.78)	14.24**	(2.02)
24 months	36	-1.84**	(-2.52)	-16.67***	(-2.65)	18.75***	(3.87)
36 months	54	-1.88***	(-3.18)	-14.69***	(-3.22)	18.11***	(6.26)
48 months	72	-1.77***	(-3.55)	-12.12***	(-2.94)	15.59***	(5.35)

The table presents the results of univariate regressions of annualised returns of the market factor ($RM - RF$, panel A), the size factor (SMB, panel B), and the value factor (HML, panel C) on the level, slope and curvature parameters of the term structure of equity risk premia for time horizons up to 48 months. Monthly returns of the market, size and value factors are taken from Kenneth French's website. T-statistics, adjusted for serial correlation (Newey and West, 1987), are in parenthesis below the coefficients estimates. The number of lags is set to 1.5 times the forecast horizon (overlapping observations). The sample period is from January 1990 to May 2019, with stock returns up to May 2023. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

slope parameter. A negative association with the value factor means that a positive term structure of equity risk premia reverses the value effect: companies with low B/M ratios yield higher average returns than companies with high B/M ratios.

Overall, the results show that the shape of the term structure of equity risk premia has informational content for future stock market returns, both in the time-series and cross-sectional dimension. In the time-series dimension, there is a positive association between the slope parameter and future stock market returns. In the cross-sectional dimension, there is a negative association between the slope parameter and both size and value factors.

Taken together, this evidence also shows that the predictions that govern the shape of the term structure of equity risk premia are accurate, on average. A positive slope means that companies with higher future growth rates carry higher risk premia. In these periods, subsequent market returns are therefore higher compared to periods with a flat term structure of equity risk premia. The negative association with the size and value factors then shows that this higher-than-average market return is largely driven by strong returns of large growth stocks.

5.2 Investment Strategies

Against the backdrop of these results, we examine whether it is possible to set up profitable trading strategies based on the slope of the term structure of equity risk premia. We investigate returns of zero-investment long-short asset allocation strategies that use the slope parameter as market timing signal.

For the market factor, we consider a strategy (strategy A) that goes long if the slope parameter is above the 30 percentile of the sample, and shorts the market factor if it is below the 30 percentile.[18] For the size and value factors, this strategy consists of a long position if the slope is lower than the sample median, and a short position otherwise. This strategy reflects the negative association between factor returns and stock returns documented in the last section.

[18]The monthly market factor return was positive in 30% of the sample period.

For size and value factors, we also consider a more aggressive strategy (strategy B) which is based on the 25 value-weight portfolios formed on market capitalisation (size) and B/M ratio (value). It consists of a long-short position in the 5 small (value) portfolios less the 5 large (growth) portfolios, again using the slope of the term structure of market risk premia as timing signal.

Table 6 presents the annual returns of the investment strategies, as well as their Sharpe (1966) ratios. Next to the investment returns, the table also presents the returns of the factors as a benchmark. For holding periods of more than one month, we examine the returns of overlapping investment strategies, similar to Jegadeesh and Titman (1993) that look into the profitability of momentum strategies. In practice this would mean to invest in a composite portfolio where each month an equal fraction of total wealth is revised. For example, for investments with a 3-month holding period this means that a third of total assets being reshuffled at the end of each month.

Long-short investments involving the market factor provide higher average returns than the market factor itself, at least for holding periods of 3 months and more. The return of this strategy is significantly positive, and often provides higher Sharpe ratios than the market factor itself. The returns of investment strategies involving the size factor show a similar picture. Both tactical investment strategies yield higher returns than the benchmark. For holding periods of 9 months and more, the investment return of strategy A is significantly positive while the factor return itself is not. The more aggressive strategy B reaches a return of up to 3.2% p.a., with Sharpe ratios almost twice as high as the SMB factor. In contrast, investment strategies involving the value factor do generally not consistently outperform their benchmark return. Only for shorter holding periods of up to 6 months, both investment strategies are better in terms of returns and Sharpe ratios than the HML factor.

Although this analysis is abstracting from transaction costs, the results suggest that investors can use changes in the term structure of equity risk premia to improve the market timing of their allocation to standard stock market risk premia.

