Option Implied Tax Rate Expectations*

Jelena Eberbach[‡], Caren Sureth-Sloane[†], Marliese Uhrig-Homburg[‡]

May 3, 2021

ABSTRACT

Capital market investors are expected to anticipate the tax implications of their decisions. Tax expectations depend on tax regulations but also on changes in the tax code and tax policy uncertainty. Using a novel data set, we show how tax expectations on dividends relative to capital gains can be extracted from derivatives prices. Our tax expectation measure is forward-looking in its nature and its monthly frequency allows us to analyze tax expectation dynamics over time. We show that option implied tax expectations are related to tax policy discussions about potential tax changes. Furthermore, we take advantage of the time varying property of tax expectations and examine their variation. The standard deviation of tax expectations reveals a counter-cyclical pattern consistent with existing literature on general policy uncertainty.

*We thank the DZ BANK Foundation for sponsoring our Bloomberg professional account.

†Department of Taxation, Accounting and Finance, Paderborn University, 33098 Paderborn, Germany, and Vienna University of Economics and Business, Austria

‡Institute for Finance, Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany

I. Introduction

In this paper, we analyze a measure of implied tax expectations extracted from derivatives prices. In general, it is difficult to determine the average tax rate across investors, since such a rate depends on the investor and investment type, which is not easily observable.[1] Most existing studies investigate tax effects directly by analyzing changes in tax rate systems or indirectly through comparing characteristics of stocks that indicate different tax sensitivities like the dividend yield or ownership structure.[2]

We exploit differences in the taxation of two dividend trading strategies to examine the dividend tax penalty as compared to capital gains taxation. Our dividend tax penalty proxy extracted from derivatives prices is forward-looking and, thus, captures expectations regarding the timing and size of the relative change of dividend to capital gains taxes.[3] In contrast to actual dividend or capital gains tax rate changes, expectations of these changes are much more volatile.[4] This is due to extensive political discussions when it comes to changing tax rates or implementing new taxation rules. In addition, there is uncertainty about the timing of tax rate changes and the interpretation of, and procedures for, newly introduced tax regulations.[5] This variation in expectations overcomes the often criticized characteristics regarding low time variation in actual tax rates, which makes econometric analyses more difficult.

How can investors' tax expectations be extracted from derivatives prices? We propose a new method to extract investors tax expectations on dividends vs. capital gains by combining two dividend trading strategies that differ in taxes. First, we make use of a novel way for investors to trade dividends, namely dividend futures, which were first exchange-traded in Europe.[6] Second, instead of trading dividends via dividend futures, one could simply invest in stocks and receive regular dividend payments, and hedge stock price movements by buying a put and writing a corresponding

[1] See e.g. Guenther and Sansing (2010).

[2] For a detailed overview see Graham (2003).

[3] The study of Sialm (2005) and Fleckenstein, Gandhi, and Gao (2019) are two of the rare studies providing empirical analyzes of the effects tax changes or tax uncertainty have on asset pricing.

[4] Relatedly, Hassan, Hollander, van Lent, and Tahoun (2019), who construct a firm-level policy risk measure based on computational linguistics analyses of the share of a firm's quarterly earnings conference calls devoted to political risks including tax policy risk, find high firm-level political risk volatility. This measure is applied in Gallemore, Hollander, Jacob, and Zheng (2021) to investigate tax policy beliefs and their impact on real investment.

[5] See, e.g., Vegh and Vuletin (2015) on the timing of tax rate changes. Osswald and Sureth (2020) study the implications of tax administrative uncertainty on the effects of tax reforms on real investments.

[6] Other papers using dividend futures for their empirical analysis include: van Binsbergen, Hueskes, Koijen, and Vrugt (2013), Wilkens and Wimschulte (2010), Kragt, de Jong, and Driessen (2020), and Gormsen and Koijen (2020).

call (i.e. applying the put-call parity). If dividends and capital gains are taxed at different rates, then the payout of these two aforementioned ways of dividend investing differs.

The dividend future, on the one hand, is an abstract claim of gross future dividends. Basically, the payoff of a dividend future at maturity is the difference between the cumulative gross dividends and the dividend future price. As a result, the fair future price is the expected value of these gross dividends under the pricing measure and does not reflect a (capital gains) tax rate. On the other hand, when trading dividend claims through the put-call parity investors face two different types of taxes, namely dividend and capital gains taxes. As a result, dividend expectations from the put-call parity result in net dividend expectations, i.e. dividends less the dividend to capital gains tax ratio. Why is dividend investing via the put-call parity strategy taxed with two types of tax rates? First, investors are stock owners, and thus, receive direct dividend payments. Those dividend payments are taxed at the dividend tax rate. Second, the strategy includes buying put and call options in order to hedge stock price changes. If now the price of the stock at the end of the holding period is higher (lower) than the strike price, then investors will receive capital gains (losses) with their option investment. Those capital gains or losses are taxed at the capital gains tax rate that is valid at the end of the period.[7]

To sum up, we can extract a marginal investor's expectations on the dividend tax penalty, $dtp = 1 - (1 - \tau^D_{t,T})/(1 - \tau^C_{t,T})$, by combining the put-call strategy and dividend futures. We use Euro Stoxx 50 options and dividend futures with up to two years maturity. This allows us to construct a constant maturity dividend tax penalty proxy that measures tax expectations for the next year.

How can the tax proxy be interpreted? The option implied dividend tax penalty proxy measures tax expectations of a marginal investor who is investing in Euro Stoxx 50 options. There is a common understanding that mainly institutional investors trade derivatives. Thus, we conjecture that the tax expectations we observe are relevant to corporate (institutional) investors.

The rest of the paper is structured as follows. Section II provides the theoretical fundamental on how taxes on dividends relative to capital gains are connected to derivatives prices. In Section III we introduce the data sources and descriptive statistics. Our empirical analysis follows in Section IV,

[7]We abstract from interest rate effects because in our sample period (2008-2016) the risk-free rate was close to zero. For easier interpretation of the taxpenalty proxy we neglect interest rate taxes also in the theoretical derivation of the dividend tax penalty proxy.

where we connect our European dividend tax penalty measure to tax political events in Germany and France. Moreover, we look at the second moment of our dividend tax penalty proxy and relate it to macroeconomic variables and the Baker, Bloom, and Davis (2016) European News Index. Finally, Section V concludes on our main findings and provides an outlook for future research.

II. Option Implied Taxes - Derivation

This section derives a proxy of investors expectations on the dividend tax penalty from derivatives prices.

A. Trading Dividends

Dividend futures are direct claims to future dividends paid by firms to their investors. Thus, they enable the investor to trade dividends without investing in the underlying stock. In particular, the underlying of dividend futures is the sum of ordinary unadjusted gross cash dividends within a given reference year. A dividend future that starts in s with maturity in m will pay out the sum of all dividends between s and m:

$$D_{s,m} = \sum_{s<k\leq m} D_k. \tag{1}$$

We define the expected preset value of all dividends paid out from s until time m under the pricing measure Q at time t as:

$$DV_{t,s,m} \equiv E_t^Q(D_{t,s,m})e^{-r_{t,m}(m-t)}, \tag{2}$$

where $s \leq t \leq m$. The starting day (s) is the trading day following the third Friday in December and the maturity (m) corresponds to the third Friday in December of the next year.

The dividend future price at time t with maturity in m is the expected time t value of all dividends paid out between s and m and can be written as:

$$DivFut_{t,s,m} = DV_{t,s,m}e^{r_{t,m}(m-t)}. \tag{3}$$

More specifically, we look at the one and two year dividend future.

Another possibility of trading dividends is to implicitly trade them via the put-call parity.

