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IMPLIED DIVIDENDS AND EQUITY RETURNS

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Abstract

This paper studies the option market's implied dividend as a predictor of future equity market returns. We introduce this variable in the simple total return framework and discuss some complications of using it as a proxy for the expected dividend. We construct some regressions using the price-dividend ratio and the implied dividend growth, and test them on six years worth of data on the EURO STOXX 50-index. The main result is that implied dividend growth exhibits some forecastability over two-year horizons, but that the dataset is too short to draw any definitive conclusions about long-horizon forecastability. We also find that traditional proxies of risk premium (volatility risk premium, credit spreads and interest rate term-spread) improve the explanatory power of implied dividend growth, and that they have very high explanatory power themselves.

Supervisor: Stefano Rossi

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1. Introduction

The topic of this essay is stock market prediction. This is a highly controversial, but very appealing subject. It is controversial because one of the most celebrated hypotheses in finance, that of efficient markets (and random asset prices), strongly contradicts any predictability in prices. The subject is highly interesting in the sense that an investor that can reliably predict asset returns has found a sure path to wealth. Over the past decades, there has been plenty of research on this subject. To the extent that a consensus has been reached, which is still subject to much discussion, predictability appears to hold only over longer time horizons (measured in years). This thesis represents an addition to the predictability literature by adding an intuitive new variable, the market's expected dividend, to the return predictability analysis.

The expected dividend is appealing to use in return forecasting because it is available a priori and because dividends constitute a large part of total equity returns. From a fundamental point of view, the value of a company's equity is equal to the present value of all the future dividends, discounted using some suitable risk premium. Hence, all else equal, if expected dividends go up, we expect the equity to become more valuable.

The regressions are motivated by trivial manipulation of identities and assumptions about the behavior of the price-dividend time series. The results are that the expected dividend growth exhibits some forecastability over long time periods, both in itself and combined with proxies of risk premium. However, this is over-shadowed by the forecastability of the risk-premium variables, such as interest rate term spread, volatility risk premium and credit spreads, in the sense that they, themselves, explain a much larger part of the variability of returns.

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This text is organized as follows. First, I put the research into context by providing some historical background with references for the interested reader. In the section "Implied dividends" I describe how the implied dividends can be obtained from the derivatives market and the importance of dividends for equity derivatives. Next, in the section named "Dividends and Returns", I discuss the role of dividends for equity returns and try, by mathematical reasoning, to provide an intuition behind the regressions which are tested. In the "Method" section, the raw data and the operations that were performed to obtain the desired variables are described. Then, the results are presented and discussed. The thesis ends with a conclusion, putting the results into perspective and suggesting further research.

2. Prior Research

Return predictability is a central issue in the study of finance. One reason is the relation to the important, and highly controversial, hypothesis that asset prices follow a "random walk". An early example of a study challenging this hypothesis was made by Fama and Schwert in 1977. They found that expected equity returns did not increase in a one-to-one fashion with inflation.

Another important aspect of the study of predictability is the "expectations hypothesis". In essence, this is the idea that forward markets are fair predictors of future moves, for example in foreign exchange or interest rates. Hansen and Hodrick (1980) and Fama (1984a) studied the predictability of currencies by running regressions of returns on interest rate differentials across countries. Adverse currency moves do not, on average, wipe out the apparently attractive return to investing in higher-yielding currencies. This effect is now known as the forward-rate bias, and is frequently implemented by market participants in a strategy known as the "carry trade". A similar effect exists for the returns on bonds across the yield curve. This was documented by Fama (1984b) for short-term returns, and Fama and Bliss (1987) for longer-terms, by running regressions of bond returns on forward-spot rate spreads. These results have been confirmed and extended over time, in for example Cochrane and Piazzesi (2005) and Campbell and Shiller (1991) . A good review of the results in yield curve expectations is made in Campbell (1995).

Returning to the main question in this thesis, that of stock market predictability, there has also been extensive research over the past two decades. Contrary to the random walk hypothesis, Poterba and Summers (1988) and Fama and French (1988a) found that past stock market returns predict subsequent returns at long horizons. In the domain of dividends, Shiller (1984), Campbell and Shiller (1988) and Fama and French (1988b) showed that the dividend/price (D/P) ratio can also predict stock market returns. In particular, Fama and French made the highly important observation that, over longer horizons, the D/P is highly significant, with an R^2 around 60% over 5-year horizons. As is described in the textbook on "Asset pricing" by Cochrane in the context of a simple autoregressive (AR) model, the long-horizon forecastability is not a distinct phenomenon; it is simply a consequence of small short-horizon variability and the slow-moving nature of the dividend/price-ratio (Cochrane 2000, pp 392-393). Since then, many studies have been performed on the subject, and the dividend /price-ratio has become something of a favorite in the academic research. Fama and French (1989) provide an excellent summary and example of the large body of work that documents variation of expected returns over time. Other variables that have been used in the predictability literature include the bond term-spread (ie. short- term yields less long-term yields), price/earnings-ratio etc. Another important contribution was made by Lettau and Ludvigson (2001) showing that the ratio of consumption to wealth forecasts equity returns. In another paper, Lettau and Ludvigson (2005) show that the consumption/wealth-ratio also forecasts dividend growth, which is not entirely surprising if price/dividend-ratio is stationary (as will be seen below). Since then, a number of macro-economic variables have been shown to forecast equity returns, among them investment/capital, labor income/total income, housing/total consumption. What these have in common are that they are all linked to the business cycle in some way. A very recent review about deeper issues on return predictability is available in Cochrane (2008).

