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Abstract

This paper assesses the estimation of the so-called equity risk premium, i.e. the expected return on equities in excess of the risk-free rate, using the dividend discount model as the organizing framework. I compare the equity risk premium estimates from different dividend discount models in terms of the in-sample and out-of-sample forecasting ability across different time horizons. Using data from the Eurostoxx 50 from 2001-2021, I find that equity risk premium estimates exhibit similar dynamics, and are elevated during periods of high uncertainty, such as the onset of the COVID-19 pandemic. Moreover, I find that the three-stage dividend discount model, which divides earnings growth into an extraordinary, transitional and steady-state phase, performs the best in terms of forecasting ability.

Keywords: expected returns, equity risk premium, dividend discount model, return predictability.

JEL classification: G10, G12, G15.

Resumen

Este trabajo evalúa la estimación de la prima de riesgo de la renta variable, es decir, el rendimiento esperado de la renta variable por encima del tipo libre de riesgo, utilizando el modelo de descuento de dividendos como marco organizativo. Comparo las estimaciones de la prima de riesgo de la renta variable a partir de diferentes modelos de descuento de dividendos en términos de la capacidad de previsión dentro y fuera de la muestra a través de diferentes horizontes temporales. Utilizando datos del EURO STOXX 50 de entre 2001 y 2021, encuentro que las estimaciones de la prima de riesgo de la renta variable muestran una dinámica similar, y son elevadas durante los períodos de alta incertidumbre, como el inicio de la pandemia de COVID-19. Además, encuentro que el modelo de descuento de dividendos en tres etapas, que divide el crecimiento de los beneficios en una fase extraordinaria, otra de transición y otra de estado estable, es el que mejor funciona en términos de capacidad de previsión.

Palabras clave: rentabilidad esperada, prima de riesgo de la renta variable, modelo de descuento de dividendos, previsibilidad de la rentabilidad.

Códigos JEL: G10, G12, G15.

Contents

1 Introduction

The equity risk premium (ERP) is arguably one of the most fundamental quantities in asset pricing, both for theoretical and practical reasons. From a theoretical standpoint, the ERP reflects the market price of equity risk. It is also regarded as a measure of aggregate risk aversion, and an important part of the asset allocation decisions of institutional and individual investors. More recently, the equity risk premium has been used as a gauge of financial stability[1], or as a leading indicator of economic activity (see, for example, Duarte and Rosa (2015)).

One of the more popular methods to estimate the equity risk premium used in practice is the dividend discount model, first popularized by Gordon (1962). The basic intuition of all dividend discount models is that the value of a stock is determined by the cash flows it provides to shareholders. The popularity behind this approach is due to its relative simplicity compared to other modelling approaches, and its consistency with no-arbitrage conditions (assuming that assets are fairly priced). However, despite its simplicity, the estimates of the ERP from dividend discount models can differ based on the assumptions one makes on future earnings growth. To this end, the purpose of this paper is to study which dividend discount model yields the most accurate estimate of the equity risk premium from a forecasting perspective. Moreover, it investigates other issues related to the estimation of the equity risk premium via dividend discount models.

To do so, this paper takes the workhorse H-model of Fuller and Hsia (1984)[2] as a starting point and studies different issues related to the dividend discount model's implementation. First, I analyze the effect of different proxies of the risk-free rate, and the use of the entire yield curve on the estimation of the equity risk premium. Second, I compare the evolution of the equity risk premium under the assumption that future dividends grow at a constant rate (i.e., constant growth models), as opposed to models that assume that dividend growth can be divided into distinct phases (i.e., multiple growth models). Moreover, following Li et al. (2013) and Chin and Polk (2015), I assess the in-sample and out-of-sample predictive power of the equity risk premium measures in forecasting future excess returns of the Eurostoxx 50 at different horizons. Third, I study the effect of the inclusion of share buybacks in the measurement of dividends, and its subsequent impact on the estimation of the equity risk premium.

The main results of the estimations are the following. First, I find that under the lens of the workhorse H-model and the two-stage model, different proxies for the interest rate or the use of the entire yield curve to represent discount rates do not have a significant effect on the resulting estimates of the equity risk premium. Second, comparing constant

1 See, for example, the Financial Stability Report of the Federal Reserve Board, and the Financial Stability Report of the Bank of England.

2 The Fuller and Hsia (1984) model builds on the Gordon (1962) model by assuming that the growth of dividends in the future can be divided into two phases: an extraordinary phase and a steady state phase.

and multiple growth models, I find that while both classes of models present similar dynamics, estimates of the equity risk premium from the three-stage and four-stage models, which divide the growth phases of dividends into an extraordinary, transitional and steady state phase[3], are more sensitive to the proxy variables for the growth rates in earnings expectations, as exhibited by higher levels of the equity risk premium during the Dot-com crisis. Moreover, studying the in-sample and out-of-sample predictive power of the different dividend discount models, I show that the three-stage model outperforms the benchmark H-model in terms of forecasting accuracy in short and long horizons. Third, the inclusion of share buybacks results in higher estimates of the equity risk premium in COVID-19 periods, which makes it the preferable model for estimation, and leads to a similar forecasting performance as a model where I measure cash flows by dividends.

The rest of the paper is organized as follows. Section 2 provides a brief review of the equity risk premium and the general version of the dividend discount model. Section 3 discusses the comparison of the models according to the different dimensions described earlier. Section 4 concludes.

3 The stages of the dividend discount model can be divided into three phases: a first stage usually called the extraordinary phase, where growth in cash flows is at a high rate, a transition phase wherein growth slows down, and a steady-state phase, which is a phase when firms reach a stable growth rate.