The put-call parity defines the relationship between the price of a European call option and put option with the same strike and maturity. The payoff at expiration of buying a put and writing a corresponding call can be replicated through purchasing one share and investing the present value of the strike and the dividends. Assuming no-arbitrage leads to the standard put-call parity relationship without taxes (Stoll, 1969):

$$S_t + p_{t,T_1} - c_{t,T_1} = Xe^{-r_{t,T_1}(T_1-t)} + DV_{t,t,T_1}, \tag{4}$$

where c_{t,T_1} and p_{t,T_1} correspond to the time t prices of a European call and put option with maturity in T_1 and strike price X. By rewriting Equation (4) we obtain the price for trading dividends that are paid out until T_1:

$$DV_{t,t,T_1} = p_{t,T_1} - c_{t,T_1} + S_t - Xe^{-r_{t,T_1}(T_1-t)}. \tag{5}$$

This equation shows that dividend-investing can be realized by buying a put option, writing a call option, purchasing the stock and borrowing cash. The conceptual difference between trading the dividend future with expiration in T_1 and the put-call parity with expiration in T_1 is that for $T_0 < t \leq T_1$ the put-call parity investment incorporates the price of dividends that are not yet distributed (DV_{t,t,T_1}), while the dividend future reflects the price for the sum of all dividends between T_0 and T_1 (DV_{t,T_0,T_1}). We can decompose the futures price into a price component $DivFut_{t,t,T_1}$ reflecting all the future dividends only and a component $D_{T_0,t}$ comprising the already distributed dividends, thus:

$$DivFut_{t,T_0,T_1} = DivFut_{t,t,T_1} + D_{T_0,t}. \tag{6}$$

The second year dividend future reflects expectations on dividends paid out between T_1 and T_2, whereas a two year put-call dividend strategy reflects dividend prices between t and T_2. In order to measure the dividend prices for the period T_1 to T_2 implied by the put-call parity, we combine the one and two year put-call strategy by shorting the put-call strategy with maturity in T_1, in other words, selling dividend claims from Equation (5) and, at the same time, buying dividend claims paid out between period t and T_2. The expected time t price of next year implied dividends is given by (Binsbergen et al., 2012):

$$DV_{t,T_1,T_2} = DV_{t,t,T_2} - DV_{t,t,T_1}, \tag{7}$$

$$DV_{t,T_1,T_2} = p_{t,T_2} - p_{t,T_1} - c_{t,T_2} + c_{t,T_1} - X(e^{-r_{t,T_2}(T_2-t)} - e^{-r_{t,T_1}(T_1-t)}). \tag{8}$$

Investing into next year implied dividends does not involve buying the equity share, but is a pure investment into two calls and puts with the same strike and maturities differing by exactly one year, plus holding a cash position.

Extracting tax expectations from option prices is possible because payoffs from the put-call parity depend on taxes, and therefore, option prices contain information on tax expectations of market participants. In the following, we show how the put-call parity relationship changes when taxes are introduced.

To derive the put-call parity with taxes, we make two assumptions. First, losses and gains are treated symmetrically, and, second, we neglect taxes on interest income that arise from investing the dividends.[8] Applying the "European tax system"[9] to the put-call parity yields the following relationship:[10]

$$DV_{t,t,T_1}(1 - \tau^D_{t,t,T_1}) = (1 - \tau^C_{t,t,T_1})(p_{t,T_1} - c_{t,T_1} + S_t - Xe^{-r_{t,T_1}(T_1-t)}). \tag{9}$$

As Equation (9) shows investors have to pay dividend taxes, τ^D, on the dividend payments they receive, and capital gains taxes, τ^C, on their profits less costs of the equity and derivatives investment. Rearranging the equation in the following way:

$$DV_{t,t,T_1}\frac{(1 - \tau^D_{t,t,T_1})}{(1 - \tau^C_{t,t,T_1})} = p_{t,T_1} - c_{t,T_1} + S_t - Xe^{-r_{t,T_1}(T_1-t)}, \tag{10}$$

shows that the dividend price implied by the put-call parity reflects expectations on net dividend payments, or more precisely, dividend expectations less expectations on the dividend tax penalty. The holder of this dividend asset receives dividends paid between t and T_1.

The expected time t price of net dividends paid out in the period between T_1 and T_2 can be

[8] During our sample period (June 2008 to December 2017) interest rates were close to zero. Thus, because of the uniqueness of our sample period, considering taxes on interest income should not alter our results.

[9] For a detailed discussion on the specific tax systems considered see Section III.B.

[10] Appendix 1 shows a detailed derivation of the influence of taxes on the put-call parity relationship.

constructed in similar fashion as Equation (8):

$$DV_{t,T_1,T_2}\frac{(1-\tau^D_{t,T_1,T_2})}{(1-\tau^C_{t,T_1,T_2})} = DV_{t,t,T_2}\frac{(1-\tau^D_{t,t,T_2})}{(1-\tau^C_{t,t,T_2})} - DV_{t,t,T_1}\frac{(1-\tau^D_{t,t,T_1})}{(1-\tau^C_{t,t,T_1})}, \tag{11}$$

$$DV_{t,T_1,T_2}\frac{(1-\tau^D_{t,T_1,T_2})}{(1-\tau^C_{t,T_1,T_2})} = p_{t,T_2} - p_{t,T_1} - c_{t,T_2} + c_{t,T_1} - X(e^{-r_{t,T_2}(T_2-t)} - e^{-r_{t,T_1}(T_1-t)}). \tag{12}$$

Thus, holding a short position in the net dividend asset with maturity in T_1 (Equation (10)) and a long position in an identical strategy with maturity in T_2 entitles the investor to receive dividends after taxes paid out between time T_1 and T_2. Accordingly, next year tax expectations $((1-\tau^D_{t,T_1,T_2})/(1-\tau^C_{t,T_1,T_2}))$ can be interpreted as the expected present value at time t of the dividend tax penalty in the period between T_1 and T_2.

A.1. Dividend Tax Penalty Proxy

We showed that option prices contain information about dividend and capital gains tax rates, and that, net dividends can be traded via put-call parity. On the other side, dividend futures allow investors to trade gross dividends. By combining these two assets, net dividends and gross dividends, we can extract expectations about the dividend tax penalty. Substituting Equation (6) into Equation (10) results in:

$$\frac{(1-\tau^D_{t,t,T_1})}{(1-\tau^C_{t,t,T_1})} = \frac{p_{t,T_1} - c_{t,T_1} + S_t - Xe^{-r_{t,T_1}(T_1-t)}}{DivFut_{t,t,T_1}e^{-r_{t,T_1}(T_1-t)}}. \tag{13}$$

We can extract an investor's expectations on the dividend tax penalty $dtp = 1-(1-\tau^D_{t,T})/(1-\tau^C_{t,T})$ implied by market prices in the following way:

$$dtp_1 = 1 - \frac{p_{t,T_1} - c_{t,T_1} + S_t - Xe^{-r_{t,T_1}(T_1-t)}}{DivFut_{t,t,T_1}e^{-r_{t,T_1}(T_1-t)}}. \tag{14}$$

The ratio between dividend prices implied by put-call parity (net present value of dividends) and dividend futures prices (gross present value of dividends) yields an investor's expectations on the current year dividend tax penalty (dtp_1). To construct the next year dividend tax penalty proxy

(dtp_2), we proceed accordingly and substitute the two year dividend future into Equation (12):

$$dtp_2 = 1 - \frac{p_{t,T_2} - p_{t,T_1} - c_{t,T_2} + c_{t,T_1} - X(e^{-r_{t,T_2}(T_2-t)} - e^{-r_{t,T_1}(T_1-t)})}{DivFut_{t,T_1,T_2} e^{-r_{t,T_2}(T_2-t)}}. \tag{15}$$

Finally, to account for cyclical distortions, we combine the current and next year dtp to get a constant one year maturity dtp:

$$dtp = \alpha dtp_1 + (1-\alpha) dtp_2, \tag{16}$$

where α is the weighting factor calculated as time left to maturity ($\alpha = \frac{T_1 - t}{T_1}$). As maturity is in December, the weighting gives a higher weight to the current year dtp_1 in the first half of the year and to next year dtp_2 in the second half of the year. This constant maturity proxy has two advantages: first, it eliminates potential illiquidity concerns regarding options with a maturity close to two years. Second, it corrects conceptual issues that arise because of potential price distortions close to options expiration.

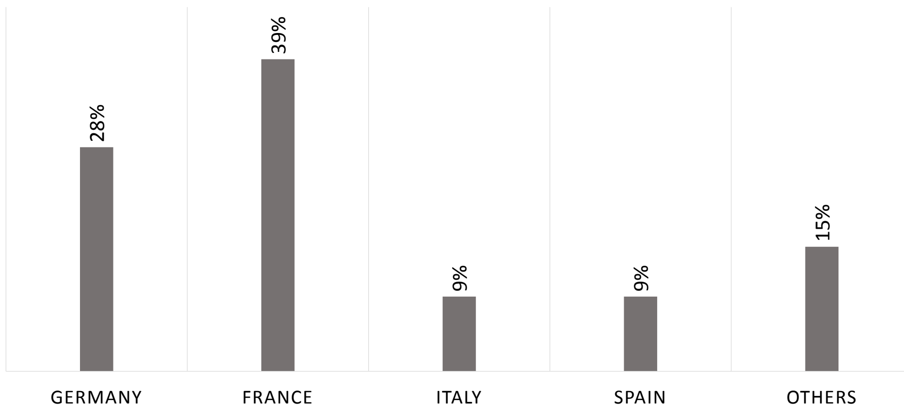
This constant maturity proxy has two advantages: First, it eliminates potential illiquidity concerns regarding options with a maturity close to two years. Second, it corrects conceptual issues that arise because of potential price distortions close to options expiration.

Additionally to the level of tax expectations, we empirically investigate the variation of our dividend tax penalty proxy. In detail, we analyze the standard deviation in dividend tax penalty expectations, that is defined as:

$$std(dtp)_t = ln(\sqrt{\frac{\sum_{i=1}^{N}(dtp_i - \overline{dtp})}{N-1}}), \tag{17}$$

where N equals the number of trading days i in each month. We take the natural logarithm of dtp volatility to reduce extreme values and to get a measure that is approximately Gaussian (Paye, 2012).