This thesis explores whether the implied dividend can forecast equity returns. More specifically, we study the effect of implied dividend *growth*. The expected dividend growth contains more information than the realized dividend, since the realized dividend is included in the expected dividend growth. Hence, if the price-dividend ratio has predictive power, which has been established in many studies cited above, the expected dividend growth should have even greater predictive power.

In summary, this study can be considered to fall into a category that combines the expectations hypothesis with the more general issue of predictability of equity returns. This is because we will use the expectations of future dividends that are implied by the market to forecast the equity returns. A simple corollary that will be performed, but is considered less important, is testing an actual expectations hypothesis for dividends. As far as I know, there is only one study that explores the implied dividend as a variable that forecasts equity returns, presented in a preprint at SSRN, Golez (2008). Golez uses the implied dividend *yield* as a proxy for the expected dividends, and finds that it serves as a good predictor of equity returns (R^2 = 19% on quarterly data on the Dow Jones Industrial Average-index in the period 1998-2006. It significantly outperformed other variables, such as the price-dividend ratio, implied volatility, implied correlation etc. Similarly, but using expected volatility instead of expected dividends, Bollerslev et al (2009) and many others before them, find that the variance risk premium (defined as the difference between implied and realized variance) also predicts equity returns quite well. I consider the approach with implied dividends to be more interesting because of its natural connection to returns (see below for a more formal discussion of this). However, we will also include the volatility risk premium in this thesis. The rationale behind adding the volatility is actually to use it as a proxy for the general risk premium which will become apparent below, but it is evident that it is of general interest as a predictor for equity returns regardless.

3. Theoretical Background

Implied Dividends

Dividends are an inherently important component of all equity derivatives. This is because the holder of a long stock-position via a derivative contract misses out on the dividends paid during the contract‘s life. For example, the owner of a one-year forward contract on a stock, ie. the right to purchase one share at a pre-determined price in one year, has the disadvantage of not receiving any dividends on the share before the contract expires. Hence, the value of his contract decreases as the dividend increases, ie. he is “short“ the dividend. Formally, the price of the forward contract, F_t, expiring at time *T*, is given by:

$$F_t = S_t e^{r(T-t)} - PV(D),$$

where S_t is the share price at time *t* (spot), *r* is the interest rate to maturity and *PV*(*D*) represents the present value of all dividends until maturity. This formula can be regarded as the price at which an investor can sell the shares at time *T*, having purchased them at time *t* and put them aside in a drawer. The investor has to pay interest on the cash used to purchase the shares, but receives all dividends during the life of the forward contract. Given the interest rate, which is generally known to market participants, the forward price and the spot price, one can calculate the dividend which is *implied* by the forward. This can either represent known dividends that have been announced, or unknown dividends. It thus represents the market‘s best “guess” of the dividend that will be paid by the company.

For an option, there exists a similar exposure because of the “forward“ embedded in the option. In the next section, we consider only European-style options, ie. options for which the shares can only be exchanged under the contract on the final date. Similarly to the forward contract, a holder of a (European) *call* option on a stock, ie. the right, but not the obligation, to purchase a share at a pre-determined price (the strike price) at a date in the future, is also short the dividend. On the other hand, the holder of a *put* option, ie. the right but not the obligation to sell a share at the strike price in the future, is long the dividend. The exact sensitivity of the option contract‘s value with respect to the dividend can be obtained using an option valuation model, e.g. Black-Scholes. However, the sensitivity is greatest for options which are deeply “in-the-money”, ie. calls with strike prices well below the current spot and puts with strike prices well above the current spot. This is because the value of these consists mostly of the “intrinsic value“, and they behave very closely to forward contracts.

Investors can get a pure exposure to dividends via option contracts too. Consider an investor buying a call and selling a put with the same strike price K and maturity T. At time T, if the share S_T trades above K, the investor will exercise the call and buy the shares at K and sell them at S_T for a profit of $S_T - K$. On the other hand, if the share trades below K, the investor will have to buy the shares at K because of the put contract, and makes a loss of of $K - S_T$. In any case, he purchases the shares for K dollars at maturity. Assume now that he also sells the same amount of shares for S_t when he enters the option contracts at time t. In this case, he has to pay the dividends to the owner of the shares during the life of the option contract. To sum up, he sells the shares for S_t and buys them back, with certainty, for K in (T – t) years. Assuming there are no risk-free opportunities (arbitrages), the value of the the long call, short put and short share (including accrued interest) would equal the strike price. The value of the whole portfolio at time T cannot exceed zero, because otherwise all investors would follow the strategy to make a risk-less profit. Hence,

$$K = \left(S_t - C + P - \mathrm{PV(D)}\right)\mathrm{e}^{\mathrm{r(T-t)}},$$

or, equivalently:

$$C - P = S_t - K\mathrm{e}^{-\mathrm{r(T-t)}} - \mathrm{PV(D)}.$$

This relationship is known as the put-call parity, and has to hold for European options in the absence of risk-free profits. For more details, see Hull (2005).

The put-call parity illustrates how an investor can get an exposure to dividends via the option market, since buying a call and selling a put is essentially equivalent to buying the forward. Hence, this “synthetic“ share, is short the dividends for the same reasons that an owner of a forward contract is - he misses out on dividend payments. It is also obvious how one can, from prices of puts, calls and interest rates, calculate the dividend which is implied by the option market. This is the proxy for the dividend expectations which will be used in this thesis.

Dividends and Returns

The price-dividend ratio is one of the most commonly used variables to forecast equity returns. At time t, it is defined as the spot price, P_t, divided by the accumulated dividends over some period up to time t, D_t. Henceforth, we will use P_t for the spot price, instead of S_t as above, because there is no longer a risk of confusion with the price of the put-option.