2 The equity risk premium and the dividend discount model

The equity risk premium can be defined, as in Duarte and Rosa (2015), as the excess return that investors expect to receive to hold risky equities over riskless bonds. In particular, one can define the equity risk premium at a given time horizon k, ERP_{t+k}, as:

$$ERP_{t+k} = E_t [R_{t+k}] - RF_{t+k}$$

In this equation, the risk-free rate, RF_{t+k}, is observed by the investor. The main challenge in measuring the equity risk premium is that the expected return on equities, $E_t [R_{t+k}]$, is unobserved, and must be inferred from observable data, which necessitates the need for a model. To this end, I adopt the dividend discount model, which is one of the workhorse frameworks of stock valuation. All variants of the dividend discount model posit that the price of the stock is determined by the future cash flows it provides to its shareholders; as such, the dividend discount model is a forward-looking model. One can connect equity prices to dividend expectations and the equity risk premium (Dison and Rattan (2017)). To see this, note that the return on equities can be expressed as:

$$1 + E_t\left[R_{t+1}\right] = \frac{E_t\left[P_{t+1}\right] + E_t\left[D_{t+1}\right]}{P_t}.$$

One can then express the price of equities as:

$$P_t = \frac{E_t\left[P_{t+1}\right] + E_t\left[D_{t+1}\right]}{1 + RF_t + ERP_t}.$$

This formula shows that the price of equities today is the sum of investors' expectations of future prices P_{t+1}, and their expectations of future dividends and other shareholder payments D_{t+1}, discounted by the cost of equity. This cost can be divided into two parts: the risk-free rate RF_t, which is the time value of money, and the equity risk premium ERP_t.

As Dison and Rattan (2017) note, the formula above is only for one period. They argue that if one applies a similar argument for subsequent periods, the price of a stock can then be expressed as the following sum:

$$P_t = \sum_{k=1}^{\infty} \frac{E_t\left[D_{t+k}\right]}{(1 + RF_t + ERP_t)^k}.$$

To estimate the equity risk premium from this formula, one must find the value of the term ERP that makes the projected stream of future dividends equal to the current equity price. Hence, this value is referred to as the market-implied equity risk premium.

There are several advantages from estimating the equity risk premium from dividend discount models. First, the model is consistent with no-arbitrage conditions. Second, the dividend discount model is relatively easy to implement. The main challenges in the calculation of the equity risk premium from these models are: (i.) the discount rate applied in the estimation, (ii.) the use of constant vs. multiple growth rate models, and (iii.) the importance of share buybacks.

3 Estimating the dividend discount model

In this section, I illustrate the different issues related to estimating the equity risk premium from the dividend discount model.

3.1 Measurement of the discount rate

One potential issue with respect to the estimation of the equity risk premium is the variable used to measure discount rates. In particular, in this article, I investigate two salient issues related to the discount rate: first, I look at the extent to which different measures of the risk-free rate will yield different estimates of the equity risk premium. Second, I study the extent to which the use of the entire yield curve changes the resulting estimates of the equity risk premium.

To see the impact of different risk-free rate measures, I consider the H-model of Fuller and Hsia (1984), which is a simplified version of the two-stage dividend discount model, a multiple-stage model that assumes that future dividend growth can be divided into an extraordinary phase and a steady-state phase[4]. It has been widely used as the workhorse model due to the fact that it implies a closed-form solution. Specifically, the price of a stock can be shown to have the following formula (Fuller and Hsia 1984, p. 51):

$$P = \frac{D\left[(1+g_n) + H\,(g_a - g_n)\right]}{ERP + rf - g_n}.$$

The assumption in this formula is that dividends initially grow at a rate g_a, but that this rate changes linearly over the following periods[5] until it converges H periods later to a long-term growth g_n. As the model has a closed-form solution, one can then express the equity risk premium as:

$$ERP = \frac{D}{P}\left[(1+g_n) + H\,(g_a - g_n)\right] + g_n - rf$$

In this expression, $\frac{D}{P}$ is the initial dividend yield. In the implementation of the model, I assume that H is equal to 5 years, as in Geis et al. (2018)[6], g_a is the mean medium-to-long term expected growth rate of earnings from I/B/E/S, and g_n is the expected long-term growth rate of GDP from the ECB Survey of Professional Forecasters. In this exercise, I compare three different risk-free rates: the EONIA OIS rate at a 10-year horizon, the French 10-year government bond rate, and the German 10-year government bond rate.

4 Another interpretation of the H-model is that of a simplified version of the three-stage model. In this case, the parameter H governs the transition from the extraordinary phase to the steady-state phase. The derivation of the H-model from this perspective is shown in Fuller and Hsia (1984), p. 52.

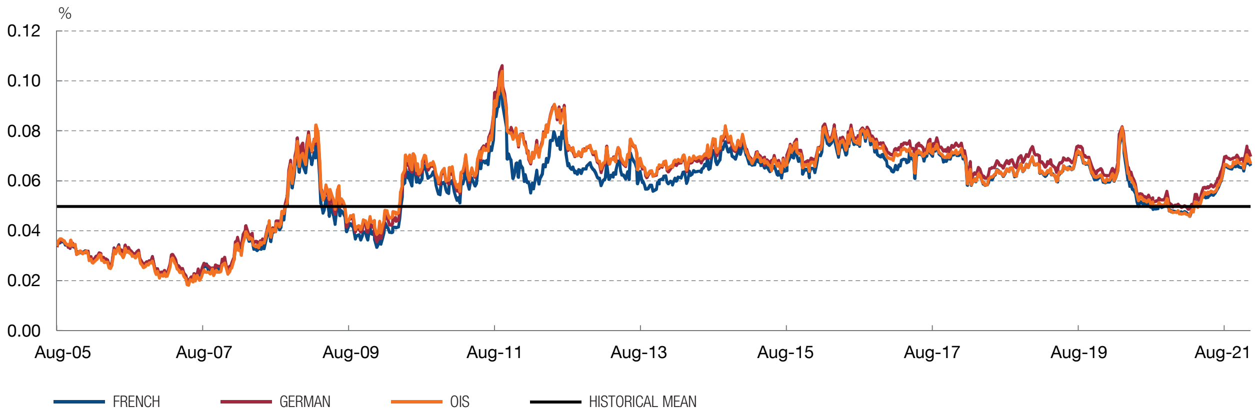
5 Unless otherwise specified, a period is equal to a year.