Figure 1. Average Percentage of Euro Stoxx 50 Members per Country



The graph shows the average percentage of Euro Stoxx 50 members by country during our sample period from July 2008 to December 2017.

III. Data and Construction of the Dividend Tax Penalty Proxy

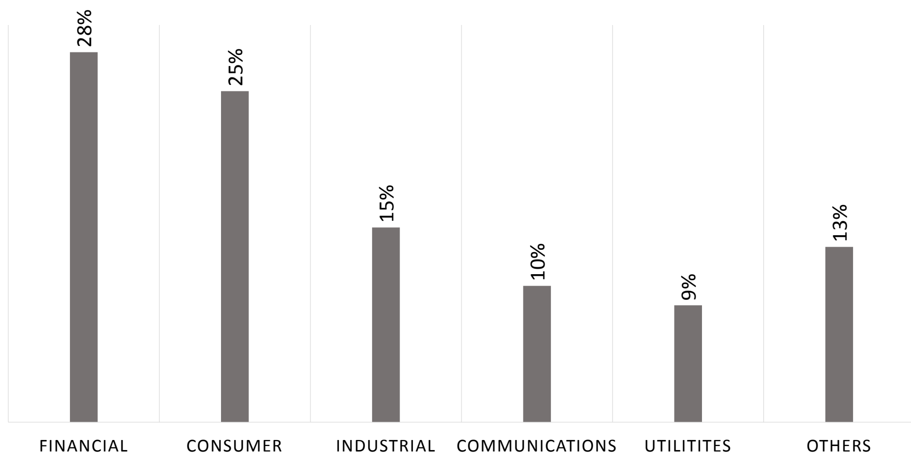
A. Data

We measure current and next year net dividend prices implied by the put-call parity from Equation (9) and (12), as precisely as possible, by using intraday transaction data on Euro Stoxx 50 index options and Euro Stoxx 50 index prices from 'Karlsruhe Kapitalmarktdatenbank' provided by Karlsruhe Institute of Technology. Daily data on Euro Stoxx 50 index dividend futures comes from Bloomberg. Interest rates are calculated using the Nelson-Siegel-Svensson model and the corresponding parameters are obtained from the European Central Bank's Statistical Data Warehouse. Our data set covers the time period between June 2008 and December 2017. The sample period is restricted to the availability of dividend futures.

Figure 1 shows the average percentage of Euro Stoxx 50 members by country. During our sample period 67% of the Euro Stoxx 50 index members are companies headquartered in Germany or France, 9% of index members are located in Italy or Spain, respectively, and other countries make up 15%. As pointed out in Figure 2, the major industries represented in the Euro Stoxx 50 index are from the financial (28%) and consumer (25%) sector.

To construct the dividend tax penalty proxy we make use of novel derivative products, particularly dividend futures, which were first exchange-traded in Europe. Trading on those products

Figure 2. Average Percentage of Euro Stoxx 50 Members per Industry



The graph shows the average percentage of Euro Stoxx 50 members by industry during our sample period from July 2008 to December 2017.

started around 2000 on over-the-counter markets. The Eurex exchange offers European dividend derivatives for maturities up to 10 years since 2008. Since then the market has been growing and to date, this is the most liquid market for dividend futures. Japan and the UK followed next. In the US dividend futures are exchange-traded only since the end of 2015.

These European dividend futures are direct claims to future dividends paid by firms to their investors. In particular, the underlying of European Euro Stoxx 50 dividend futures is the sum of ordinary unadjusted gross cash dividends declared and paid by all constituents of the Euro Stoxx 50 index within a given reference year. We use dividend futures with up to two years maturity. This allows us to construct two different dividend tax penalty proxies. One that measures marginal tax expectations of the current year and one that measures next year tax expectations.

Therefore, Table I summarizes the descriptive statistics of daily dividend future prices with one year and two years maturity (i.e. current and next year dividend future). The mean expectation on the dividend distribution of Euro Stoxx 50 members in the current year (~116 index points) is higher than expectations for the next year (~108 index points). Figure 3 shows the 30-day moving average of the daily dividend future price over time. During the financial crisis in 2008 the dividend future with maturity in the current and next year drops suddenly. Until 2014 expectations on current year dividend payout are higher than on next year total dividends. From 2014 and 2015 the expectations on the dividend pay out of Euro Stoxx 50 members in the next and current year

Table I
Summary Statistics Dividend Futures

This table shows descriptive statistics (average, standard deviation, minimum, median and maximum) of daily current and next year dividend future (*df*) prices in index points. The quoted spread is the difference between the bid and ask price scaled by the mid price. Sample period: July 2008 to December 2017.

	Mean	Std. Dev.	Min.	Median	Max.
(A) dividend future current year					
df mid price	116.719	10.209	95.017	115.098	158.990
df quoted spread	0.258	0.389	0.000	0.169	5.376
(B) dividend future next year					
df mid price	108.410	13.932	52.686	110.513	139.401
df quoted spread	0.625	0.976	0.000	0.337	13.191

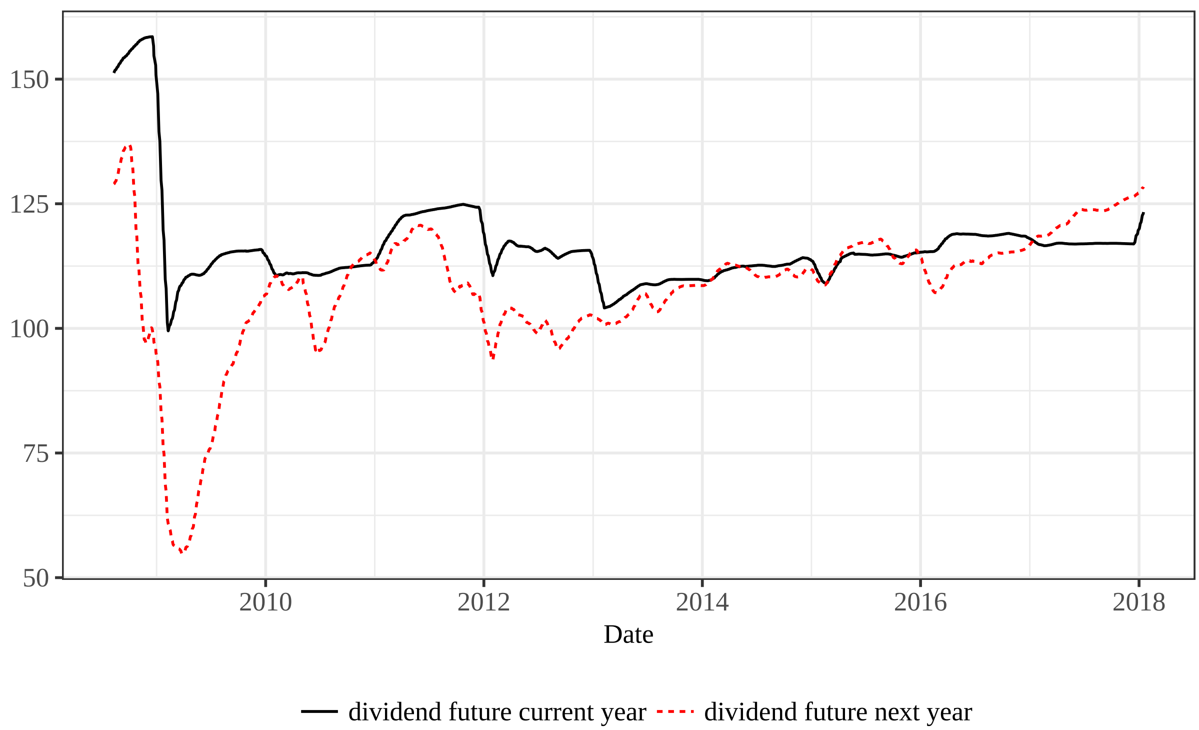
are overlapping. In 2016 (2017) investors expected higher (lower) dividend pay-out in the current year compared to the next year. The mean of the quoted bid-ask spread is very low (0.258% and 0.625%, respectively) and the median even lower (0.169% and 0.337%, respectively) implying a highly liquid market. Figure 4 graphs the 30-day moving average of the quoted bid-ask spreads over time and shows an increase in liquidity over time.

B. *Taxation and Put-Call-Parity*

Our empirical analyses are based on Euro Stoxx 50 derivatives. French and German companies make up almost 70% of Euro Stoxx 50 (see Figure 1) constituents and, in general, the majority of investors in options markets are corporate (institutional) investors, so, the tax systems we apply to the put-call parity are those of France and Germany related to corporate investors.