In this section, we will introduce the expected dividend growth and see how it has the similar intuition of the price-dividend ratio. The return from holding a share from time t to time t+1 is equal to the change in price and the dividend paid out:

$$R_{t+1} = \frac{P_{t+1} + D_{t+1}}{P_t}$$

where $D_{t+1}$is the dividend paid in time t+1, and P_{t+1} is the price of the share at time t+1. Now, we can rewrite this as:

$$\frac{P_{t+1} + D_{t+1}}{P_t} = \frac{D_t}{P_t}\frac{D_{t+1}}{D_t}[1 + (P_{t+1}/D_{t+1})]$$

Taking logs, we obtain:

$$r_{t+1} = -(p_t - d_t) + \Delta d_{t+1} + \ln[1 + \exp(p_{t+1} - d_{t+1})]$$

where the small letters correspond to the log of the corresponding capital letter and $\Delta d_{t+1} \equiv d_{t+1} - d_t$ is the (log) dividend growth. Furthermore, we linearize the logarithmic term around the mean price-dividend ratio P/D:

$$r_{t+1} = -(p_t - d_t) + \Delta d_{t+1} + \ln\left(1 + \frac{P}{D}\right) + \frac{P/D}{1 + P/D}[(p_{t+1} - d_{t+1}) - (p - d)] \qquad (1)$$

Introduce the factor $\rho = \frac{P/D}{1+P/D}$. Taking expectations with all information available at time t, we obtain:

$$E_t[r_{t+1}] = -(p_t - d_t) + E_t[\Delta d_{t+1}] + \rho E_t[p_{t+1} - d_{t+1}] + const.$$

Now, we make the simplifying assumption that the log price-dividend ratio is a martingale, ie. that $E_t[p_{t+1} - d_{t+1}] = (p_t - d_t)$. This is a rather strict, but not entirely unreasonable, condition which is made to avoid iterating the price-dividend ratio forward (avoiding variables that are not known a priori), as is commonly done to obtain an infinite series of returns and dividend growth. If many investors would expect this ratio to go up, then they could buy equities and sell dividends and vice versa. Hence, one can expect the present price-dividend ratio to be a fair predictor of the future ratio. Most studies in predictability assumes a mean reverting price-dividend ratio. For example, Golez (2008) makes the stricter assumption the last term is constant and equal to the long-term average of the price dividend ratio. In light of this, the martingale assumption may be considered rather weak. Under the martingale assumption, one obtains:

$$E_t[r_{t+1}] = (p_t - d_t)(\rho - 1) + E_t[\Delta d_{t+1}] + \ const. \qquad (2)$$

This expression will form the basis of our regression. We regress the returns on the present price-dividend ratio and the dividend-growth expectations. Golez (2008) argues that, since the expected returns and dividend growth rates have been found to be highly correlated, a regression of the form (2) is subject to multi-colinearity problems. Using a not very rigorous derivation, he arrives at another regression that mitigates the multi-colinearity problem. Using the fact that $(p_t - d_t)$ is known at time t:

$$-(p_t - d_t) + E_t[\Delta d_{t+1}] = \mathrm{E_t}[\ln\frac{D_t}{P_t}] + E_t[\ln\frac{D_{t+1}}{D_t}] = E_t[\ln(D_{t+1}/P_t)]$$

Thus, if $\rho E_t[p_{t+1} - d_{t+1}]$ is constant, then (1) becomes:

$$E_t[r_{t+1}] = E_t[d_{t+1}] - p_t + const., \qquad (3)$$

which is the form used by Golez. We will also make use of this form in the empirical analysis. It is worth noting that there is really no fundamental reason to demand full rigor in prediction studies. The only implication is that regressions are not equivalent to the basic relation (1). The variables future dividend-price ratio and expected dividend growth might still be useful in predicting future equity returns.

To see what happens without these assumptions, consider equation (1). We obtain, by adding $(p_t - d_t)$ to both sides and subtracting the return r_{t+1}:

$$p_t - d_t = -r_{t+1} + \Delta d_{t+1} + \ln\left(1 + \frac{P}{D}\right) + \rho\,[(p_{t+1} - d_{t+1}) - (p - d)].$$

By repeatedly using this expression (using the transformation $t \to (t+1)$) for the subsequent log-price dividend ratio in the bracket, we obtain an infinite series of the form:

$$p_t - d_t = const. + \sum_{j=1}^{\infty} \rho^{j-1}\,(\Delta d_{t+j} - r_{t+j}) \tag{4}$$

The convergence of this sum depends on the limit behavior of the discount factor ρ and price-dividend ratio, but should be apparent from an economic point of view since infinite price-dividend ratios over longer periods appears unlikely.

Equation (4) shows that that the price dividend ratio will increase if the expected dividend growth goes up and/or expected returns fall. As is discussed by Cochrane (2000, 2008) in many papers, if prices and dividends are cointegrated and dividend growth is unpredictable, then all variation in the price-dividend ratio must come from the variation in expected returns. Hence, if both returns and dividend growth were unforecastable, then price-dividend ratio should be constant, which it is not. Hence, as Cochrane puts it, we cannot ask separately whether returns and dividend growth are forecastable. Instead, the correct question is "which of returns and dividend growth is forecastable, or how much of each?".