Table 6: Long-short investment returns

Holding period		Factor Return	Factor Sharpe ratio	Strategy A Return	Strategy A Sharpe ratio	Strategy B Return	Strategy B Sharpe ratio
1 month	$RM - RF$	7.95%***	0.156	6.80%**	0.133		–
	SMB	1.39%	0.036	1.41%	0.037	1.76%	0.032
	HML	1.77%	0.050	3.45%*	0.097	4.07%	0.077
3 months	$RM - RF$	8.19%***	0.270	8.60%***	0.285		–
	SMB	1.30%	0.060	1.09%	0.050	1.50%	0.046
	HML	1.93%	0.082	2.44%	0.104	3.40%	0.100
6 months	$RM - RF$	8.28%***	0.381	9.06%***	0.423		–
	SMB	1.15%	0.082	2.12%*	0.151	2.92%	0.136
	HML	2.14%	0.118	2.00%	0.110	2.18%	0.090
9 months	$RM - RF$	8.55%***	0.478	9.19%***	0.524		–
	SMB	1.19%	0.105	2.29%**	0.206	3.15%*	0.178
	HML	2.22%	0.143	1.71%	0.110	1.69%	0.081
12 months	$RM - RF$	8.69%***	0.548	8.90%***	0.565		–
	SMB	1.24%	0.130	2.46%***	0.265	3.22%**	0.220
	HML	2.18%	0.152	2.10%	0.147	2.17%	0.114

The table reports the annualised returns of long-short investments using the slope of the term structure as timing signal. As benchmark, the two columns on the left present the returns and Sharpe (1966) ratios of the three Fama and French (1993) factor returns, i.e., the market factor ($RM - RF$), the size factor (SMB), and the value factor (HML).
For the market factor, strategy A consists of a long position if the slope is higher than the sample 30-percentile, and a short position otherwise. For size and value factors, strategy A consists of a long position if the slope is lower than the sample median, and a short position otherwise. Strategy B is based on the 25 value-weight portfolios formed on market capitalisation (size) and B/M ratio (value). It consists of a long-short position in the 5 small (value) portfolios less the 5 large (growth) portfolios, again using the slope of the term structure of market risk premia as timing signal.
The factor returns and returns of the 25 value-weight portfolios formed on market capitalisation and B/M ratio are obtained from Kenneth French's website. Standard errors are adjusted for serial correlation (Newey and West, 1987). *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively. The sample period is from January 1990 to May 2019, with returns up to May 2020.

6. Robustness Checks

This section presents several robustness checks of the baseline model. These analyses show that the main results are largely robust to changes in the empirical set-up.

6.1 Regression-based Earnings Forecasts

In the baseline analysis, future earnings and dividends are obtained from equity analyst forecasts. While this approach is intuitive and common practice in the literature, it comes with two major drawbacks.

First, not all companies listed in the U.S. equity market are followed by equity analysts, which means that the estimated aggregate equity yield curve does not reflect the entire U.S. equity market. Especially small companies (too small to be of interest to institutional investors) and companies with high B/M ratios (considered a sign of distress) are not always followed by equity analysts. Yet, such companies have shown to provide higher returns, on average. An argument against this concern is that literally all large and mid-sized companies are followed by equity analysts. Given that the market equity yield is calculated as the dividend-weighted equity yield, this study is based on 95% of the U.S. market capitalization, and is therefore representative for the market portfolio.

Second, the ICC approach relies on the premise that analyst forecasts accurately reflect the average investor's expectations about future cash flows. Yet, many studies have shown that analyst forecasts can be biased due to conflicts of interests (Chan et al., 2007; Ljungqvist et al., 2009). If this is the case, they are not a compelling proxy of the market participants' true expectations. Especially a market-wide bias in analyst forecasts might increase or decrease the estimated aggregate equity yield curve. Again, there are some arguments against this concern. Most of all, a market-wide bias in analyst forecasts leaves cross-sectional differences in forecasted earnings and dividend growth rates unchanged. Hence, while the level of the equity yield curve might be biased, its overall shape – which is of primary interest in this study – is left unchanged. Furthermore, if market participants believe in biased forecasts, forecast and pricing errors cancel out. Hence, the only remaining concern is a possible systematic relation between forecast bias and a firm risk characteristics, such as firm size, B/M ratio or earnings growth rates, that might drive the results. However, previous studies (Chava and Purnanandam, 2010; Chen et al., 2013) do not find such a relation.

Nevertheless, we carry out a set of robustness tests by replacing dividend and earnings forecasts provided by equity analysts by earnings forecasts obtained from predictive regressions. In a series of papers, Hou et al. (2012) and Li and Mohanram (2014) propose various models to predict the firms' earnings using cross-sectional earnings forecasts. The main advantage of regression-based forecasts is that they (i) allow estimating future earnings for companies without analyst coverage and (ii) are not subject to any biases caused by the analysts' conflicts of interest. These papers also show that these forecasts tend to be – to some extent – more accurate than analyst forecasts.

Table 7 presents the summary statistics of the average market equity yields derived from regression-based earnings forecasts for selected maturities. We resort to the earnings forecast model by Hou et al. (2012) abbreviated HVZ, the earnings-persistence (EP) model, and the residual income (RI) model, both proposed by Li and Mohanram (2014). Figure 10 presents the term structure of market equity risk premia, the term structure of interest rates and the market equity yield curve obtained from the various models.