Which taxation rules alter the put-call parity? When trading dividends via the put-call parity, the initial investment involves buying an equity share and hedging stock price movements by buying a put and shorting a call. This investment strategy is financed with a credit. At maturity an investor receives gains or losses from selling the equity share in T_1. Additionally, the investor makes gains or losses with trading the put and the corresponding call. The tax treatment of transactions from equity shares in comparison with options is therefore important to the put-call parity. In Germany and France gains from derivatives and equity shares are treated identical in terms of taxation. In contrast to tax systems in some other countries with more differentiated regulations such as Australia, in Germany and France, we do not have to distinguish between taxes on transactions

Figure 3. Dividend Future Price

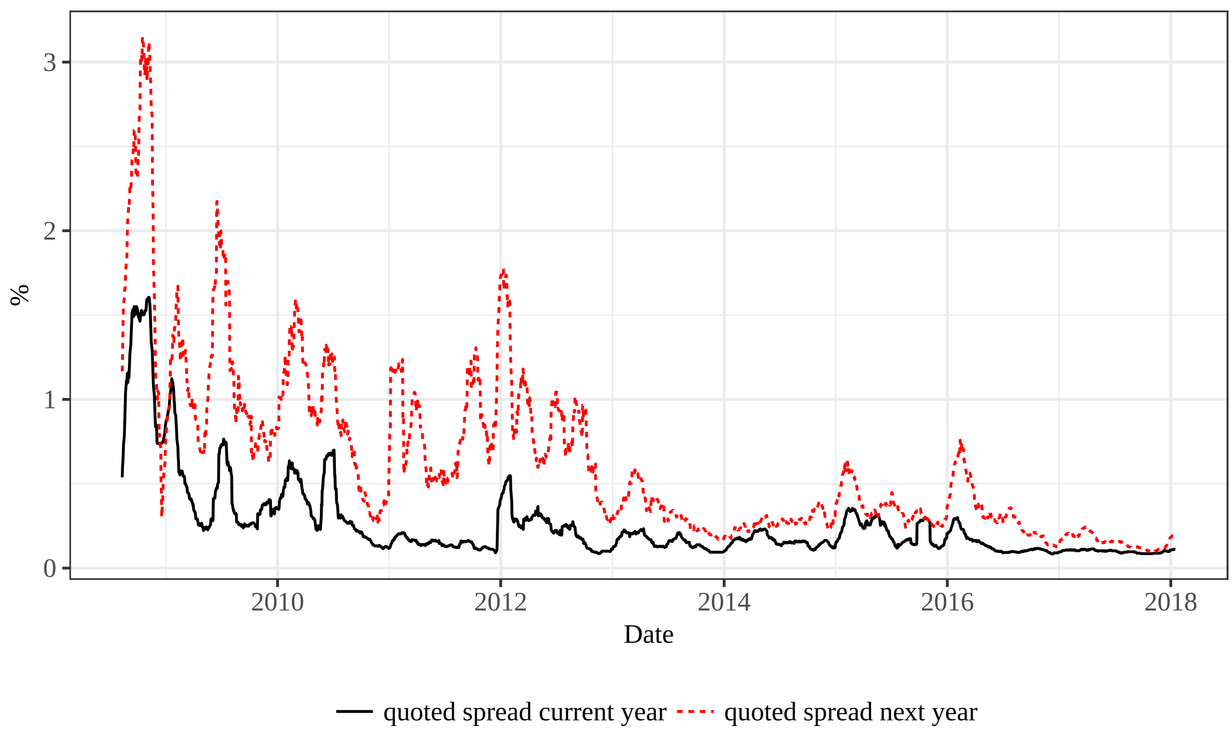


The graph shows 30-day moving average of the dividend future price with one year maturity (current year) and tow years maturity (next year) current. Sample period: July 2008 to December 2017.

from shares and options. This makes the interpretation of the tax proxy implied by options prices much more intuitive. Further, when trading the put-call strategy, a tax on dividend payments is imposed. The taxation of dividends and capital gains of corporate (institutional) investors in France depends on the holding period, investment size and type of investor. For corporate holdings below 5% in national companies, dividend and capital gains are taxed at the same rate. However, for substantial or long-term investment a preferential capital gains tax rate is applicable. In this case, capital gains and dividends are taxed at different rates. An additional surcharge to the dividend tax was introduced in 2012 and ultimately abolished in 2018.

For German corporate investors, capital gains and dividend earnings for low holdings are also taxed at different rates. While dividends and capital gains are uniformly tax-exempted for the receiving corporation for holdings of 10% and above, for lower holdings dividends are subject to corporate taxes. By contrast, capital gains are exempted to an extent of 95% leading to a very low

Figure 4. Dividend Future Quoted Spread



The graph shows 30-day moving average of the quoted bid- ask spread of the dividend future with one year maturity (quoted spread current year) and tow years maturity (quoted spread next year) current. Sample period: July 2008 to December 2017.

effective capital gains tax rate. Corresponding tax effects emerge if German corporates invest in French stocks and receive dividend or capital gains in return.

We assume that the majority of institutional investments is characterized by such low holdings leading to differing tax rates on capital gains and dividends. To proxy for the emerging dividend tax penalty in France and Germany, we introduce two different tax rates into the put-call parity: one for dividends τ^D and one for capital gains τ^C. As we show in Section II.A.1, this enables us to derive a proxy that measures the ratio of dividend to capital gains tax rates from derivatives prices.

C. Construction of the Dividend Tax Penalty Proxy

The prices for puts, calls, and the index needed to calculate net dividend prices implied by Equation 10 and 12 are on an intra-daily basis. We use equity index options with up to two years maturity and expiration in December.[11] Following Binsbergen, Brandt, and Koijen (2012), Hautsch (2012) and Muravyev (2016), we employ a standard prescreening of the intraday dataset to eliminate incorrect and illiquid observations:

(a) We delete transactions outside the main trading hours. This means, we exclude the first and the last hour of trading and select option prices and index values between 10 a.m. and 4:30 p.m., where liquidity is highest.

(b) We include only observations with a trade price larger than the tick size (10 cents) and maturity of at least seven days.

(c) As our sample period includes the financial crisis and the European debt crisis, we observe days with extreme intraday volatility of Euro Stoxx 50 index returns. Thus, we delete outliers that occur on days in which the intraday standard deviation of Euro Stoxx 50 index returns is above its' 95% quantile.

(d) Finally, to ensure a liquid sample and avoid biases through transaction costs, we delete options outside of the moneyness[12] range of (0.9, 1.1).

Applying all this conditions gives 1,566,879 observations, of which 50.07% are puts and 49.93% are calls. In order to calculate our monthly measure of current and next year net dividend expectations, we start with the matching of the intra-daily components of the put-call parity.

First, current year net dividend prices with maturity in T_1 (Equation 10) are calculated by matching the nearest call and corresponding put options with the same strike and maturity, that are traded closest to each other in time within a one hour window. On average, the trading time of the put and call pair diverges by 13:42 minutes for the current year's net dividend price. Second, to calculate next year net dividend prices (Equation 12), we carry out the matching in two steps, since the strategy involves matching four puts and calls. In the first step, we match the put and corresponding call closest in time with the same strike and with maturity in T_2 within a 90 minutes window. The average divergence in the matching time is 11:19 minutes. It is noteworthy that the matching time for puts and calls with longer maturity is lower, although we have considerably less observations. This could be an indication that a larger proportion of options with longer maturities

[11] Dividend Futures expire on the third Friday in December, and, therefore, we need the corresponding puts and calls also expiring on the third Friday in December.

[12] Moneyness is defined as the exercise price over the stock price.

Table II
Summary Statistics *dtp*

This table shows descriptive statistics (average, standard deviation, minimum, median and maximum) of the 30-day moving average of current year, next year and constant maturity dividend tax penalty (*dtp*) in per cent. Sample period: July 2008 to December 2017.

		Mean	Std. Dev.	Min.	Median	Max.
(A)						
	dtp current year	14.883	11.145	-6.405	12.740	42.541
Median	*dtp next year*	14.610	8.223	-4.460	13.811	32.288
	dtp constant maturity	14.385	8.904	-4.880	12.608	38.253
(B)						
	dtp current year	15.199	11.169	-7.356	13.213	43.152
Mean	*dtp next year*	14.838	8.206	-1.178	13.874	31.227
	dtp constant maturity	14.530	9.184	-4.582	12.860	38.517

are traded in combined put-call strategies. In the second step, we combine the put and call pairs expiring in T_1 with the put and call pairs which expire in T_2.[13]

We have intraday data on Euro Stoxx 50 index points on a 15 second frequency. After matching the options pairs we add the closest index observation in time. Risk-free rates are calculated on a daily basis and are added as last component. Instead of the median across all intra-daily prices we also compute a measure based on the mean and compare their properties. To account for potential measurement error or market microstructure issues we take the median across all intra-daily calculated net dividend prices. This results in our final measure of net dividend prices.

Finally, in order to calculate the dividend tax penalty proxy from Equations 14 and 15, we need to take the proportional difference of net dividend prices and gross dividend prices (price of the index dividend future). As Euro Stoxx 50 index dividend futures have rather stable intraday prices, we use end of day mid-quotes to calculate the dividend tax penalty proxy. In the last step, we combine the current and next year dividend tax penalty expectations to obtain a constant one year maturity dividend tax penalty proxy. We do so by taking a weighted mean of the current and next year dividend tax expectations (see Equation 16).