Now, to more formally express forecastability of returns we construct a simple (autoregressive, AR(1)) model of the dynamics of the price-dividend ratio (following Cochrane, 2000, pp 402-405). The model has the following form:

$$x_t = c + bx_{t-1} + \delta_t$$

Using this ansatz, together with equation (3), we can derive the corresponding (de-meaned) model for the price-dividend ratio (see Cochrane, 2000 for details):

$$(d_{t+1} - p_{t+1}) = b(d_t - p_t) + \delta_{t+1}/(1 - \rho b)$$

In this model, the expected log price-dividend ratio is linearly dependent on the prior period‘s value. Hence, equation (2) is valid, although with different coefficients, also in this setting, without the martingale assumption. This justification of equation (2) is less ad-hoc and is also easier to test on the sample. However, bear in mind that, although the regression equation (2) might add some intuitive understanding as to why the dividend expectations can predict equity returns, variables used for prediction may be chosen quite arbitrarily. This will become more obvious in choosing a proxy for the risk premium.

The novelty in this study will be the use of the market‘s *implied* dividend in the regression, instead of the realized (as in the price-dividend ratio) or analyst forecast dividends which have been used extensively in prior studies. Indeed, a plethora of approaches have been developed to model expected dividend growth, and one author exclaims the expected dividend growth to be “unobservable to the econometrician“ (Rytchkov, 2008). Now, although this is essentially correct because of the unobservable risk premium, the approach using the market‘s implied dividend should indeed be worth exploring. The approach has several advantages.

First of all, the test works independently of the stochastic process followed by dividends, which cannot be said about the model developed in Rytchkov (2008) for example. It is also independent on the model used to price the options, since the implied dividend can be obtained via an arbitrage argument from the put-call parity. However, there is also the disadvantage that the implied dividend contains a risk premium, which is not equal to the risk premium on equity (normally it is lower because of the lower volatility of dividends). Thus, the dividend implied from options prices is not exactly equivalent to the dividend which the market expects. This risk premium would not be an issue if it was constant. Unfortunately, this is normally not the case, both because of variability in overall risk appetite, but also due to effects of supply and demand in the derivatives market (Manley & Mueller-Glissmann, 2008). However, at short maturities, such as 1 month and 3 months, the risk premium should be low and quite constant, because most dividends have already been announced.

There is a detail which should be mentioned. By the Jensen inequality it follows that $E_t[\ln D_{t+1}] = E_t[d_{t+1}] \leq \ln E_t(D_{t+1})$. Taking the logarithm of the implied dividend is therefore not the same as the expected value of the log-dividend. Hence, performing the regression with the log-implied dividend is only a proxy of equation (2) which we aim to test. However, we expect the expected log-dividend and the log-expected dividend to be closely correlated, and, from now on, we will assume them to be equal. More importantly, as was mentioned above, the true expected dividend $E_t[D_{t+1}]$, and the dividend implied by the put-call parity PV(D) are not equivalent because of the risk premium. We expect the relation to have the following form:

$$PV(D) = \frac{E_t[D_{t+1}]}{\left(1 + r_f + r_p\right)^{T-t}},$$

where r_f is the risk-free rate and r_p is a risk premium on dividends. Thus, if we use the log-implied dividend ln PV(D) in (4), we expect to also obtain a term for the risk-free rate and risk premium. Thus, in logarithms, a more precise regression including the dividend growth would have the form:

$$r_{t+1} = \beta_0 + \beta_1(p_t - d_t) + \beta_2(\ln \mathrm{PV}(\mathrm{D_{t+1}}) - \ln(\mathrm{D_t})) - \beta_3 risk\ premium_t + \varepsilon_{t+1}. \quad (5)$$

We will try to proxy the risk-premium term in a variety of ways: first as the volatility risk premium of the same maturity (defined as the implied volatility less the volatility which has been realized over the same period), and also by using credit spreads and the slope of the yield curve. These can all be considered as general measures of the market‘s risk appetite. Their most important property is that they are available ex-ante, and are good proxies of the risk premium. Implied volatility, in particular, reflects the market‘s expected volatility, and is therefore directly linked to the *equity* risk premium. Furthermore, the implied volatility premium should capture some of the supply-demand effects in the equity derivatives market, which has significant effect on the implied dividend. The approach of using implied volatility premium as a proxy for equity risk premium was introduced by Merton (1980).

4. Method and Data

The following regression, inspired by equation (2) above, is the most important in this thesis, and can be used to illustrate the basis of the variables:

$$r_{t+1} = \beta_0 + \beta_1(p_t - d_t) + \beta_2 \Delta d_{t+1} + \varepsilon_{t+1} \quad (6)$$

In this regression, r_{t+1} is the *total* return realized on the index from time t to t+1, p_t is the price of the index at time t, d_t is the dividends paid out on the index in period t, and $\Delta d_{t+1} = d_{t+1} - d_t$, is the implied dividend growth (d_{t+1} represents the expected dividends for time t+1). All variables are logarithms. We illustrate the basis of all variables schematically in table 1.

0 to T months	**Between T and 2T months**
Dividends paid out, D_t Price P_t at the end of period	Implied divs. at the beginning of period, D_{t+1} Return at end of period, R_{t+1}, including divs.

Table 1. The variables used in the regression (6) in the general case of a *T*-month period

The dividends paid out during an *n*-month period are the present dividends, D_t. The price at the end of that period is the present price, P_t. The implied dividends from the options market at the end of this period (or, equivalently, the start of the next n month period) gives the expected dividend, D_{t+1}. Finally, at the end of the second *n* month period, we calculate the total return, including all dividends that were paid out by companies in the index. Each week we will calculate all these parameters for T = 1, 3, 6, 9, 12, 24 months (which are overlapping), in order to study predictability across different periods, and use the weekly time series to estimate the regressions. Since the periods are overlapping, there will be serial correlation between the errors ε_{t+1} in all regressions. Hence, we need to use take account for this when estimating the standard errors. Hence , all regressions were estimated with the Stata-software package, using the Newey-West procedure for calculating the standard errors. We choose the maximum number of lags to consider as the number of overlapping observations, ie. the number of weeks in the considered period minus one (since we have weekly data). For example, in 6 months there are 24 weeks, so we consider 23 lags in the Newey-West procedure.