6 Fernandez Lafuerza and Mencia (2021) also use H = 5 as their parameter in the estimation of the cost of bank equity in Europe.

Chart 1

EQUITY RISK PREMIUM WITH DIFFERENT PROXIES FOR THE INTEREST RATE

This figure shows the estimates of the ERP coming from the benchmark H-model which studies the effect of using different proxies for the discount rate: the OIS 10-year rate (blue), the German 10-year government rate (red), and the French 10-year government rate (orange). The historical mean is in the green line. Estimation sample from August 2005 to December 2021, weekly frequency.



SOURCE: Datastream and author's calculations.

The results of this comparison are in Chart 1, which I plot from August 2005 to December 2021[7]. As the chart indicates, the use of different variables for the discount rate does not affect the dynamics of the equity risk premium. What it does affect, however, in some periods, is the level of the equity risk premium. In particular, I find that the level of the equity risk premium is higher during much of the European sovereign debt crisis period (2012-2014), depending on whether I use as proxies the German and the OIS bond rates as opposed to the French government bond rate[8]. The estimates also show that the equity risk premium has been well above the historical mean, which is approximately 5 percent, and has been hovering around 5 to 7 percent post global financial crisis, consistent with results from Geis et al. (2018). Finally, I find that the equity risk premium shoots up to extremely high levels in periods of uncertainty. For example, the level of the equity risk premium was above the 95th percentile of the entire time series during much of the European sovereign debt crisis, and at the onset of the COVID-19 pandemic.

The second issue related to the risk-free rate that I study is whether the use of a single risk-free rate or the entire yield curve matters for the estimation of the equity risk premium. For this purpose, I utilize the general version of the two-stage dividend discount model, which is based on the following formula in Sorensen and Williamson (1985) (pp. 66-67)[9]:

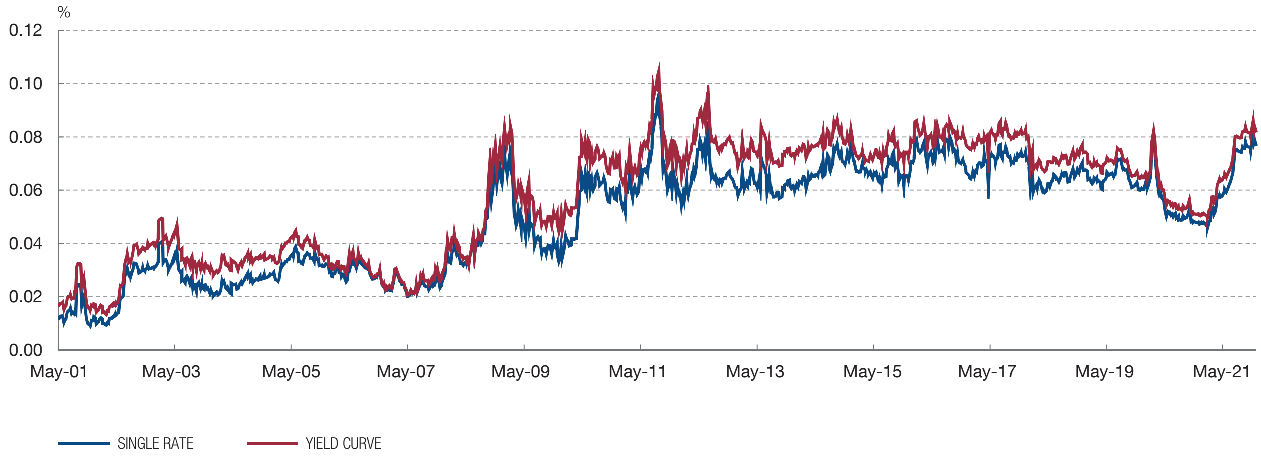
7 I start the comparison at this point as the OIS 10 year rates first become available in Datastream on August 2005.

8 One could surmise that it could be due to the role of the German government bond as a “safe haven” bond during most of the European sovereign debt crisis.

9 Sorensen and Williamson (1985) also show that the two-stage model has a closed form formula that can be solved on the assumption that the same interest rate is applied at each period of the extraordinary growth period.

Chart 2
COMPARING SINGLE INTEREST RATES VS. THE YIELD CURVE

This graph compares estimates of the equity risk premium coming from the two-stage model, assuming that the risk free rate is the same throughout all periods (blue) and that the risk free rate can be approximated with the entire yield curve (red). The risk-free rate in this estimation is the French interest rate. The estimation sample is from June 2001 to December 2021, weekly frequency.



SOURCE: Datastream and author's calculations.

$$P_t = \sum_{k=1}^{A} \frac{D_0 (1+g_a)^k}{(1+ERP+rf_t)^k} + \frac{D_0 (1+g_a)^k (1+g_n)}{(1+ERP+rf_n)^A (rf_n + ERP - g_n)}.$$

As in the H-model, the two-stage model assumes that there are two stages of growth: an extraordinary period of growth (from time t = 1 to A), followed by a stable phase from time A onwards. Compared to the H-model, the discount rate applied can be different at each period of the extraordinary phase, or it can be the same risk-free rate throughout the entire period. As the yield curve contains information about how investors expect future interest rates to evolve over time, in this section, I study whether introducing the yield curve leads to changes in the estimated equity risk premium.

The results of this comparison are in Chart 2, which I plot from June 2001 to December 2021. I illustrate the effect of using the yield curve for case of French government bonds, as for the latter there exists the most complete set of interest rates for different time horizons available from Datastream[10]. In this implementation, I choose A = 5, which corresponds to the extraordinary period in the H-model above. This implies that the risk free rates I am using are the 1 year to 5-year French government bond rates (when I use the entire yield curve) and the 10-year interest rate for the steady state period, and the 10-year rate

10 In the case of the German sovereign bonds, complete information for rates with maturities of 1 year to 10 years are available from Datatream from June 2002, while in the case of the EONIA OIS, the complete information from Datastream is only available from August 2005.