When using regression-based earnings forecasts based on the Hou et al. (2012) model, the average equity yield curve is very similar to the baseline model derived from analyst forecasts. The average equity yield over all maturities reaches 11.26%, which perfectly matches the yield derived from analyst forecasts (11.27%). The only difference is that the average term structure of equity risk premia is slightly hump-shaped, increasing for the first years before declining in the long-run. This can also be seen in the slightly negative slope parameter of -0.24%.

Table 7: Term structure of market equity yields (regression-based earnings forecasts)

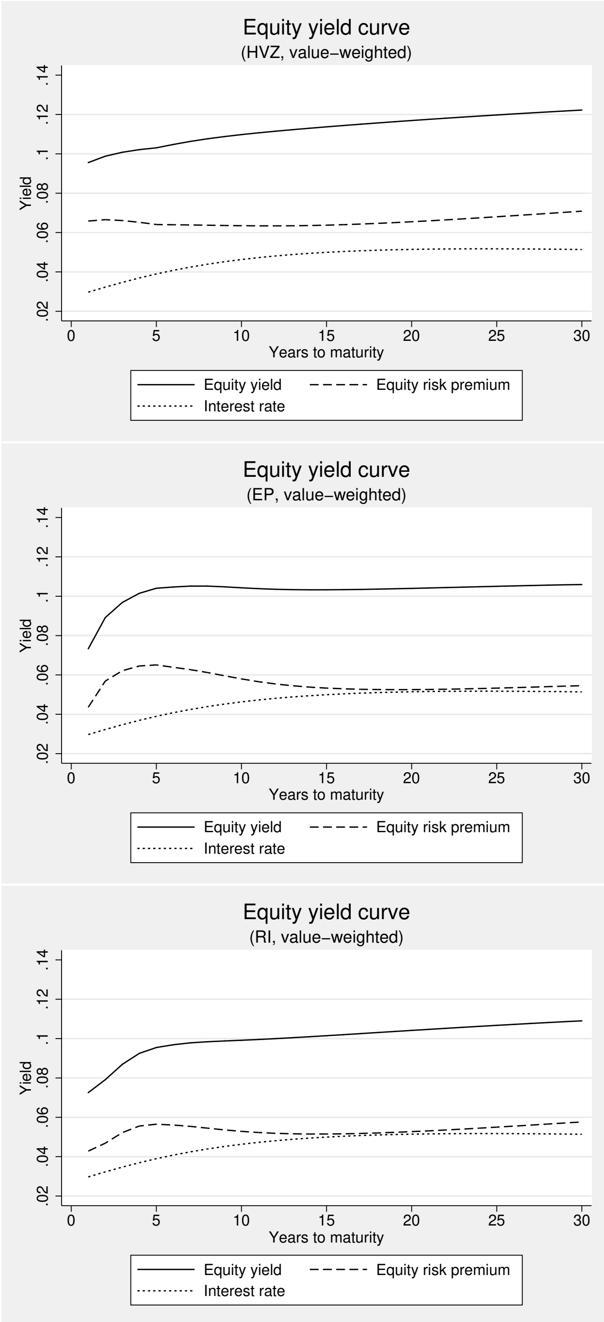
Model		Maturity (τ) 1 year	5 years	10 years	20 years	30 years	Slope	All maturities
	Risk-free rate ($i_{t,\tau}$)	2.97	3.90	4.63	5.14	5.14	1.66***	4.69
HVZ	Risk premium ($rp^m_{t,\tau}$)	6.59	6.41	6.35	6.55	7.09	-0.24*	6.57
	Equity yield ($y^m_{t,\tau}$)	9.56	10.31	10.98	11.69	12.23	1.42***	11.26
EP	Risk premium ($rp^m_{t,\tau}$)	4.36	6.51	5.80	5.25	5.45	1.44***	5.56
	Equity yield ($y^m_{t,\tau}$)	7.33	10.41	10.43	10.40	10.60	3.10***	10.25
RI	Risk premium ($rp^m_{t,\tau}$)	4.28	5.65	5.29	5.27	5.76	1.00***	5.33
	Equity yield ($y^m_{t,\tau}$)	7.25	9.55	9.92	10.42	10.90	2.66***	10.02

The table presents the time-series averages of the monthly risk-free rate ($i_{t,\tau}$), market risk premium ($rp^m_{t,\tau}$), and market equity yield ($y^m_{t,\tau}$) derived from regression-based earnings forecasts for different maturities (in percent). The regression-based earnings forecast model by Hou et al. (2012) is denoted HVZ. The earnings persistence (EP) as well as the residual income (RI) models are proposed by Li and Mohanram (2014). The slope parameter is calculated as the difference in the 10-year and the 1-year yield. Statistical significance of the slope parameter is estimated using a t-test, with standard errors being adjusted following Newey and West (1987) using 24 lags. The sample period is from October 1990 to June 2019.