Data

Weekly data (at Friday‘s close) of all option prices on the EURO STOXX 50-index (SX5E for short), which is the index with the most liquid derivatives in Europe, was obtained for the period January 2003-March 2009 from the database IVolatility.com. The implied dividends were calculated using the put-call parity (at the mid spread for puts and calls) for all strikes close to at-the-money (between 90% and 110% of the spot), with the additional condition that the bid-offer spread is tight enough (defined as 30% between bid and offer). These values of the implied dividends for each maturity were averaged, with negative averages set to zero. To obtain values for the generic time periods of 1, 3, 6, 9 months, a linear interpolation between the maturities was performed.

For the periods 1 year and 2 years, due to the relative scarcity and of maturities of exchange-traded options, we used OTC-quotes on *dividend swaps* obtained from the equity derivatives desk at Morgan Stanley. These are (typically) longer term contracts to exchange, at the end of the year specified in the contract, the difference between the strike (ie. the implied dividend) and the accumulated dividends paid by companies in the index during the year. For more details about dividend swaps, see Manley & Mueller-Glissman (2008). To obtain the values for the generic periods of 1 year and 2 years, an interpolation was performed taking into account the distribution of dividend payments over the year. The following formula was used, taking a day in 2005 as example:

$$Implied\ 2Y\ dividends = (DS\ 2005 - Dividends\ already\ paid\ in\ 2005) + DS\ 2006 + [(Dividends\ already\ paid\ in\ 2005)/(DS\ 2005)\ ] \times DS\ 2007,$$

where *DS* Y denotes the dividend swap on the dividends paid in the year Y (between January 1st and December 31st). In the first years of the dataset, between 2003 and 2005, the data of quoted dividend swaps is somewhat scarce (with approximately 10-20% of days lacking a value).

The risk-free interest rate, due to its low relative significance in the put-call parity, was taken, for all maturities below 1 year as the 6 month Euribor fixing.

The realized (gross) dividends were calculated using data from Bloomberg. Historical implied volatilities for the generic time periods 1,3, 6, 9, 12, 24 months was obtained from Morgan Stanley, calculated by linear interpolation between maturities. The volatility risk premium, defined as the implied volatility minus the prior realized volatility was calculated using the standard deviation of log-returns in the SX5E price series.

Credit spreds (iTraxx Europe generic 5-year and iTraxx Crossover generic 5-year) and the yield curve slope (2-10y EURIBOR) were also obtained from Bloomberg. Unfortunately, iTraxx was only introduced in June of 2004, so regressions including iTraxx could only be estimated with data after June 2004.

5. Results

This part is organized as follows. First, we briefly study the realized dividend which the implied dividend is supposed to "predict" by performing a regression which is similar to a test of the expectations hypothesis. We also describe the outcome of the strategy of buying implied dividends and holding the contract to maturity (via a dividend swap for example).

Next, we study the behavior of the price-dividend ratio series to see whether the assumption that it follows an AR(1)-process is reasonable.

Then, we present the results of the main return regression, both in the form of equation (6) and in the form of Golez (eq. (3)). Various measures of risk-premia are then added to isolate the true expected dividend. Finally, we perform some basic tests of robustness of the return regression. Summary statistics for the main variables are presented for 6 month, 12 month and 24 month periods in the appendix (table 1).

Implied and Realized Dividends

We can test the expectations hypothesis on the implied dividends by regressing the implied dividend on the subsequently realized dividends:

$$RealizedD_{t+1} = \beta_0 + \beta_1 ImpliedD_{t+1} + \varepsilon_{t+1}$$

The result of these regressions for different periods is presented in table 2. As is expected, the realized dividends are generally below the implied dividends. If this can be explained by a risk premium, or whether there is a persistent bias that can give investors higher risk-adjusted returns, is left open. Worth noting is that over short periods, 1 and 3 months, β_0 can be interpreted to be approximately the value of the risk premium, corresponding to a typical annual risk premium of 3.3-5% (calculated using an average annualized implied dividend of 115 index points).

We also include the results of using implied dividends (see appendix, table 2) as a trading strategy, buying the implied dividend (either in the form of a short synthetic against the shares or via a dividend swap) and holding it over the period. The tentative conclusion of this table is that buying implied dividends has been a very attractive investment opportunity over the past 6-years, especially over long maturities (buying two year dividend swaps has been profitable in 98% of the weeks). This consistent over-supply of dividends has been discussed before (Manley & Mueller-Glissmann, 2008). As the main reason, the popularity of longer-dated "bullish" structured products for retail clients has been identified, which create long dividend exposures for the banks that sell them. Note, however, that transaction costs may be large (the implied dividend is calculated mid-spread) and that there is no guarantee that this performance will persist. Another important transaction cost, at shorter maturities especially, is the cost of capital of being long implied dividends without the dividend swap. The ability for ordinary investors to gain exposure to implied dividends has been simplified by the introduction of exchange-traded dividend futures on the Eurex-exchange.