Table II shows the mean, standard deviation, minimum, median and maximum values of the monthly current year, next year and constant maturity *dtp* expectations. Comparing the statis-

[13] The relevant point in time for the second step matching is the midpoint between the put and call pairs of the first matching step.

tics in Panel (A) and (B) indicates that taking the median or mean of the intraday data yields very similar descriptive statistics. This implies that *dtp* proxy is robust with regard to different aggregation methods. The main difference is the higher standard deviation of the mean measure. In general, the median measure is a more stable statistical measure, and, thus, in the following analysis, we calculate the dividend tax penalty by using monthly medians. On average, dividend tax penalty expectations for the current year are higher than expectations for the next year. During our sample period the average expected tax difference between dividends and capital gains tax rates for the constant maturity of one year is 15.98%. The standard deviation of 9.4% and the wide range between minimum and maximum values suggests that expectations on taxes fluctuate considerably over time. This constant maturity proxy has two advantages: First, it eliminates potential illiquidity concerns regarding options with a maturity close to two years, and, second, it corrects conceptual issues that arise close to options expiration.

IV. Empirical Analyses

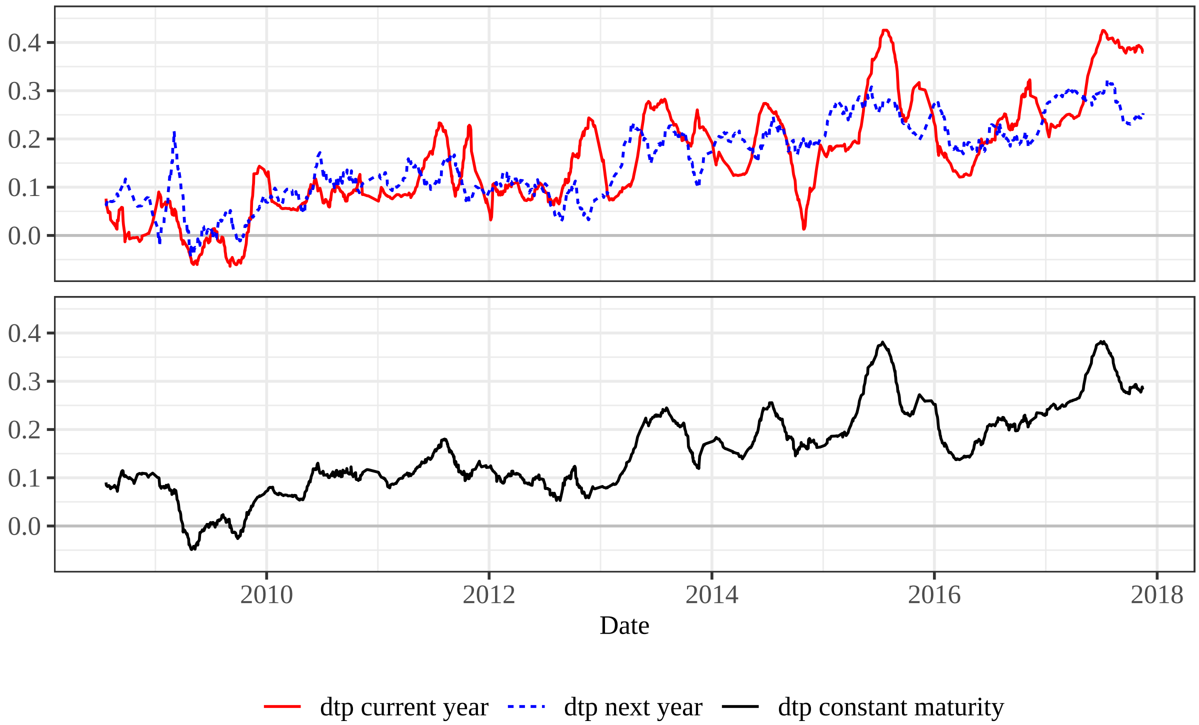
A. Properties of Dividend Tax Penalty Expectations

Figure 5 illustrates the current and next year *dtp* over time, as well as the constant maturity *dtp*, that is, the linear combination of current and next year *dtp*. The graph shows that current and next year *dtp* expectations follow a similar course, while the current year *dtp* fluctuates more. Investors' expectations on the penalty of dividend vs. capital gains taxes increases over time and peaks in the mid of 2015 and 2017 at approximately 0.38. Table III shows correlations between different *dtp* measures and confirms the graphical impression. The correlation between the current and next year *dtp* is 0.65, which shows that tax expectations for this and next year have a common ground. The constant maturity *dtp* exhibits correlations above 0.8 with current and next year *dtp*.

B. Dividend Tax Penalty and Fiscal Policy

Figure 6 and 7 show the 30-day moving average of the constant one year maturity dividend tax penalty proxy. The vertical lines in Figure 6 and 7 represent events that are related to the future corporate tax regulation in Germany and France, respectively. These events and their relation to the dividend tax penalty proxy will be discussed in the following.

Figure 5. Current, Next and Constant Maturity *dtp*



The graph shows the 30-day moving average of current, next and constant maturity dividend tax penalty proxies in basis points. Sample period: July 2008 to December 2017.

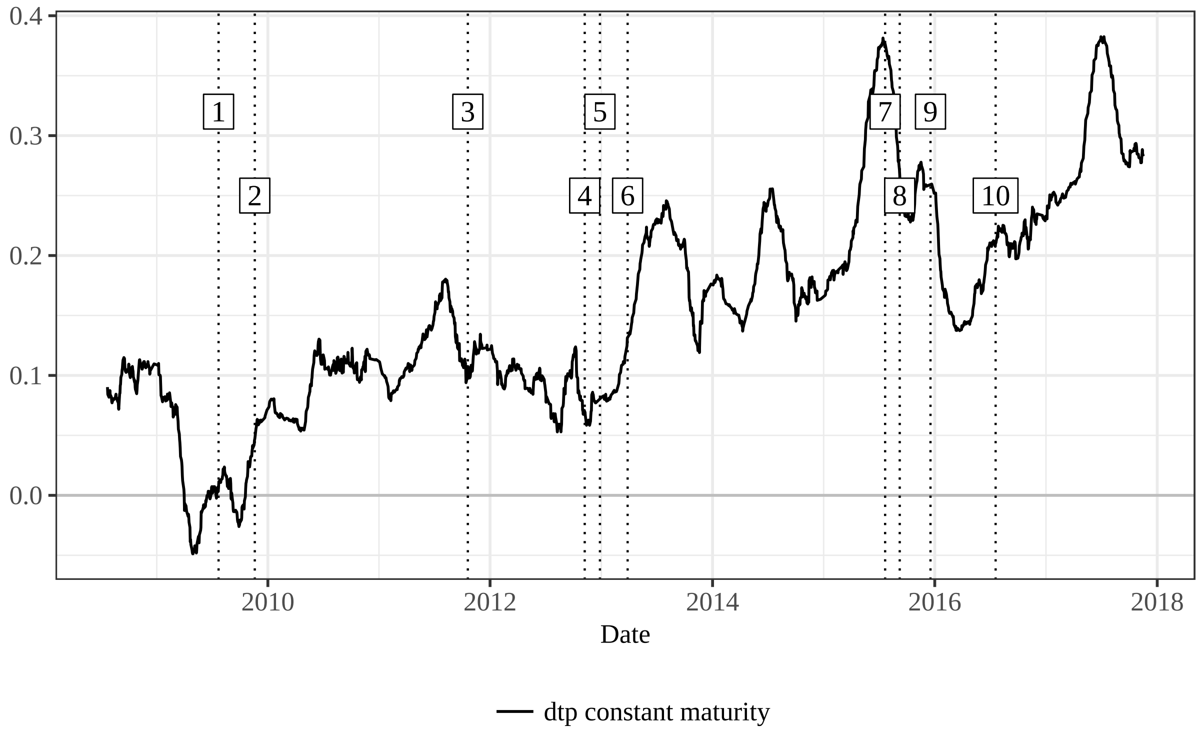
Table III
Correlation Among *dtp* Specifications

This table shows pairwise correlations for different specifications of the dividend tax penalty. In detail, constant maturity (dtp), current year dividend tax penalty (dtp_1), and next year dividend tax penalty (dtp_2) correlations are reported. Sample period: July 2008 to December 2017.

		dtp specifications		
		(1)	(2)	(3)
(1)	dtp	1.000		
(2)	dtp_1	0.869	1.000	
(3)	dtp_2	0.873	0.646	1.000

According to the European fundamental freedoms, tax residents and tax EU non-residents are to be treated equally. If this is not the case, the principle of free movement of capital is violated. Such an infringement of the free movement of capital by the Italian Republic (Case C-540/07) was brought before the European Court of Justice (ECJ) by the Commission of the European Communities on 11/30/2007. Finally, on 11/19/2009 (event no. 2), the unequal treatment of