(for the single interest rate). As the figure illustrates, using the yield curve to represent the discount rate does not result in substantial changes, as the resulting estimate of the equity risk premium remains practically the same.

3.2 Constant vs. multiple growth rates

Another issue is related to the assumption made on the growth rate of cash flows. Dividend discount models are typically divided into two categories: constant growth models and multiple-stage growth models. Constant growth models, such as the Gordon growth model, assume that dividends grow at a constant rate over time. Moreover, the model assumes that the growth rates of cash flows is equal to the risk-free rate. The multiple-stage models build on the Gordon growth model by assuming that growth rates vary over time. In this article, I compare results from an implementation of the Gordon growth model, and three different multiple-stage models: the H-model and the two-stage model introduced earlier, the three-stage model of Sorensen and Williamson (1985), and two additional models: the four-stage model, and the five-stage model. The rest of the multiple stage models are different from the two-stage models that we have considered earlier in the text in that they introduce more phases in the dividend discount model. Specifically, the three-stage model introduces a transitional phase between the extraordinary growth phase and the steady state phase[11]. The four stage model is distinct from the three stage model in that it distinguishes the first year of earnings growth[12], while the five-stage model divides the extraordinary phase into three separate years, to take into account the possibility of different growth rates for each year in the extraordinary phase[13]. The summary of the models, and their specific assumptions, are in Table 1. I provide more details on the models in the Appendix to this article.

The estimates of the equity risk premium are shown in Chart 3. In the implementation of these models, I work with the entire yield curve for all the multiple stage models. I find that, while the estimates present similar dynamics, there are certain differences in the levels of the variables. In particular, I find that the three-stage and four-stage models present higher estimates of the equity risk premium during the Dot-com crisis. This is primarily due to the influence of the period of extraordinary growth (short-term growth) in both the three-stage and four-stage models. To show this , I decompose the equity risk premium into the following components: short-term growth, medium-term growth, long-term growth, interest rates, and dividends[14]. As Chart 4 indicates, the weight of the short-term growth is higher, compared to the other components.

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11 I use the growth rate in earnings per share over the next 12 months as the variable for the extraordinary growth phase (Datastream: A12GRO), the medium-to-long term growth rates for the transitional phase (Datastream: ALTMN), and the expected long term growth rate of GDP from the ECB Survey of Professional Forecasters as the growth rate for the steady state phase. To remove outliers in the variables, I smooth them using a locally weighted linear regression.

12 To distinguish the first year of growth from the other phases, I use the weighted average one year forward EPS growth. (Datastream: AF1GRO).

13 The growth rates for the first three years of growth are the weighted average one year forward EPS growth (AF1GRO), two year forward EPS (AF2GRO), and three year forward EPS (AF3GRO). The growth rate for the transitional phase is the medium-to-long term growth rates (ALTMN) and the steady-state growth rate is that expected GDP growth rate from the ECB Survey of Professional Forecasters. To remove outliers in the variables, I smooth them using a locally weighted linear regression.

14 To decompose the equity risk premium, I linearize the stock price formula of both the three-stage and four-stage models.

Table 1
DIVIDEND DISCOUNT MODEL ASSUMPTIONS

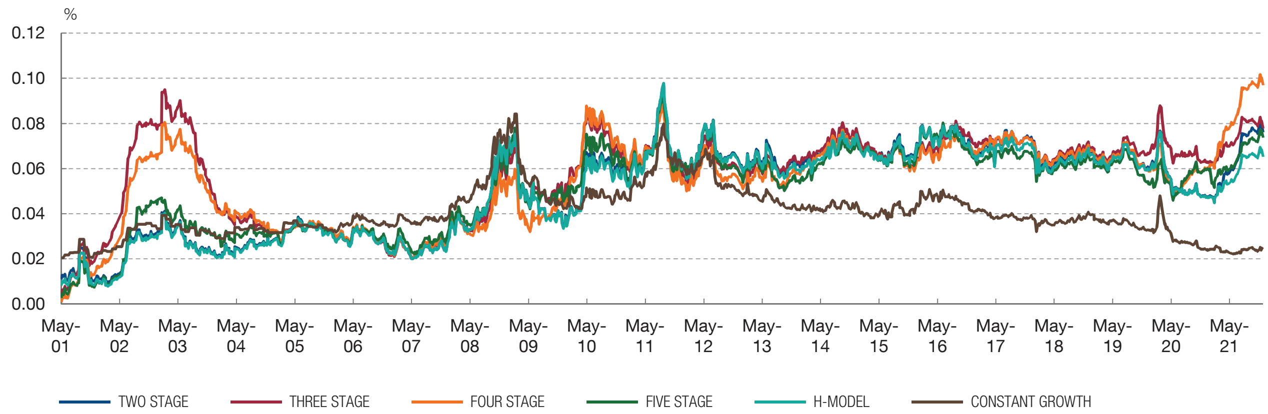
The following table illustrates the assumptions on the dividend discount models that were estimated. The first column provides the model name, the second column provides the stages, the third column describes the extraordinary phase (whether the model permits one, and its length), the fourth column describes the transitional phase (whether the model permits one, and the length), and the fifth column indicates whether the model features a steady state phase. Y = yes, N = no.

Model name	Number of stages	Extraordinary phase		Transitional phase		Steady state phase (Y/N)
		Y/N	Length	Y/N	Length	
Constant growth	1	N	N/A	N	N/A	Y
H-model	2	Y	10 years	N	N/A	Y
Two stage	2	Y	10 years	N	N/A	Y
Three stage	3	Y	5 years	Y	5 years	Y
Four stage	4	Y	1st year distinguished from the suceeding 5 years	Y	5 years	Y
Five stage	5	Y	distinguishes first three years	Y	7 years	Y

SOURCE: Banco de España.