T	$\boldsymbol{ImpliedD_{t+1}}$	Const, $\boldsymbol{\beta_0}$	N obs
1	1.0823 (12.58)	-3.0482 (-0.33)	266
3	1.055 (34.2)	-4.8147 (-1.17)	297
6	0.9628 (11.67)	13.5352 (1.04)	283
9	0.9367 (14.24)	17.6546 (1.76)	270
12	0.8057 (12.33)	25.9568 (3.09)	249
24	0.7915 (17.11)	40.8287 (6.38)	164

Table 2. Realized dividends, with t-values in paranthesis, of regression (6) over subsequent overlapping periods (T = 1, 3, 6, 9, 12, 24 months) using weekly SX5E price data between January 2003 and Febuary 2009

Dynamics of the Price-Dividend Series

Figure 1a) in the Appendix displays the weekly changes in the log-price dividend ratio over the period Jan 2003-Feb 2009, where the dividends are calculated over the generic time periods 1, 3, 6, 9, 12 and 24 months. As is expected, the volatility over longer periods is very low, in contrast to shorter periods.

Figure 1b) displays the behavior of the log-price dividend ratio over subsequent (but not overlapping) periods, for each week. This is the one that is most relevant for the derivation above, since all regressions, including the AR(1) model, are based on non-overlapping periods.

A glance on figure b) reveals some interesting facts. Not surprisingly, the series exhibits high seasonality at shorter periods, which is a consequence of the bulk of dividends being paid during a couple of months. At the longer periods, there appears to be a negative trend, reflecting a decrease in the price-dividend ratio since 2003. To make it more formal, using the AR(1) approach which was introduced above, we present summary statistics of the following regression in table 3:

$$p_{t+1} - d_{t+1} = c + b(p_t - d_t) + \delta_{t+1} \quad (7)$$

T	$(p_t - d_t), b$	const, c	N obs	R^2
1	0.3573 (5.65)	2.5677 (8.4)	266	0.1361
3	-0.1236 (-1.11)	4.2621 (11.3)	297	0.0164
6	-0.7751 (-7.24)	6.4456 (14.42)	283	0.6331
9	-0.2035 (-2.11)	4.1775 (10.54)	270	0.0289
12	0.9259 (1.08)	0.1594 (0.05)	257	0.156
24	-0.6222 (-2.18)	5.6633 (5.96)	197	0.0402

Table 3. Coefficient, with t-values in parenthesis, of regression (7). We regressed annualized realized dividends over periods (T = 1, 3, 6, 9, 12, 24 months) on the realized dividend on the subsequent (non-overlapping) period of same length. Weekly SX5E-data between January 2003 and Febuary 2009. .

Table 3 confirms our conclusions the graph in the appendix. At 24 months, the downward trend is significant over the whole sample. At shorter periods, the results are inconclusive. What is apparent, however, are the generally low R^2-values of the regressions. Hence, the AR appears to be quite weak for the sample. This may be due to the short data set, consisting of merely one business cycle. Of course, it means that the assumption that the price-dividend follows an AR(1)-process is weak. However, this is only relevant in the sense that testing the main regression is not longer equivalent to testing the return-identity (1) which we started from. Still, the regressions can end up being very relevant for predicting equity market returns, as we will see in the next section.

Main Regression - Return Prediction Using Implied Dividends

Now we turn to the main issue in this thesis, whether implied dividends can be used to predict equity returns. Table 4 illustrates the result of the regressions (8-11) for each period length. Equation (10) is the main regression and equation (11) is the form of the main regression used in Golez (2008). The other two are just reduced equations, including price-dividend ratio and expected dividend growth separately.

$$r_{t+1} = \beta_0 + \beta_1(p_t - d_t) + \varepsilon_{t+1} \quad (8)$$

$$r_{t+1} = \beta_0 + \beta_2 \Delta \mathrm{d}_{t+1} + \varepsilon_{t+1} \quad (9)$$

$$r_{t+1} = \beta_0 + \beta_1(p_t - d_t) + \beta_2 \Delta \mathrm{d}_{t+1} + \varepsilon_{t+1} \quad (10)$$

$$r_{t+1} = \beta_0 + \beta_3(d_{t+1} - p_t) + \varepsilon_{t+1} \quad (11)$$

Table 3 contains some interesting results. First of all, the implied dividend growth Δd_{t+1} has quite high explanatory power over two years (R^2 = 21%) and is generally significant, but very poor over shorter periods. Furthermore, the price-dividend ratio appears to be a quite poor predictor of returns, which is apparent across all time horizons. Most coefficients are insignificant at periods below 24 months. Hence, neither variable appears successful in predicting returns, although implied dividend growth seems to outperform price-dividend ratio over long horizons. Also, we see some evidence of multi-colinearity, for example in the 12 month regression. Both variables have, independently (equations (8) & (9)), low explanatory power but, taken jointly, it increases significantly. In this case, we see that the single variable implied dividend *yield* (equation (11)) mitigates this.

Furthermore, at longer maturities, the coefficient of the log-implied dividend *growth* is negative, in contrast to what would be the intuitive answer (higher expected dividends lead to higher returns). The same, that the coefficient is negative, holds also for the implied dividend *yield*, $(d_{t+1} - p_t)$. This is not as counter-intuitive, as an increase in dividend *yield* could be the effect of dividends going up or prices coming down.

In general, the negative sign on expected dividends could be due to the fact that there is a non-constant risk premium contained in the implied dividend. At the shorter time periods between 1 and 6 months, where the risk premium is normally smaller and less volatile, the coefficients of implied dividend are positive, as expected.