The two forecasting models proposed by Li and Mohanram (2014) generate rather different average equity yield curves. Average market equity yields derived from the earnings persistence and the residual income model are about a percentage point lower, reaching 10.25% and 10.02%, respectively. The term structure of equity risk premia of both the earnings-persistence and the residual-income model have pronounced hump shape. In the first 5 years, the term structure of the equity risk premia is strongly upward-sloping. However, for maturities longer than 5 years, the term structure of the equity risk premia is slightly downward-sloping.

Lower average equity risk premia obtained from the two regression-based models proposed by Li and Mohanram (2014) than those obtained from equity analyst forecasts shows that analyst earnings and dividend forecasts are higher than their regression-based counterparts. If taking that stance that regression-based forecasts are not biased, this could be interpreted as evidence for some positive systematic analyst forecasts biases.

Figure 10: U.S. equity yield curve using regression-based earnings forecasts



The graph plots time-series averages of the (value-weighted) term structure of market equity risk premia ($rp^m_{t,\tau}$), the term structure of interest rates ($i_{t,\tau}$) and the market equity yield curve ($y^m_{t,\tau}$) for United States using regression-based earnings forecasts. The regression-based earnings forecast model by Hou et al. (2012) is denoted HVZ. The earnings persistence (EP) as well as the residual income (RI) models are proposed by Li and Mohanram (2014). The sample period is from October 1990 to June 2019.

Overall, this robustness check shows that different earnings forecast models generate different equity yield curves. The term structures of equity risk premia have different shapes, with a tendency of a hump-shaped version: short-run equity risk premia are either lower than long-run equity risk premia, or at the same level. Yet, once adding the term structure of interest rates, all models agree on an upward-sloping equity yield curve.

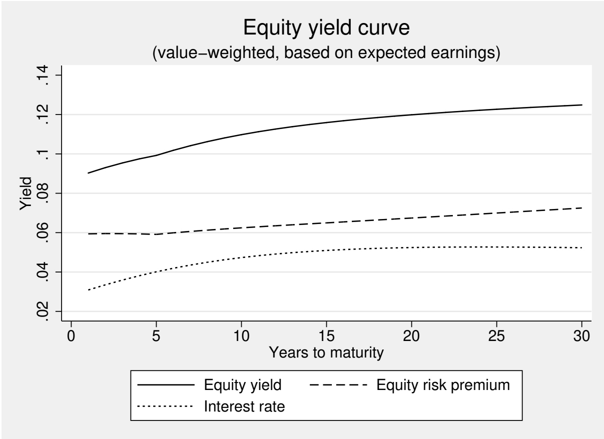
6.2 Earnings-weighted Market Equity Yields

In return for investing in a company, investors are entitled to dividend payments. This is the motivation for calculating the market equity yield curve as dividend-weighted average equity yield. Yet, equity analysts tend to concentrate on earnings forecasts rather than dividend forecasts. In this study, future dividends are hence often not directly taken from analysts, but calculated by applying an assumed payout ratio to earnings forecasts. Another drawback of using a dividend-weighted market equity yield is that a substantial fraction of companies do not even pay out any dividends at all, either because they are still in their growth phase, or because of financial difficulties. Finally, dividends can be affected by one-off payments, such as special dividends, that might not be representative for the companies' long-term financial situation.

In this section, we therefore recalculate the market equity yield curve by weighting individual equity yields by the companies' future earnings rather than dividends. Although earnings are not directly accessible to investors, this calculation might be based on more accurate and reliable analyst forecasts. A drawback of this analysis is, however, that companies with projected losses enter with a negative weight into the market equity yield.

Figure 11 shows the average market equity yield curve when weighting individual equity yields by the firms' earnings rather than dividends. The chart is very similar to figure 2. Only at the short end, there are some minor differences between the two approaches.

Figure 11: Average U.S. equity yield curve based on earnings



The graph plots time-series averages of the (value-weighted) term structure of market equity risk premia ($rp^m_{t,\tau}$), the term structure of interest rates ($i_{t,\tau}$) and the market equity yield curve ($y^m_{t,\tau}$) for United States from January 1990 to May 2019.

The reason for this striking similarity is that analysts' dividend forecasts – if available – nevertheless play an important role to compute the firms' equity yields: future dividends are used to calculate the firms' payout ratios, which are in turn important to predict changes in book values of equity capital, see appendix A. In the long-run, dividend payout ratios are assumed to fade to their long-run levels, such that ultimately the dividend-weight of each company is similar to its earnings-weight.