Figure 6. Option Implied Dividend Tax Penalty Expectation - German Tax Events



Events: 1. Action against Federal German Republic 2. ECJ decision (Italy) 3. ECJ decision (Germany) 4. Proposal for a tax exemption of free float dividends 5. German Bundesrat decides against tax exemption of dividends 6. Increase of dividend tax rates 7. Investment Tax Reform Act (publication draft protocol) 8. Statement of several interest groups 9. Introduction Investment Tax Reform Act 10. Amendment of Investment Tax Reform Act

residents and non-residents with regard to dividend taxation was established in the ECJ's judgment against Italy. Italy was then required to remedy this infringement of fundamental freedoms by amending its legislation. A change in the law could provide equal treatment either through a uniform taxation of dividends or a uniform exemption. The ECJ ruling triggered discussions on the design of dividend taxation in many EU member states, among them also Germany and France, and is also part of a series of further proceedings at the ECJ on infringements of these individual member states in their dividend taxation. Although, the judgment of the court was implemented in national law only years later, the graph implies that the dividend tax penalty proxy reacted directly after the court decision (event no. 2) and after that consistently remained above zero. This is a hint that investors expected regulators to implement a uniform taxation of dividends.

For example, the Commission of the European Communities brought an action against the

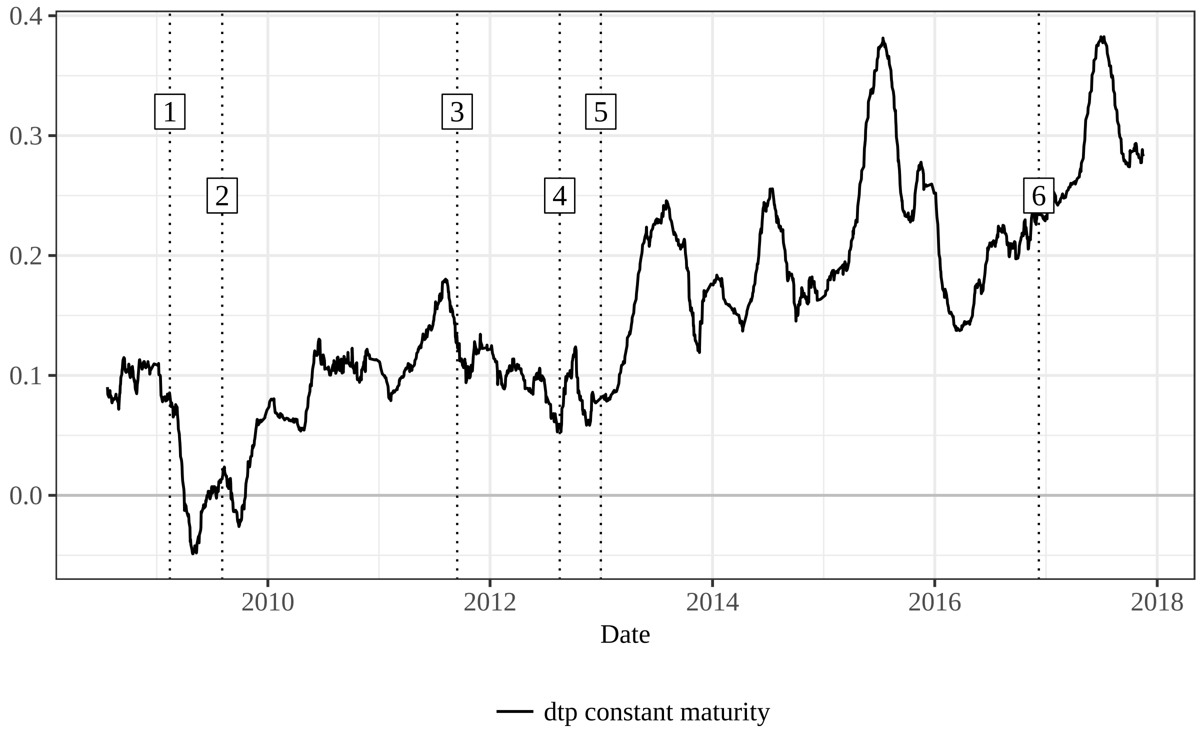
Federal Republic of Germany on 07/23/2009 (event no. 1, Case C-284/09). The subject matter of the action is the German rules on the taxation of dividend distributions (German capital gains tax on portfolio dividends to foreign corporations). The provisions of the German Income Tax Act provided that parent companies that were unlimitedly tax liable in Germany could credit withholding tax in the assessment procedure to the corporate income tax. As a result, German parent companies were economically exempt from withholding tax. For parent companies with limited tax liability in Germany (EU non-residents), on the other hand, the possibility of being completely exempt from withholding tax existed only if the parent company in question held a corresponding minimum stake of 10% (as of 2009) in the subsidiary's capital. Below this minimum holding, however, no exemption was possible under German law for EU non-residents parent companies in the same way as for German parent companies. On 10/20/2011, the ECJ finally ruled against Germany in this case, classifying this unequal treatment in dividend taxation as contrary to European law. As a result, various reform proposals were discussed in Germany to achieve EU conformity of dividend taxation. One of the proposals is the tax exemption of dividends from free float shares, i.e., shares with a participation rate of less than 10% held by tax residents and tax EU non-residents. Various draft bills are being introduced and discussed in the German Bundestag and German Bundesrat. Event no. 4 in Figure 6 belongs to a proposal of the parliamentary group of CDU/CSU and FDP for a tax exemption of free float dividends (11/06/2012). Thereafter, we observe a decreasing dividend tax penalty proxy. It turns out that this proposal did not find a majority in the Bundesrat (12/17/2012, event no. 5), and correspondingly, thereafter, Figure 6 indicates increasing expectations reflected in our dividend tax penalty. With the law of 03/28/2013 (event no. 6), after extensive debates in the Bundestag, Bundesrat and Mediation Committee, the opposite approach is finally taken, and a dividend tax was introduced for German parent companies for free float dividends. After this decision, we observe a shift in the mean of our *dtp* measure.

Even though dividends and capital gains are often seen as alternative ways for shareholders to benefit from their shareholdings, only the taxation of dividends was adjusted as part of this reform. Capital gains from free float shares, on the other hand, were not subject of this law. In the Mediation Committee, however, it was stated that in the planned reform of the German Investment Tax Act (InvStG), the German government will also address the tax treatment of capital gains from free float in the future. Hence, for the time being, we observe an unequal treatment of dividends and capital gains in Germany, and thus, a dividend penalty. In order to counter this unequal treatment, a draft of the Investment Tax Reform Act was presented by the Federal Ministry of Finance on 07/22/2015 (event no. 7), in which the taxation of capital gains from free float sales with simultaneous exclusion of loss offsetting is proposed. Loss offsetting is a major assumption in the derivation of the *dtp* proxy from derivatives prices. Figure 6 implies an increase in our proxy after the expected exclusion of loss offsetting. Press releases, comment letters and further statements have been issued by several interest groups, such as the German Banking Association (09/03/2015) or the Federal Chamber of Tax Advisors (09/08/2015, event no. 8), opposing the taxation of capital gains from free float shares. Accordingly, expectations reverted back, which is reflected in a decrease of our *dtp* measure. Event no. 9, the draft bill for a law to reform investment taxation (Investment Tax Reform Act) of 12/16/2015 is followed by a further decrease in *dtp* expectations. Finally, the law to reform investment taxation (Investment Tax Reform Act) of 07/19/2016 (event no. 10) adopted amendments that are less far-reaching but counter the refund of capital gains tax in some special cases. Thus, contrary to the original proposal, a taxation of capital gains from free float shares was not introduced. At present, however, the German government continues to search for a solution that is compatible with the state aid requirements of European Union law in order to revisit a possible introduction of tax liability for capital gains from free float investments at a later date. In other words, the dividend penalty remains in place, as does uncertainty about the future German tax treatment of capital gains from free float.

The French taxation of dividends and capital gains also underwent a number of changes. However, in many cases dividends and capital gains are subject to an identical corporate tax rate. Nevertheless, taxation is characterized by severe uncertainty due to many changes and judgments. For example event no. 1 in Figure 7, is the ruling of 02/13/2009 of the Conseil d'État stating that in France dividend payments to domestic pension funds are tax exempt pursuant to Art. 206 (5) CGI, whereas a withholding tax is levied on dividend payments to foreign pension funds. According to the Conseil d'État, the higher burden on foreign pension funds constitutes an unjustified restriction on the free movement of capital within the European Union. Hence, it has requested the tax authorities to repeal the above-mentioned decrees.