Chart 3
COMPARING SINGLE VS. MULTIPLE STAGE MODELS

This graph compares the estimates of the equity risk premium from constant and multiple growth models. The models estimated are the constant growth (brown), the H-model (aqua), the two-stage (blue), the three-stage -model (red), the four stage model (orange) and the five stage model (green). The estimation sample is from June 2001 to December 2021, weekly frequency.

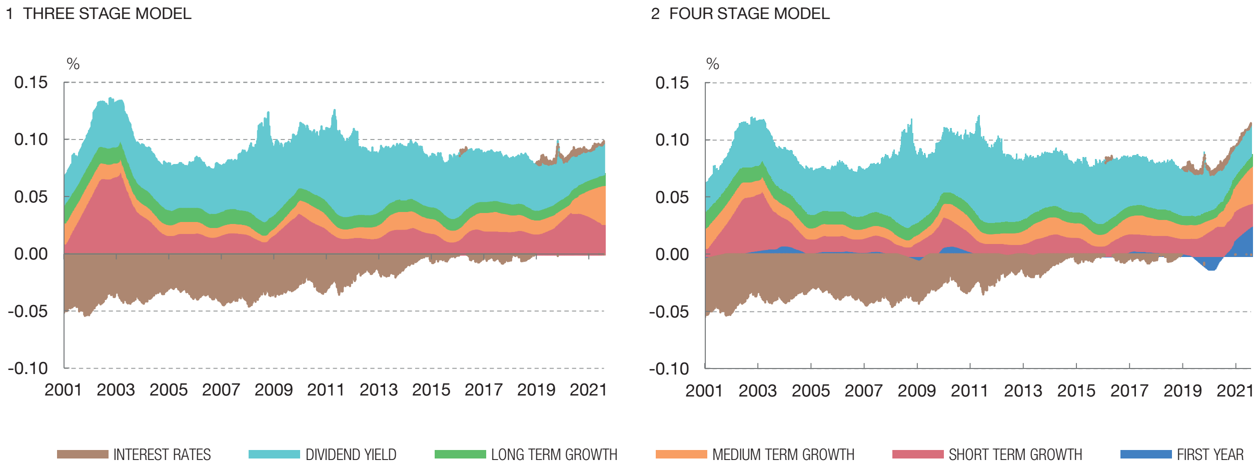


SOURCE: Datastream and author's calculations.

Though the models present similar dynamics, to select the model that can be used for policy analysis, I need a formal criterion to compare the different estimates of the equity risk premium. In this regard, I study their ability to forecast excess returns, following Li et al. (2013) and Chin and Polk (2015). The rationale behind this is due to the interpretation of the ERP as the expected future excess returns. As Pastor et al. (2008) note, the implied ERP from dividend discount models is a good proxy for time-varying expected returns. Given

Chart 4
EQUITY RISK PREMIUM DECOMPOSITION

This figure decomposes the equity risk premium estimated from the three-stage model and the four-stage models into their respective components. Data from June 2001 to December 2021, weekly frequency.



SOURCE: Datastream and author's calculations.

that it can be considered as a proxy for expected returns, Li et al. (2013) investigate the usefulness of the ERP as a predictive variable of excess returns. Relative to Li et al. (2013), I assess which dividend discount model performs best in terms of forecast accuracy.

To do so, I estimate the following regression with average k-period returns as the dependent variable regressed on individual predictor variables X_t at time t: $\frac{r_{t,t+k}}{k} = a + bX_t + e_{t+k}$. In this equation, $r_{t,t+k}$ is the cumulative sum of the monthly total log excess returns[15] on a -period horizon, wherein is equal to 3, 6, 12, 24 and 36 months. The predictor variable X_t is each of the estimates of the equity risk premium from the different models. I then study the in-sample and out-of-sample predictive power via the Diebold-Mariano (1995) test, wherein the benchmark model that I consider is the H-model. I first present the regression results in Table 2 below.

As the results indicate, the equity risk premium estimates are in general predictive of future excess returns across all horizons. The resulting R^2's are also more or less in line with previous literature[16]. Moreover, the results also indicate that across all horizons, the three-stage model performs the best in terms of explanatory power. I now look at the in-sample predictive power by conducting the Diebold-Mariano (1995) test over each horizon. The Diebold-Mariano (1995) test is a test of the predictive accuracy of two competing models. As the H-model has been the workhorse model for the estimation of the equity

15 Excess returns here are computed from the EUROSTOXX 50 price index, which does not include dividends reinvested.

16 For example, in the case of the dividend discount models, the results of Li et al. (2013) indicate that the adjusted R-squared's of the in-sample predictability regressions range from 0.07 (for a three-month horizon) to 0.27 (for a three-year horizon).

Table 2
PREDICTIVE REGRESSIONS

This table presents predictability results of the regression $\frac{r_{t+1}}{k} = a + bX_t + e_{t+k}$ for different time horizons. The first column describes the dividend discount model. The second column is the time horizon, k, in months. The third column is the estimate of parameter b, the fourth column is the corresponding standard error calculated via the Newey-West formula, and the fifth column is the corresponding R-squared. Sample: June 2001 to December 2021.

Constant growth	k	b	Std. Error	R-squared	Three stage	k	b	Std. Error	R-squared
	3.0	0.717**	(0.283)	0.006		3	1.664***	(0.160)	0.093
	6.0	1.745***	(0.399)	0.018		6	2.718***	(0.221)	0.126
	12.0	4.604***	(0.578)	0.059		12	4.715***	(0.308)	0.186
	24.0	6.744***	(0.707)	0.086		24	6.385***	(0.363)	0.243
	36.0	5.855***	(0.795)	0.056		36	8.802***	(0.359)	0.396
H-Model	k	b	Std. Error	R-squared	Four stage	k	b	Std. Error	R-squared
	3.0	1.528***	(0.156)	0.083		3	1.691***	(0.162)	0.093
	6.0	2.361***	(0.217)	0.102		6	2.676***	(0.231)	0.114
	12.0	3.809***	(0.306)	0.132		12	4.450***	(0.331)	0.150
	24.0	4.708***	(0.365)	0.147		24	6.227***	(0.384)	0.213
	36.0	4.615***	(0.413)	0.120		36	8.617***	(0.388)	0.350
Two stage	k	b	Std. Error	R-squared	Five stage	k	b	Std. Error	R-squared
	3.0	1.498***	(0.154)	0.082		3	1.716***	(0.165)	0.093
	6.0	2.313***	(0.215)	0.100		6	2.664***	(0.230)	0.114
	12.0	3.679***	(0.304)	0.125		12	4.268***	(0.325)	0.145
	24.0	4.596***	(0.363)	0.142		24	5.286***	(0.386)	0.162
	36.0	4.572***	(0.409)	0.122		36	5.688***	(0.428)	0.161