7. Concluding Remarks

This paper proposes a new perspective on the market equity yield curve. Instead of treating the equity market as one single entity, we go one level deeper and consider the equity market as what it really is – a large market of many different individual equity shares. Hence, we start by estimating equity yields of individual shares using the implied cost of capital. Then we aggregate individual equity yields over the entire market to obtain the market equity yield curve.

This methodology allows studying the composition effects that drive the market equity yield curve. During the period from 1990 to 2019, the U.S. equity yield curve features a positive aggregation effect, which implies an upward-sloping term structure of equity risk premia. Together with the concave shape of the bond yield curve, the unconditional market equity yield curve was upward-sloping. Yet, there is considerable variation in the equity yield curve over time, depending on the business cycle. We also identify periods with a downward-sloping equity yield curve.

The intuition behind these results is simple. Since companies with higher-than-average risk premia were expected to grow, on average, faster than companies with low risk premia, high equity yield companies were expected to increase in market share when expanding the investment time horizon.

The upward-sloping term structure of equity risk premia is thus the result of the positive association between expected returns and forecasted growth at the firm level. While this empirical finding depends to some extent on model assumptions, various robustness checks show that changing some of these assumptions are unlikely to overturn the results, i.e., generating a significantly downward-sloping average equity yield curve. Under certain conditions, the slope of the term structure of risk premia is negative, but when adding the risk-free rate, the equity yield curve is upward-sloping. Of course, this analysis covers only the years from 1990 to 2019. The pattern might be different in other sample periods – or going forward.

These findings have some interesting implications. First, given the match between our results and previous evidence obtained from market dividend futures, firm-level equity risk premia might indeed be close to flat, on average. Second, it seems difficult to support a downward-sloping market equity yield curve – unless firm-level risk premia are much more downward-sloping than previously thought.

The findings of this paper might also be valuable for tactical asset managers. Investors can use the shape of the term structure of equity risk premia as a signal to profitably optimizing their exposure to a large risk premia. As this paper shows, a positive slope of the term structure of risk premia is able to predict higher-than-average market returns, which are driven by large growth stocks.

Appendix A:
Implementation of the Residual Income Model

This appendix describes the empirical implementation of the three-stage residual income model by Gebhardt et al. (2001). While we follow Gebhardt et al. (2001) as close as possible, we divert from their methodology in a few instances.

In the first five years (explicit forecast period), the forecasted return on equity ($froe_{t+\tau}$) is derived from the mean earnings forecast of equity analysts, provided by IBES (Gebhardt et al. (2001) use only explicit earnings forecasts for the first three years, but the availability of earnings forecasts four and five years ahead has increased significantly since then). If the mean earnings forecast is not available for all 5 years into the future, an earnings forecast is generated by applying the mean long-term earnings growth rate to the furthest available earnings forecast. If no mean long-term earnings growth rate is available, we use the average growth rate of the available mean earnings forecasts instead. Since not all earnings forecasts are positive, we use the arithmetic mean growth rate. Long-term earnings growth rates (either provided by IBES or inferred from the growth rate in earnings) higher than 0.50 and lower than -0.25 are set to missing.

This procedure, however, only generates sensible earnings forecasts if the furthest available earnings forecast (and hence, $froe_{t+\tau}$) is positive. If the furthest earnings forecast is negative, we forecast the return on equity by converging the $froe_{t+\tau}$ of the previous year to the long-term return on equity $\overline{roe}$ using an AR(1) process:

$$froe_{t+\tau} = \rho_r froe_{t+\tau-1} + (1 - \rho_r)\overline{roe}, \tag{A.1}$$

where we assume $\rho_r = 0.8$. This assumption is based on empirical studies (Hou et al., 2012) that document a strong positive autocorrelation of the firms' return on equity of around 0.8. However, the results are robust to different values of the autocorrelation parameters ρ_r and ρ_p.

To remove the impact of outliers, the $froe_{t+\tau}$ forecasts are winsorised to lie in an interval between -0.5 and 1. This procedure however only allows for sensible $froe_{t+\tau}$ forecasts if the predicted book value of equity per share at end of the fiscal year $t + \tau$ is positive. In case it is negative, the observation is dropped from the sample.

Similar to Gebhardt et al. (2001), the long-term industry $\overline{roe}$ is the median roe of all companies belonging to the same industry, using the 48-industry classification by Fama and French (1997). The median is calculated using 10 years of past data. Companies with a negative roe are excluded when calculating this median.