This unfavorable taxation of investment income to foreign pension funds in France is not an

Figure 7. Option Implied Dividend Tax penalty Expectation - French Tax Events



Events: 1. Statement of Conseil d'État on dividend taxation 2. Preliminary ruling to eliminate double taxation 3.ECJ decision (France) 4. Additional tax on dividends 5. Finance Act for 2013 6. Reminder on law adjustment by the European Commission

isolated case in the European Union. The European Commission has sent letters of formal notice to several member states. These letters point towards the need of future tax reforms in several European member states.

Furthermore, lodged on 08/04/2009 (event no. 2), the Conseil d'État (France) seeks an interpretation of Articles 43 and 56 of the Treaty Establishing the European Community at the ECJ in the context of a dispute between the Ministre du budget, des comptes public et de la fonction publique (Minister for the Budget, Public Accounts and the Civil Service) and Société Accor. The Conseil d'État asked for a preliminary ruling about differences in the application of a tax credit to eliminate double taxation of dividends distributed by a parent company to the shareholders that have been obtained from a subsidiary established in France, but not offered if those dividends come from a subsidiary established in another Member State of the European Community. The ECJ decided on 09/15/2011 on this request (Case C310/09), declared the existing French regulation, which provided for different treatment in the onward transfer of dividends received by a French parent company from a French subsidiary, to be contrary to European law. While a tax credit was available in the case of a subsidiary domiciled in France, it was not open to foreign subsidiaries. Since France did not adjust their law accordingly, the European Commission called on France (12/08/2016, event no. 8) again to fully comply with this ECJ ruling.

Tax uncertainty also ranges around the introduction of a supplementary charge on dividend distribution in 2012. Dividend distributions made as of 08/17/2012 by French companies were subject to a 3% additional tax on top of the underlying corporate income tax, which could partly explain the increase in expectations on the dividend tax penalty from event 6 on. The supplementary charge was finally abolished as of 01/01/2018 following several rulings and reforms such as legislative changes affecting shareholdings above 5%.

Among many other legislative changes, for example, regarding payments to parent companies in so-called uncooperative countries, the scope of taxation of capital gains was increased from 10% to 12% as part of the Finance Act for 2013, which was passed on 12/30/2012. However, this reform only applies if a long-term net capital gain has been generated in the fiscal year. However, we cannot not observe a subsequent decrease in *dtp* expectations in Figure 7.

To summarize, in France and Germany and other European member states, the number of changes in the taxation of dividends and capital gains experienced and the changes to be expected in the future, to meet EU fundamental freedoms or national level anti-discrimination rules, are considerable, and thus, have to be expected to be anticipated by corporate investors.

C. Variations in Tax Expectations, Policy Uncertainty, and Economic Conditions

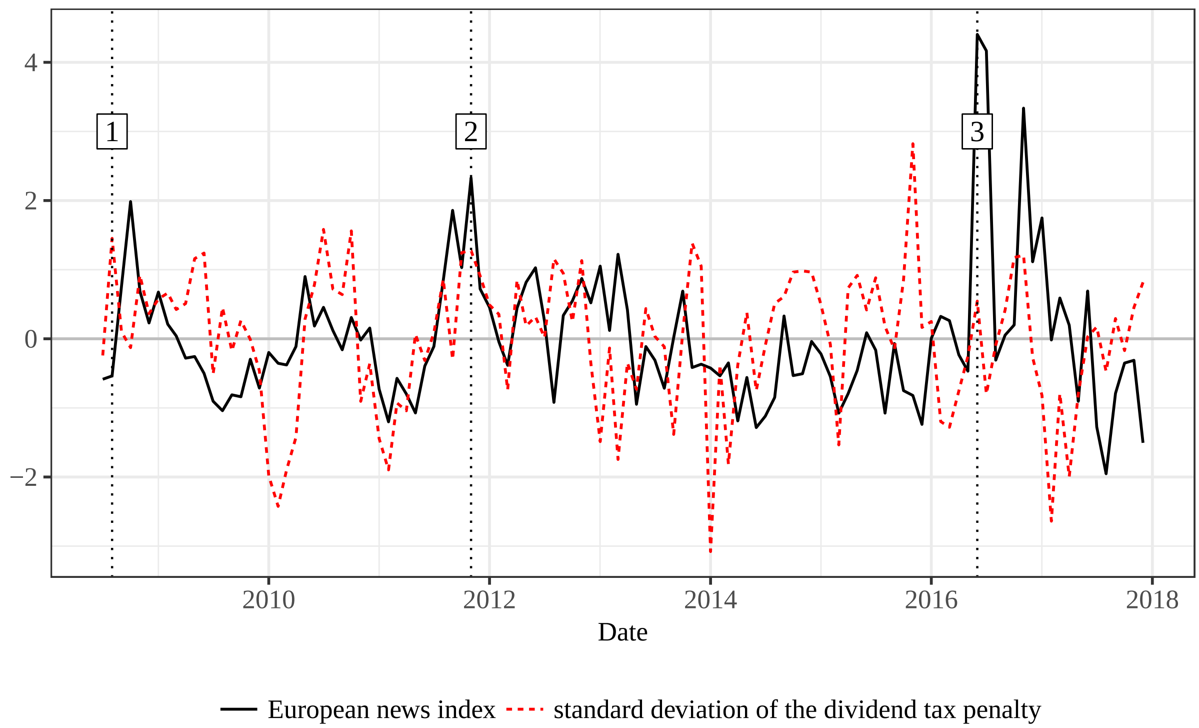
As Figures 6 and 7 show, *dtp* expectations change in response to political discussions related to the tax treatment of dividends and capital gains. To capture this variation, we consider the standard deviation of dividend tax penalty expectations. Table IV reports descriptive statistics for the natural logarithm of the standard deviation of daily dividend tax penalty values within one month (see Equation 17). The minimum and maximum values suggest that there is considerable time variation in this second moment of option implied tax expectations. Thus, we expect to gain interesting insights by relating the magnitude of this variation to measures of policy-related economic uncertainty and economic conditions more general.

Table IV
Summary Statistics *std(dtp)*

This table shows descriptive statistics (average, standard deviation, minimum, median and maximum) of variations in tax expectations ($std(dtp)$) defined as the logarithm of the volatility of dtp, where the volatility of dtp is the standard deviation of daily dividend tax penalty values within one month. The time period is between July 2008 and December 2017.

	Mean	Std. Dev.	Min.	Median	Max.
std(dtp)	-2.915	0.553	-4.216	-2.848	-1.111

Figure 8. Standard Deviation of Tax Expectations and General Political Uncertainty



The graph shows the Baker, Bloom, and Davis (2016) European News Index and the standard deviation of daily dividend tax penalty values within one month ($std(dtp)$). Both time-series are standardized and demeaned. *Events:* 1. Peak of the financial crisis 2. Peak of the European debt crisis 3. Brexit referendum. Sample period: July 2008 to December 2017.

Figure 8 illustrates the standardized and demeaned time-series of the European news index together with our standard deviation of tax expectations. The European news index of Baker, Bloom, and Davis (2016) is based on the newspaper coverage frequency of policy-related economic uncertainty articles. The graph points out that the standard deviation of tax expectations implied by derivatives prices and the European news index reflecting reported policy uncertainty are positively related. In particular, the time-series correlation between the European news index and standard deviation of daily dividend tax penalty values within one month is 0.13. This is meaningful taking into account that the most heavily weighted component of the news measure is economic policy uncertainty, whereas investor tax related fiscal policy news make up a rather small subset of the uncertainty captured by the European news index. Both variables spike towards end of 2008 and in the second half of 2011, which can be related to the intensification of the financial and euro area debt crisis (events no. 1 and 2). The Brexit referendum and its outcome caused the global peak in the European news index in June 2016 (event no. 3), although, the standard deviation of dividend tax penalty was not affected as much by Brexit the graph still reveals an increase, pointing towards at least some Brexit-induced tax uncertainty.

Pastor and Veronesi (2013) analyze the effects of general policy uncertainty on asset prices in a theoretical and empirical framework.[14] Their model predicts that uncertainty about future policy implementations is larger during weaker economic conditions. The intuitive reason behind this is that governments are more likely to change their policies in weak economic conditions. An initial result that confirms their predictions for the relation between macroeconomic conditions and fiscal policy uncertainty is the already graphically visible connection between crisis related events and spikes in our uncertainty measure.[15]

Further, we contribute to this literature by relating the standard deviation of our dividend tax penalty expectations measure to economic conditions. Therefore, we relate $std(dtp)$ to different macroeconomic variables (i.e. unemployment ($unempl$), industrial production (ip), price/earnings ratio (pe) and term spread (ts)). Table V reports the summary statistics of the European News Index and macroeconomic variables.

The results in Table VI point out that $std(dtp)$ is higher during weaker macroeconomic times. In detail, $std(dtp)$ is positively correlated with unemployment and negatively correlated with industrial production, the price/earnings ratio and slightly negatively with term spread. The correlation with the unemployment rate is the highest with 37%. The countercyclical behavior of $std(dtp)$

[14]An early attempt to integrate tax uncertainty into a theoretical framework gives the paper of Sialm (2006). He provides theoretical evidence that uncertain income taxes increase the equity premium.