SOURCE: Datastream and author's calculations.

risk premium, I consider the H-model as the benchmark and the rest as alternatives. The corresponding null hypothesis, hence, is that the H-model and the alternative model have the same forecasting accuracy. The sign of the DM statistic, meanwhile, provides us a sense of which model is outperforming the other. When the DM statistic is positive (negative), the H-model underperforms (outperforms) the alternative predictor.

The results of the in-sample comparisons are in Table 3. The results indicate that the three-stage model (1, 2, and 3 years), four-stage model (2 and 3 years) and five-stage model (3 years) outperform the H-model over long horizons. Meanwhile, the H-model outperforms the constant growth model across all horizons, and exhibits a similar forecasting ability as the two-stage model.

I then consider what happens when I look at an out-of-sample forecasting exercise, which take into account whether the range of forecast variables would have been able to predict returns in real-time. To do so, I perform a recursive estimation, wherein I consider the first ten years as the training sample for the exercise. I then compute the same hypothesis test with the Diebold-Mariano (1995) test statistic over each horizon.

Table 3

IN-SAMPLE PREDICTABILITY RESULTS

The table presents the Diebold-Mariano (1995) test statistic, and the corresponding p-value, for the in-sample predictability test. Each row corresponds to the predictive variable in question, which is the model-implied equity risk premium coming from a constant growth model or a multiple stage model. Each column corresponds to the time horizon considered.

	k = 3		k = 6		k = 12		k = 24		k = 36	
	DM	p-value	DM	p-value	DM	p-value	DM	p-value	DM	p-value
Constant growth	-2.40	0.02	-2.32	0.02	-1.89	0.10	-2.79	0.02	-2.08	0.04
Two stage	-0.48	0.63	-1.29	0.13	-3.14	0.00	-1.52	0.13	-0.08	0.93
Three stage	0.37	0.71	0.87	0.38	1.86	0.06	2.34	0.02	4.64	0.00
Four stage	0.42	0.64	0.42	0.62	0.39	0.70	1.82	0.07	4.64	0.00
Five stage	1.10	0.27	1.46	0.15	1.24	0.25	1.57	0.11	4.78	0.00

SOURCE: Datastream and author's calculations.

Table 4

OUT-OF-SAMPLE PREDICTABILITY RESULTS

The table presents the Diebold-Mariano (1995) test statistic, and the corresponding p-value, for the out-of-sample predictability test. Each row corresponds to the predictive variable in question, which is the model-implied equity risk premium coming from a constant growth model or a multiple stage model. Each column corresponds to the time horizon considered.

	k = 3		k = 6		k = 12		k = 24		k = 36	
	DM	p-value	DM	p-value	DM	p-value	DM	p-value	DM	p-value
Constant growth	1.37	0.17	1.96	0.05	0.11	0.91	-1.04	0.30	-3.48	0.00
Two stage	-1.21	0.26	-2.81	0.04	-2.20	0.03	-4.00	0.00	-1.99	0.05
Three stage	2.45	0.01	2.93	0.00	3.16	0.00	4.15	0.00	2.41	0.02
Four stage	-8.12	0.00	2.83	0.00	3.08	0.00	3.63	0.00	0.66	0.51
Five stage	1.29	0.18	2.64	0.01	3.14	0.08	-2.89	0.00	-5.48	0.00

SOURCE: Datastream and author's calculations.

The results of this estimation are in Table 4. As the table indicates, the three-stage model performs better than the H-model across all horizons. The four stage model, while it outperforms the H-model over a 6-month horizon and over long horizons (1 and 2 years), is outperformed by the H-model at a horizon of three months. The five-stage model also exhibits the same pattern; it has superior forecasting performance at short horizons, but it performs poorly at long horizons. The constant growth model outperforms the H-model in short horizons, but performs poorly at long horizons. Finally, the two-stage model is outperformed by the H-model across all horizons.

In sum, the evidence in this section suggests that the three-stage model performs best out of all the candidate dividend growth models, as it yields the highest R-squared, has predictive power both in-sample and out-of-sample that outperforms the benchmark H-model.