Future book values of equity are calculated using the clean surplus relation: $B_t = B_{t-1} + I_t(1 - p_t)$. To that end, one has to make assumptions about future payout ratios, p_t. In a slight variation of Gebhardt et al. (2001) we use the IBES mean dividend forecast of equity analysts to forecast future payout ratios. However, IBES mean dividend forecasts are only available for a small subset of companies, especially for more than one year ahead. If no mean dividend forecast is available and future earnings as derived above a negative, we assume a payout ratio of 0. Otherwise, we compute a future payout ratio by converging the last available $p_{t+\tau}$ to the long-term payout ratio $\bar{p}$ using an AR(1) process:

$$p_{t+\tau} = \rho_p p_{t+\tau-1} + (1-\rho_p)\bar{p}, \tag{A.2}$$

where we assume, similar to above, $\rho_p = 0.8$. To remove the impact of outliers, the $p_{t+\tau}$ forecasts are winsorised to lie in an interval between 0 and 1.

Similar to the return on equity, we use an industry-specific long-term payout ratio $\bar{p}$, calculated as the median payout ratio of all companies belonging to the same industry, using 10 years of past data. Companies with a negative p_t, a p_t of 0 (no dividends), and those with a p_t larger than 1 are excluded when calculating this industry-specific median.

In the transition period between years 5 and 30, a company's *roe* and payout ratio p is assumed to converge to its long-term average, using the two formulas above. Hence, the three-stage residual income model can be written as:

$$\begin{aligned} P_t &= B_t + \sum_{\tau=1}^{5} \frac{froe_{t+\tau} - (i_{t,\tau} + rp_t)}{(1 + i_{t,\tau} + rp_t)^{\tau}} B_{t+\tau-1} \quad \textit{(Explicit forecasts)} \\ &+ \sum_{\tau=6}^{30} \frac{\rho_r^{\tau-5} froe_{t+5} + (1-\rho_r^{\tau-5})\overline{roe} - (i_{t,\tau} + rp_t)}{(1 + i_{t,\tau} + rp_t)^{\tau}} B_{t+\tau-1} \quad \textit{(Transition period)} \\ &+ \frac{\overline{roe} - (i_{t,30} + rp_t)}{(i_{t,30} + rp_t)(1 + i_{t,30} + rp_t)^{29}} B_{29}. \quad \textit{(Terminal value)} \end{aligned} \tag{A.3}$$

We follow the procedure of Gebhardt et al. (2001) to match the firms' book value to IBES forecasts. For more details, see sections 2.3 to 2.6 of Gebhardt et al. (2001). Finally, note that share repurchases and new equity issues are excluded in this analysis due to the problems related to obtaining reliable forecasts of their recurrence for such a large sample.

Appendix B:
Detailed Summary Statistics

This appendix presents some further univariate analyses of risk premia and firm characteristics.

Similar to Gebhardt et al. (2001), we form, each month, 5 portfolios (quintiles) based on a variety of firm characteristics and measure their mean and median risk premia, see table B.1. In addition, we present the difference in risk premia between the two extreme portfolios (P1 and P5).

Since some firm characteristics are not available for all firms, the sample size is reduced. For example, long-term earnings growth forecasts are not available for all companies. To estimate the market beta, we require a minimum of 24 months of stock returns. Similarly, we only report the average daily transaction volume if there are more than 6 months of trading data available. Finally, price momentum requires 6 months of prior stock returns.

The table confirms the negative relation between risk premia and firm size, as well as the positive relation between risk premia and the B/M ratio. Furthermore, firms with better information availability (analyst coverage) and higher liquidity (transaction volume) have significantly lower risk premia, in line with Gebhardt et al. (2001). Next, the table shows that firms with both higher systematic risk (market beta) and idiosyncratic risk (standard deviation of returns) have significantly higher risk premia. We thereby confirm the prediction of the CAPM, as well as prior empirical evidence on the pricing of idiosyncratic risk (Malkiel, 1997).

Finally, companies with higher expected growth rates, as proxied by analysts' long-term growth expectations, exhibit higher expected returns. At the same time, there is a negative relation between firm risk premia and price momentum. Both results can be intuitively understood with the help of the constant growth model, $P_t = D_{t+1}/(y - g)$. Solving for the expected return, $y = D_{t+1}/P_t + g$, it follows that – ceteris paribus – a higher stock price implies a lower expected return. In turn, a higher dividend growth rate increases the expected return.

This explanation rests of course upon the ceteris paribus assumption. Different from us, Gebhardt et al. (2001) document a negative relation between expected growth and expected stock returns. This difference can be attributed to the time period analysed: when restricting the sample to the years before 1996, similar to Gebhardt et al. (2001), firms with high growth forecasts have lower expected returns.