T	$(p_t - d_t)$	t	Δd_{t+1}	t	$d_{t+1} - p_t$	t	Const, β_0	t	R^2	Obs
1	0.02241	0.55	-	-	-	-	-0.105	-0.6	0.002	287
	-	-	0.0473	1.39	-	-	0.004	0.06	0.013	263
	-0.0093	-0.16	0.0526	1.01	-	-	0.040	0.18	0.013	263
	-	-	-	-	0.0320	0.69	0.149	0.91	0.004	283
3	0.0599	1.06	-	-	-	-	-0.202	-0.8	0.023	297
	-	-	0.0575	1.52	-	-	0.026	0.38	0.047	293
	-0.0080	-0.09	0.0616	1.02	-	-	0.056	0.16	0.047	293
	-	-	-	-	0.0677	1.14	0.285	1.43	0.029	293
6	0.0507	0.65	-	-	-	-	-0.141	-0.42	0.018	283
	-	-	0.0256	0.61	-	-	0.044	0.59	0.014	281
	0.0540	0.43	-0.0027	-0.04	-	-	-0.154	-0.3	0.017	281
	-	-	-	-	0.0357	0.52	0.175	0.73	0.008	281
9	0.0444	0.58	-	-	-	-	-0.096	-0.31	0.006	270
	-	-	0.0013	0.02	-	-	0.061	0.81	0.000	268
	0.1294	0.74	-0.0633	-0.52	-	-	-0.398	-0.6	0.017	268
	-	-	-	-	-0.0419	-0.37	-0.086	-0.2	0.005	268
12	0.5730	0.83	-	-	-	-	-1.937	-0.78	0.086	257
	-	-	-0.0169	-0.1	-	-	0.069	0.83	0.000	249
	0.8978	1.19	-0.3330	-1.4	-	-	-3.051	-1.14	0.155	249
	-	-	-	-	-0.4645	-1.2	-1.516	-1.1	0.082	249
24	-0.2885	-2.07	-	-	-	-	1.136	2.51	0.045	197
	-	-	-0.3363	-1.98	-	-	0.124	5.05	0.211	164
	0.0144	0.18	-0.3402	-1.82	-	-	0.073	0.25	0.211	164
	-	-	-	-	-0.3246	-1.76	-1.038	-1.51	0.140	169

Table 4. **Main regression of total returns:** Coefficients, with t-values, of regressions (8)-(11) for overlapping T-month periods using weekly SX5E-data between January 2003 and February 2009.

Adding Risk Premium

Earlier, risk premium was introduced in order to isolate the expected dividend from the implied dividend. However, we have seen that they are also important in their own right, as is evident from their popularity in a myriad of studies on stock market return predictability. We test the hypothesis that risk premium can enhance the predictability of implied dividends by using the following regressions, with the third one being the modified Golez (2008)-type regression. The results are presented in table 4.

$$r_{t+1} = \beta_0 + \beta_1(p_t - d_t) + \beta_2\Delta \mathrm{d}_{\mathrm{t+1}} + \beta_3(implied\ vol - realized\ vol)_t + \varepsilon_{t+1} \quad (12)$$

$$r_{t+1} = \beta_0 + \beta_1(p_t - d_t) + \beta_2\Delta \mathrm{d}_{\mathrm{t+1}} + \beta_4(iTraxx\ Europe)_t + \varepsilon_{t+1} \quad (13)$$

$$r_{t+1} = \beta_0 + \beta_1(d_{t+1} - p_t) + \beta_3(implied\ vol - realized\ vol)_t + \beta_4(iTraxx\ Europe)_t + \varepsilon_{t+1} \quad (14)$$

$$r_{t+1} = \beta_0 + \beta_1(p_t - d_t) + \beta_2\Delta \mathrm{d}_{\mathrm{t+1}} + \beta_6(Yield\ spread\ 10y - 2y)_t + \varepsilon_{t+1} \quad (15)$$

$$r_{t+1} = \beta_0 + \beta_1(p_t - d_t) + \beta_2\Delta \mathrm{d}_{\mathrm{t+1}} + \beta_3(implied\ vol - realized\ vol)_t + \beta_4(iTraxx\ Europe)_t + \varepsilon_{t+1} \quad (16)$$

Table 4 contains a lot of information. First of all, there is an extremely high explanatory power over 2 years. Obviously, the higher R^2-value could just be a consequence of adding variables. Note, however, that the main regression, taken with either iTraxx or the term-spread (10 year yield minus 2 year yield), increases R^2 from 21% (see table 3) to 70% (equations (13) & (15)). Further, we see that the added variables increase the significance of the price-dividend and implied dividend growth variables, meaning that the added variables improve the forecastability of these original two variables. Also worth noting is that, after adding the different proxies of risk premium, the coefficients on implied dividend are now positive at 24 months, which agrees with our intuition, in contrast to the findings without risk-premia. Similarly for the alternative form of the main regression (equation (14)), the R^2 over two years exceeds 70% after controlling for volatility risk-premium and iTraxx.

However, as is apparent from the literature on return forecasting, it is very difficult to interpret values of R^2 for processes which are highly persistent, such as the long horizon price-dividend ratio and the long horizon-dividend growth (Bollerslev et al. 2009).

A natural question is whether these risk-premium variables, by themselves, can be used to predict returns. Indeed, this seems to be the case. For example, regressing 2-year returns on volatility risk-premium, term-premium and iTraxx (143 observations) gives an R^2 above 85%. The complete results for 12 and 24 month periods can be found in table 3 in the appendix. The important conclusion is that, despite being an interesting variable to study, the forecastability of the implied dividend is negligible compared to that of more commonly used variables. These time series are much less persistent than the long -horizon price-dividend and dividend growth series, and the R^2-value can therefore be interpreted with confidence as being high.