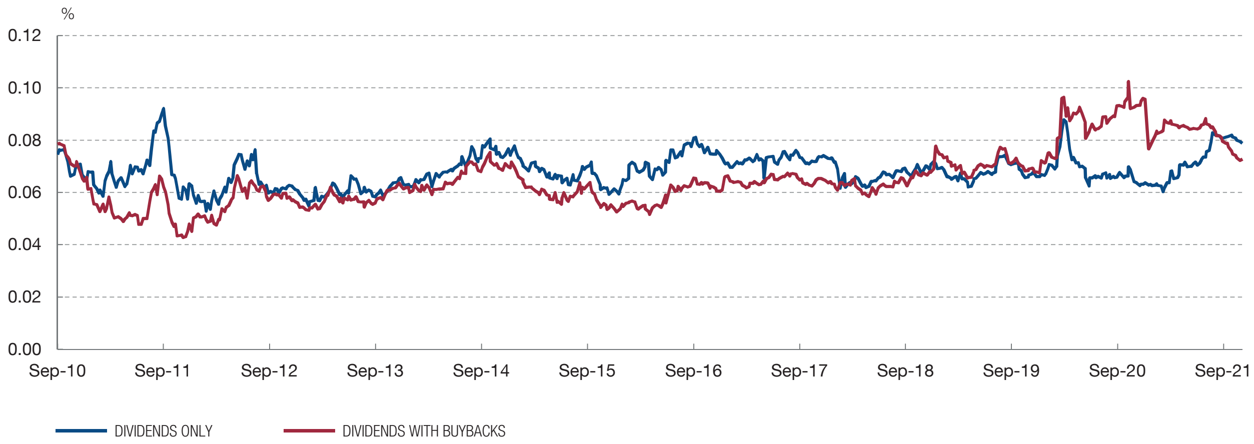
3.3 Measurement of cash flows

Most estimations of the equity risk premium using the dividend discount model use dividends to measure pay-outs to shareholders. However, dividends may be a poor proxy for expected cash flows from holding equities, especially if firms compensate their shareholders through other forms. One such compensation is via share buybacks. Though the use of this tool as compensation has historically been of secondary importance, there has been a recent rise in share repurchases, both in the US and in Europe, as firms "aim to signal to investors a positive long-term outlook".[17] Moreover, the inclusion of share buybacks has been shown to have some impact in the estimation of the equity risk premium (see e.g., Geis et al. (2018) and Dison and Rattan (2017)).

To see the impact of the inclusion of share buybacks, I compute the equity risk premium via the three-stage model. Specifically, I compare the results of a model wherein I work with dividends and a model wherein I combine dividends and share buybacks[18]. Chart 5 shows the estimates for the three-stage dividend discount model from September 2010 to November 2021, as information on buybacks is only available on these dates[19]. The

Chart 5
EFFECTS OF THE MEASUREMENT OF DIVIDENDS

This graph compares the estimates of the equity risk premium coming from the three-stage dividend discount model, wherein the relevant change comes from the measurement of cash flows. The blue line corresponds to a model where I use only dividends to measure cash flows, while the red line includes share buybacks. The estimation period is from September 2010 to November 2021, weekly frequency.



SOURCE: Datastream and author's calculations.

17 See "Buybacks Hit Record After Pulling Back in 2020", by Karen Langley, published in the Wall Street Journal on December 21, 2021 edition (for the US), and "European Banks Boost Payouts With $5 Billion in New Buybacks" by Nicolas Comfort, published in Bloomberg on October 29, 2021 edition (for Europe).

18 I follow Ilmanen (2011) by modifying the aggregate dividend pay-out ratio as the following formula: $DP = (D + S)/MC$, where D is the total dividends, S is the total share buybacks issued, and MC is the total market capitalization. One challenge that I encountered is the calculation of the modified version of the dividend yield with share buybacks. The model that I implement uses variables that I mostly observe at a weekly frequency, including the market capitalization. However, I only observe dividends and share buybacks available at a yearly frequency. To compute the implied dividend yield, hence, I perform a linear interpolation that makes use of weekly information on the dividend yield that is available from Datastream.

19 I perform the same exercise for the rest of the dividend discount models, and the results are similar.

results indicate that while the estimates of the equity risk premium present similar dynamics, the estimates of the risk premium that includes share buybacks presented higher levels of the equity risk premium at the onset of the COVID-19 pandemic.

To determine which model presents more reliable estimates of the equity risk premium from a forecasting perspective, I repeat the same in-sample and out-of-sample forecasting exercise[20]; however, instead of considering the first ten years as the training sample, I consider the first five years, given sample availability. The results indicate that both models present similar forecasting performance[21]; however, the model with share buybacks is the more preferable model given that the corresponding equity risk premium estimates reflect the increase in payments of share buybacks by firms during the COVID-19 pandemic.

20 The regression results indicate that both variables are positive and significant at the 1 percent level across all horizons. Results are available upon request.

21 Results are available upon request. The results for the forecasting exercise were done for a three, six and one-year horizon as the sample length is not enough to perform tests on the two and three year horizons.

4 Conclusion

In this paper, I assess the estimation of the equity risk premium using data from the Eurostoxx 50 from 2001-2021, with the dividend discount model as the empirical framework. In particular, I study three main issues encountered in the estimation of the equity risk premium: (i.) the effect of proxies for the risk-free rate and the yield curve; (ii.) comparing constant growth and multiple growth models, and (iii.) the inclusion of share buybacks in the estimation of dividend yields.

This article obtains the following findings. First, in the context of the workhorse H-model and the two-stage model, I find that using different proxies for the risk-free rate, or the use of the entire yield curve, do not imply significant changes to the estimates of the equity risk premium. Second, comparing constant and multiple growth models, I find that most multiple growth models present similar dynamics. However, comparing the explanatory power (via predictive regressions) and the in-sample and out-of-sample forecasting power, I find that the three-stage model shows better forecast accuracy in comparison with the other models both in short and long horizons. Finally, looking at the measurement of cash flows, the inclusion of share buybacks presents in estimates of the equity risk premium that present similar dynamics; however, the preferred model to estimate the equity risk premium is the model with share buybacks, as it reflects the additional shareholder payments in terms of buybacks during the COVID-19 pandemic.

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Appendix A catalog of dividend discount models

This appendix outlines the different dividend discount models used in the estimation of the equity risk premium in this article. I first start with the discussion of the constant growth models, and then proceed with the discussion of the multiple growth models.

Constant growth model. The constant growth model assumes that future cash flows grow at a rate g in perpetuity. Hence, the constant growth model implies that we can simplify the dividend discount model into:

$$P_t = \frac{D_t}{rf + ERP - g}.$$

In this model, we can then compute a closed-form solution for the equity risk premium: $ERP = \frac{D}{P} + g - rf$. The typical assumption is to assume that g = rf, which leaves the dividend yield as the measure of the equity risk premium.