Table B.1: Risk premia and firm characteristics

		Smallest				Largest		
Ranked by:	Observations	P1	P2	P3	P4	P5	P5-P1	t-stat.
Firm size (mn)	802,670	91.5	304.2	748.5	1,936.8	19,628.8		
Mean risk premium		7.79%	6.81%	6.25%	5.73%	5.55%	-2.23%***	-10.01
Median risk premium		7.25%	6.51%	6.03 %	5.67%	5.36%	-1.89%***	-8.80
B/M ratio	802,670	0.14	0.33	0.50	0.71	1.47		
Mean risk premium		5.76%	5.80%	5.97%	6.44%	8.16%	2.40%***	8.68
Median risk premium		5.11%	5.58%	5.93 %	6.30%	7.78%	2.67%***	12.43
Analyst coverage	802,670	1.57	3.55	5.75	9.70	19.73		
Mean risk premium		6.91%	6.59%	6.37%	6.16%	5.87%	-1.04%***	-4.53
Median risk premium		6.51%	6.27%	6.08%	5.91%	5.60%	-0.91%***	-4.28
Daily transaction volume (mn)	800,973	0.292	1.668	5.333	16.599	131.742		
Mean risk premium		7.12%	6.75%	6.31%	6.04%	5.89%	-1.24%***	-5.46
Median risk premium		6.60%	6.43%	6.04%	5.85%	5.62%	-0.98%***	-4.40
Market beta	747,165	0.07	0.68	0.98	1.34	2.65		
Mean risk premium		5.94%	6.04%	6.34%	6.62%	7.09%	1.15%***	5.99
Median risk premium		5.50%	5.76%	6.11%	6.32%	6.67%	1.17%***	5.51
Daily standard deviation	800,850	1.46%	2.03%	2.59%	3.34%	4.96%		
Mean risk premium		5.16%	5.81%	6.39%	6.89%	7.87%	2.71%***	10.71
Median risk premium		5.04%	5.69%	6.23%	6.63%	7.18%	2.15%***	10.48
Long-term growth	610,778	5.66%	11.04%	14.37%	18.76%	31.57%		
Mean risk premium		6.00%	6.19%	6.33%	6.30%	6.54%	0.54%***	4.49
Median risk premium		5.71%	6.03%	6.12%	6.06%	6.06%	0.35%**	2.46
Price momentum	801,256	-29.56%	-8.22%	3.19%	15.50%	51.62%		
Mean risk premium		7.89%	6.48%	6.03%	5.83%	5.90%	-1.99%***	-11.90
Median risk premium		7.40%	6.26%	5.83%	5.65%	5.55%	-1.85%***	-11.62

Each month, all stocks are sorted into five portfolios based on each of the eight firm characteristics. The table reports the time-series average (mean and median) of the firm risk premia (rp) of each portfolio. The firm characteristics are: firm size (market capitalisation) in millions, book-to-market (B/M) ratio of equity, analyst coverage as the number of one-year ahead earnings forecasts, the average daily transaction volume over the previous year (in millions), the 5-year monthly rolling market beta, the average standard deviation of the previous year's daily returns, the median long-term growth rate as provided by equity analysts, and the 6-month price momentum.

In addition, the table presents the difference in risk premia between the two extreme portfolios (P1 and P5). T-statistics are adjusted for serial correlation (Newey and West, 1987) using 24 lags (overlapping observations). *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix C: Relation to Gormsen and Lazarus (2023)

This appendix compares the main results with some results presented in Gormsen and Lazarus (2023). Gormsen and Lazarus (2023) calculate *ex-post* excess returns of 10 value-weight portfolios sorted on the firms' forecasted long-term growth (LTG) rate as provided by equity analysts from 1981 to 2019. In their table 2, they find a hump-shaped relation between portfolio excess returns and forecasted growth. Furthermore, firms with high predicted growth rates have, on average, slightly lower excess returns, although this relation is not significant. After controlling for standard measures of risk (i.e., CAPM alphas and Sharpe ratios), they find a negative relation between risk premia and growth. This result is different from one of the main results of this study, which shows a positive relation between expected returns and growth.

There are potentially many reasons for the results to diverge: (i) Gormsen and Lazarus (2023) examine realised excess returns, while this study examines expected risk premia; (ii) Gormsen and Lazarus (2023) consider a longer time period (1981-2019) than this study (1990-2020); (iii) Gormsen and Lazarus (2023) obtain their results using a single growth rate (LTG), while this study uses a combination of many different analyst forecasts; and (iv) Gormsen and Lazarus (2023) examine 10 value-weighted portfolios, while this study aggregates individual firm data over the entire market.

This appendix presents some analyses that examine explanations (iii) and (iv) in more detail.

C.1 Growth rates

First, we examine whether the differences are due to using different growth rates. Gormsen and Lazarus (2023) obtain their results using a single growth rate (LTG), while this study uses a combination of many different analyst forecasts. Yet, table B.1 also shows a positive relation for the LTG rate and firm risk premia. This suggests that the difference between Gormsen and Lazarus (2023) and this study is not caused by using different growth rates.