[15]Relatedly, Hassan, Hollander, van Lent, and Tahoun (2019), who construct a firm-level policy risk measure based on computational linguistics analyses of the share of a firm's quarterly earnings conference calls devoted to political risks including tax policy risk, find high firm-level political risk volatility. This measure is applied in Gallemore, Hollander, Jacob, and Zheng (2021) to investigate tax policy beliefs and their impact on real investment.

Table V
Summary Statistics of Macroeconomic Variables

This table shows descriptive statistics (average, standard deviation, minimum, median and maximum) of macroeconomic variables between July 2008 and December 2017.

	Mean	Std. Dev.	Min.	Median	Max.
Unemployment (*unempl*)	0.108	0.081	-0.190	-0.01	0.400
Industrial production (*ip*)	-0.007	1.135	-4.100	0.100	2.500
Price-earnings ratio (*pe*)	17.005	4.613	7.840	17.687	25.592
Term spread (*ts*)	1.516	0.777	-0.580	1.610	3.300
News index (*news*)	1.850	0.610	0.879	1.731	4.333
Euro Stoxx 50 volatility (*volatility*)	21.713	10.915	6.080	19.535	72.150

Table VI
Correlation Between std(dtp) and macroeconomic variables

This table shows monthly pairwise correlations of *std*(*dtp*) with unemployment (*unempl*), industrial production (*ip*), price/earnings ratio (*pe*), term spread (*ts*), the Baker, Bloom, and Davis (2016) European News Index (*news*) and Euro Stoxx 50 index volatility (*volatility*). Sample period: July 2008 to December 2017.

		std(dtp) and macroeconomic variables						
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	*std(dtp)*	1						
(2)	*unempl*	0.37	1					
(3)	*ip*	-0.36	-0.40	1				
(4)	*pe*	-0.33	-0.52	0.25	1			
(5)	*ts*	-0.05	0.34	0.21	-0.20	1		
(6)	*news index*	0.13	0.17	-0.14	-0.26	-0.21	1	
(7)	*volatility*	0.39	0.52	-0.43	-0.46	-0.08	0.40	1

is consistent with the predictions of the model of Pastor and Veronesi (2013). Further indication gives the positive correlation of 0.39 between std(dtp) and Eurostoxx 50 index volatility. Overall, these relations to economic conditions suggest that our approach of estimating option-implied tax expectations may also be helpful in inferring uncertainty about tax policy from such forward-looking information.

V. Conclusion

Exploiting tax differences in two otherwise equivalent dividend investing strategies, we construct a forward-looking measure for option implied tax expectations. Analyzing this market-implied dividend tax penalty measure over time and in face of tax-related policy events we find that changes in our tax expectations are connected to tax-related political discussions. Moreover, variations in tax expectations are more pronounced during weaker economic conditions. This finding points towards a counter-cyclical pattern of tax policy uncertainty that is consistent with existing literature that relates general political uncertainty to macroeconomic conditions.

In future research, our newly established tax expectation measure can be used to estimate tax uncertainty, provide useful insights on the systematic nature of tax uncertainty and to assess how tax expectations and tax uncertainty are capitalized into asset prices and ultimately affect decision making in firms, e.g., payout or investment decisions.

REFERENCES

Baker, Scott R., Nicholas Bloom, and Steven J. Davis, 2016, Measuring Economic Policy Uncertainty, *The Quarterly Journal of Economics* 131, 1593–1636.

Binsbergen, Jules van, Michael Brandt, and Ralph Koijen, 2012, On the Timing and Pricing of Dividends, *American Economic Review* 102, 1596–1618.

Fleckenstein, Matthias, Priyank Gandhi, and Pengjie Gao, 2019, Tax Risk and Asset Prices: Evidence from Dual-class Corporate Bonds in the 19th Century, p. 71.

Gallemore, John, Stephan Hollander, Martin Jacob, and Xiang Zheng, 2021, Tax Policy Beliefs and Investment: Evidence from the 2016 U.S. Election and the Tax Cuts and Jobs Act, *SSRN Electronic Journal*.

Gormsen, Niels Joachim and Ralph S J Koijen, 2020, Coronavirus: Impact on Stock Prices and Growth Expectations, *The Review of Asset Pricing Studies* 10, 574–597.

Graham, John R., 2003, Taxes and Corporate Finance: A Review, *Review of Financial Studies* 16, 1075–1129.

Guenther, David and Richard Sansing, 2010, The Effect of Tax-Exempt Investors and Risk on Stock Ownership and Expected Returns, *Accounting Review - ACCOUNT REV* 85.

Hassan, Tarek, Stephan Hollander, Laurence van Lent, and Ahmed Tahoun, 2019, Firm-Level Political Risk: Measurement and Effects, *The Quarterly Journal of Economics* 134, 2135–2202.

Hautsch, Nikolaus, 2012, *Econometrics of Financial High-Frequency Data*. (Springer Berlin Heidelberg, Berlin, Heidelberg).

Kragt, Jac, Frank de Jong, and Joost Driessen, 2020, The Dividend Term Structure, *Journal of Financial and Quantitative Analysis* 55, 829–867.

Muravyev, Dmitriy, 2016, Order Flow and Expected Option Returns: Order Flow and Expected Option Returns, *The Journal of Finance* 71, 673–708.

Osswald, Benjamin and Caren Sureth, 2020, Do country risk factors attenuate the effect of taxes on corporate risk-taking?, Working paper, TRR 266 Accounting for Transparency Working Paper Series No. 28.

Pastor, Ľuboš and Pietro Veronesi, 2013, Political uncertainty and risk premia, *Journal of Financial Economics* 110, 520–545.

Paye, Bradley S., 2012, 'Deja vol': Predictive regressions for aggregate stock market volatility using macroeconomic variables, *Journal of Financial Economics* 106, 527–546.

Sialm, Clemens, 2005, Tax changes and asset pricing: Time-series evidence, Working paper, National Bureau of Economic Research.

Sialm, Clemens, 2006, Stochastic taxation and asset pricing in dynamic general equilibrium, *Journal of Economic Dynamics and Control* 30, 511–540.

van Binsbergen, Jules, Wouter Hueskes, Ralph Koijen, and Evert Vrugt, 2013, Equity yields, *Journal of Financial Economics* 110, 503–519.

Vegh, Carlos and Guillermo Vuletin, 2015, How Is Tax Policy Conducted over the Business Cycle?, *American Economic Journal: Economic Policy* 7, 327–70.

Wilkens, Sascha and Jens Wimschulte, 2010, The pricing of dividend futures in the European market: A first empirical analysis, *Journal of Derivatives & Hedge Funds* 16, 136–143.

Table A1
Derivation of the Tax-Dependent Put-Call Parity

This table derives the present value of after-tax dividends. The no-arbitrage arguments are based on the put-call strategy that involves initial investment in a stock, a put option and a call short. This investment is financed with a credit in t. For simplification we assume one dividend payment in t_d. The investor has to pay taxes (τ_D) on dividends in t_d and invests the remaining after-tax dividend payment in a riskless asset until T_1, then, the investor receives interest income. At maturity in T_1 the investor also receives capital gains from its stock and options investment. This capital gains are taxed at the capital gains tax rate (τ_c). Credit costs are fully tax-deductible.

Position	t	t_d	T_1	
			$S_{T_1} <= X$	$S_{T_1} > X$
Put-call-strategy				
Put long	$-P$		$X - S_{T_1}$	0
Call short	C		0	$-(S_{T_1} - X)$
Stock long	$-S_t$	D_{t_d}	S_{T_1}	S_{T_1}
Taxes on capital gains (τ_c)				
Put long			$-(X - S_{T_1} - P)\tau_c$	$+P\tau_c$
Call short			$-C\tau_c$	$-(X - S_{T_1} + C)\tau_c$
Stock long			$-(S_{T_1} - S_t)\tau_c$	$-(S_{T_1} - S_t)\tau_c$
Credit for financing strategy				
Credit	$S_t + P - C$		$-(S_t + P - C)e^{r(T_1-t)}$	$-(S_t + P - C)e^{r(T_1-t)}$
Tax treatment of credit costs				
Credit interests tax deduction			$(S_t + P - C)(e^{r(T_1-t)} - 1)\tau_c$	$(S_t + P - C)(e^{r(T_1-t)} - 1)\tau_c$
Taxes on dividends (τ_D)				
Dividend taxation		$-D_{t_d}\tau_D$		
Dividend investment		$-D_{t_d}(1 - \tau_D)$	$D_{t_d}(1 - \tau_D)e^{r(T_1-t_d)}$	$D_{t_d}(1 - \tau_D)e^{r(T_1-t_d)}$
Sum	=0	=0	$\stackrel{!}{=} 0 \rightarrow$ Solve for $D_{t_d}e^{-r(t_d-t)}\dfrac{(1-\tau_D)}{(1-\tau_c)}$	