Two-stage model. The two-stage model assumes that there are two phases: an extraordinary phase of growth, where dividends grow at a rate g_a and a stable phase, where dividends grow at a rate g_n. The price of a stock can then be shown to be equal to the following quantity (Sorensen and Williamson (1984)):

$$P_t = \sum_{t=1}^{A} \frac{D_0 (1+g_a)^t}{(1+ERP+rf)^t} + D_A \sum_{t=A+1}^{\infty} \frac{(1+g_n)^{t-A}}{(1+ERP+rf)^t}.$$

In this formulation, the first sum is the extraordinary phase, while the second sum is the stable phase. One can then compute the geometric progression in the stable phase to obtain the following sum:

$$P_t = \sum_{t=1}^{A} \frac{D_0 (1+g_a)^t}{(1+ERP+rf)^t} + \frac{D_0 (1+g_a)^t (1+g_n)}{(1+ERP+rf)^A (rf+ERP+g_n)}.$$

In this equation, D_0 is the initial dividend, g_a is the extraordinary growth rate, and g_n is the stable growth rate. A is a parameter that represents the end period of extraordinary growth. In the empirical implementation comparing the effect of the yield curve, I set A = 5, while in the comparison of the different multiple stage models, I set A = 10, to facilitate comparisons. To compute the implied equity risk premium, I minimize the difference[22] between the model-implied price-dividend ratio (which I observe at a weekly frequency), and the observed price-dividend ratio: $\min_{ERP} \left(P/D - P/D_{model} \right)^2$. In the estimation, I

22 In the implementation of the minimization problem, I utilize the fzero and lsqnonlin optimization routines in Matlab. One issue that I found out is that the minimization problem is sensitive to starting points. To ensure that I obtain reasonable results, I use the estimates from the H-model as a starting point.

assume that g_a is the mean estimate of long-term EPS growth, and g_n is the long-term GDP expectations coming from the ECB Survey of Professional forecasters.

H-model. The H-model is a modification of the two-stage model that assumes that the transition from the extraordinary phase to the stable phase of growth moves linearly, governed by the parameter H). The price of a stock then is:

$$P_t = \frac{D\left[(1+g_n) + H\,(g_a - g_n)\right]}{ERP + rf - g_n}.$$

The model can then be simplified to have the following formula: $ERP = \frac{D}{P}\,[(1+g_n) + H\,(g_a - g_n)] + g_n - rf$. In the implementation of the model, I take H = 5.

Three-stage model. The three stage model that I describe here is based on the exposition in Sorensen and Williamson (1984). The model is composed of three phases: an extraordinary phase (with growth rate g_a, a transition phase (with growth rate g_b, and a stable phase (with growth rate g_n). The formula is:

$$P_t = \sum_{t=1}^{A} \frac{D_0\,(1+g_a)^t}{(1+ERP+rf)^t} + D_0\,(1+g_a)^A \sum_{t=A+1}^{B} \frac{(1+g_b)^{t-A}}{(1+ERP+rf)^t}$$

$$+ \frac{D_0\,(1+g_a)^A (1+g_b)^{B-A} (1+g_n)}{(1+ERP+rf)^B (rf+ERP-g_n)}.$$

As in the two-stage model, I minimize the difference between the model implied price-dividend ratio and the observed one in the data. In this estimation, I take as g_a the expected growth rate in EPS over the next 12 months, g_b as the mean estimates of long term EPS growth, and g_n is the long term nominal GDP expectations coming from the ECB Survey of Professional forecasters. In the empirical implementation, A = 5 and B = 10.

Four stage model. The four stage model is one where I permit the division of the first year from the rest of the years in the three stage model. The resulting formula is:

$$P_t = \frac{D_0\,(1+\widetilde{g_1})}{1+ERP+rf}$$

$$+ \sum_{t=2}^{A} \frac{D_0\,(1+\widetilde{g_1})\,(1+\widetilde{g_a})^{t-1}}{(1+ERP+rf)^t} + D_0\,(1+\widetilde{g_1})\,(1+\widetilde{g_a})^{A-1} \sum_{t=A+1}^{B} \frac{(1+g_b)^{t-A}}{(1+ERP+rf)^t}$$

$$+ \frac{D_0\,(1+\widetilde{g_1})\,(1+\widetilde{g_a})^{A-1} (1+g_b)^{B-A} (1+g_n)}{(1+ERP+rf)^B (rf+ERP-g_n)}.$$

In this modification, I follow Geis et al. (2018) in two ways; first, I set A = 5 and B = 10. Second, to introduce the extraordinary growth rate in periods 2 to 5, I make the following calculation of $\widetilde{g_a}$: $\tilde{g}_a = \left(\frac{1+g_b}{1+g_a}\right)^{1/4} - 1$. The rest of the variables remain to be the same. That is, the growth rate for the first year is the expected growth rate in EPS over the next 12 months, g_b as the mean estimates of long term EPS growth (both available from Datastream), and g_n is the long term nominal GDP expectations coming from the ECB Survey of Professional Forecasters.

Five-stage model. The five-stage model assumes that the first three years have different growth rates for each year, which I represent as g_1, g_2, and g_3. After the first three years, the model proceeds with a transitory phase and a steady state phase. The resulting formula from this implementation is:

$$P_t = \frac{D_0(1+g_1)}{(1+ERP+rf)} + \frac{D_0(1+g_1)(1+g_2)}{(1+ERP+rf)^2} + \frac{D_0(1+g_1)(1+g_2)(1+g_3)}{(1+ERP+rf)^3}$$

$$+ D_0(1+g_1)(1+g_2)(1+g_3)\sum_{t=1}^{B}\frac{(1+g_b)^t}{(1+ERP+rf)^{t+3}}$$

$$+ \frac{D_0(1+g_1)(1+g_2)(1+g_3)(1+g_b)^B(1+g_n)}{(1+ERP+rf)^{3+B}(rf+ERP-g_n)}.$$

For the first three years, I use the calendarized weighted average growth rate of the EPS 1 year, 2 years, and 3 years forward, which I obtain from Datastream. I take g_b as the mean estimates of long term EPS growth, and g_n the long term GDP expectations coming from the ECB Survey of Professional Forecasters. In this implementation, I take B = 7. This implies that the number of periods until the steady state phase is 10.

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