Nevertheless, we calculate the implied 5-year ($g_{t,5} = D_{t,5}/D_{t,1}$) and 10-year ($g_{t,10} = D_{t,10}/D_{t,1}$) dividend growth rates as projected by the residual income model (RIM) used in this study, and correlate them with the median LTG rate, as used in Gormsen and Lazarus (2023).

Since not all firms are forecasted to pay out dividends in year 1 (d_1), and not all firms have an LTG estimate (analysts do not publish LTG rates for all firms), the sample of firm-months observations is reduced by 38.4%. Panel A of table C.1 shows that the growth rates implied by the RIM over 10 years are similar in magnitude to the median LTG (although they have a larger standard deviation). Panel B shows that the correlations are around 20% for the 5-year implied growth rate and 15% for the 10-year implied growth rate, with both being highly significant. This suggests that the growth rates implied by the RIM are qualitatively similar to the median LTG. To conclude, differences in growth

Table C.1: Comparison of growth rates

Panel A: Summary statistics

	Mean	Std. Dev.
$g_{t,5}$	5.50	17.00
$g_{t,10}$	13.43	54.67
Median LTG	15.19	9.70

Panel B: Correlation statistics

	$g_{t,5}$	$g_{t,10}$	Median LTG
$g_{t,5}$	1.000		
$g_{t,10}$	0.771***	1.000	
Median LTG	0.198***	0.153***	1.000

Panel A presents the mean and standard deviation of the various growth rates in percent. Panel B presents the linear correlation statistics. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively. Observations: 495,144.

rates are unlikely to explain the divergence between Gormsen and Lazarus (2023) and this study.

C.2 Portfolios

Second, we examine whether the differences are due to different aggregation mechanisms: Gormsen and Lazarus (2023) examine 10 value-weighted portfolios, while this study aggregates individual firm data over the entire market. We hence adopt the strategy of Gormsen and Lazarus (2023), and form, each month, 10 portfolios (deciles) based on the median LTG and measure the portfolio's risk premia, see table C.2.

Using equal-weight portfolios, there is a positive relation between risk premia and median LTG, in line with table B.1 (see appendix B). However, when using value-weight portfolios, as in Gormsen and Lazarus (2023), the relation becomes highly non-monotonic, and the difference in risk premia between P10 and P1 reverses: Similar to Gormsen and Lazarus (2023), risk premia are higher for deciles with low forecasted growth rates.

Panel C of table C.2 helps to explain the reason for the difference between equal-weight and value-weight portfolios. The panel presents the monthly average correlations between the firms' market capitalization and risk premia for each of the 10 portfolios.

The panel shows that the correlation between firm size and risk premia is not constant across the 10 portfolios sorted on LTG, but declines with the firms' forecasted growth. The pattern is not monotonic: in the portfolios with low LTG firms, the association between firm size and risk premia is weak, but it is pronounced (negative) for firms with higher LTG rates. The difference in correlation between the two extreme portfolio is statistically significant.

Table C.2: Risk premia of portfolios sorted on LTG

Panel A: Equal-weight portfolios

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
LTG	3.0%	8.3%	10.2%	11.8%	13.2%	15.1%	17.1%	19.9%	24.3%	39.2%	
Risk premium	5.9%	6.1%	6.2%	6.2%	6.3%	6.3%	6.2%	6.3%	6.3%	6.8%	0.9%***

Panel B: Value-weight portfolios

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
LTG	4.0%	8.3%	10.1%	11.7%	13.1%	15.1%	16.9%	19.8%	24.0%	38.1%	
Risk premium	6.1%	6.2%	5.9%	5.4%	5.6%	5.4%	5.4%	5.4%	5.5%	5.6%	-0.5%***

Panel C: Correlation between firm size and firm risk premia

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
Correlation	-0.002	-0.008	-0.066	-0.112	-0.123	-0.115	-0.117	-0.103	-0.081	-0.124	-0.123***

Panels A and B of this table present the monthly average risk premia of 10 portfolios sorted on the firm's long-term growth (LTG) rates, as provided by analysts. Panel A uses equal-weight portfolios; panel B uses value-weight portfolios. All portfolio risk premia are statistically different from 0 at the 1% level. Panel C presents the monthly average correlation between the firms' market capitalization and risk premia for each of the 10 portfolios. P1 includes the firms with the lowest LTG rates, while P10 includes the firms with the highest LTG rates. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

This means that in the value-weight analysis, firms with higher risk premia are underweighted in the high LTG portfolios. Thus, using value-weight portfolios decreases risk premia of portfolios with high forecasted growth rates relative to using equal-weight portfolios. As a result, the overall relation between growth and risk premia across the 10 portfolios is reversed. This analysis suggests that the results by Gormsen and Lazarus (2023) are at least partly driven by their use of value-weight portfolios.

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