We can compare some of the results to other studies. For example, Bollerslev et al (2009) use the variance risk premium (implied variance less the realized variance) as a variable in the return regression on monthly data of the S&P 500 during the period1990-2007. Exclusively, they find a positive effect of variance risk-premium on returns (in contrast to our findings over longer periods). However, their explanatory power is similar in magnitude to ours over overlapping annual periods (theirs is in the interval 20-35%). The fact that they find positive coefficients on volatility risk premium raises suspicion about the sample used here, especially since the period from late 2007 and onwards was marked by an elevated implied volatility risk-premium and significantly negative returns. Hence, we would like to test for robustness by dividing the sample into two parts. This will be done in the following section.

T	Const, β_0	$(p_t - d_t)$	Δd_{t+1}	$(d_{t+1} - p_t)$	Volatility RP	iTraxx Europe	EUR 2y10y	Obs	R^2
1	0.0604 (0.23)	-0.0297 (-0.41)	0.0786 (1.33)	-	3.1498 (2.22)	-	-	228	0.076
	0.3106 (1.05)	-0.0203 (-0.3)	0.0775 (1.36)	-	-	-0.0047 (-1.89)	-	217	0.102
	0.4416 (1.8)	-	-	0.0696 (1.24)	2.2861 (1.65)	-0.0038 (-1.49)	-	230	0.114
	-0.1305 (-0.65)	-0.0014 (-0.03)	0.045 (0.9)	-	-	-	0.1936 (1.81)	263	0.046
	0.2891 (0.98)	-0.0317 (-0.44)	0.0887 (1.5)		2.2238 (1.58)	-0.0039 (-1.49)	-	217	0.129
3	0.1348 (0.35)	-0.0448 (-0.44)	0.094 (1.53)	-	1.4506 (0.92)	-	-	242	0.068
	0.55 (1.59)	-0.0642 (-0.71)	0.0924 (1.63)	-	-	-0.0064 (-3.19)	-	231	0.312
	0.6844 (3.33)	-	-	0.1017 (1.95)	0.3959 (0.32)	-0.0064 (-2.96)	-	231	0.309
	-0.1076 (-0.4)	-0.015 (-0.22)	0.048 (1.04)	-	-	-	0.2534 (2.61)	293	0.217
	0.5551 (1.62)	-0.0684 (-0.78)	0.0971 (1.75)	-	0.422 (0.33)	-0.0063 (-3.03)		231	0.313
6	-0.101 (-0.28)	-0.0028 (-0.04)	0.0239 (0.52)	-	6.0279 (1.85)	-	-	229	0.227
	0.5738 (1.86)	-0.0546 (-0.82)	0.0616 (2.07)	-	-	-0.0082 (-3.96)	-	218	0.43
	0.4723 (2.56)	-	-	0.0629 (1.35)	4.12 (1.66)	-0.0071 (-3.62)	-	218	0.514
	-0.0331 (-0.08)	-0.0312 (-0.34)	0.0245 (0.57)	-	-	-	0.2466 (2.46)	281	0.295
	0.5481 (1.73)	-0.0836 (-1.38)	0.071 (2.24)	-	4.1546 (1.69)	-0.0071 (-3.52)	-	218	0.514
9	-0.3605 (-0.47)	0.1095 (0.55)	-0.0571 (-0.42)	-	0.3061 (0.1)	-	-	216	0.012
	0.4917 (0.81)	-0.039 (-0.22)	0.0806 (0.87)	-	-	-0.008 (-7.95)	-	205	0.407
	0.6949 (2.82)	-	-	0.1017 (1.33)	0.7123 (0.36)	-0.0081 (-8.47)	-	205	0.406
	-0.2849 (-0.58)	0.0503 (0.44)	-0.0335 (-0.4)	-	-	-	0.2033 (2.17)	268	0.274
	0.474 (0.74)	-0.0398 (-0.22)	0.0861 (0.92)	-	0.8144 (0.41)	-0.0081 (-7.98)	-	205	0.411
12	-5.1231 (-2.82)	1.5029 (2.92)	-0.2411 (-1.96)	-	-2.3307 (-1.74)	-	-	202	0.405
	-5.8975 (-2.05)	1.7208 (2.19)	-0.2491 (-1.79)	-	-	-0.0016 (-0.54)	-	191	0.414
	-1.1639 (-1.26)	-	-	-0.4376 (-1.65)	-3.3174 (-1.31)	-0.0044 (-1.44)	-	191	0.272
	-1.7747 (-0.85)	0.4856 (0.83)	-0.0637 (-0.44)	-	-	-	0.1688 (2.28)	249	0.336
	-5.5597 (-2.3)	1.6346 (2.46)	-0.2476 (-1.95)	-	-2.2683 (-1.57)	-0.0005 (-0.17)	-	191	0.435
24	-0.1362 (-0.39)	0.0619 (0.65)	-0.0664 (-0.4)	-	-1.3128 (-5.92)	-	-	130	0.32
	-0.8297 (-1.65)	0.0699 (0.45)	-0.0576 (-0.8)	-	-	0.0192 (4.81)	-	120	0.706
	-0.293 (-0.81)	-	-	0.0654 (0.97)	-0.7409 (-2.97)	0.0175 (3.64)	-	120	0.742
	-0.734 (-1.55)	0.1565 (1.25)	0.2118 (5.53)	-	-	-	0.2493 (4.96)	164	0.696
	-1.0145 (-1.77)	0.1282 (0.69)	0.1308 (1.1)	-	-0.8594 (-2.51)	0.0178 (4)	-	120	0.748

*Table 5.*Total-return regressions (12)-(16) with risk premia included (volatility risk premium, iTraxx EUR-index and EUR 2y-10y yield) with t-values in parenthesis. Weekly data between January 2003 and Febuary 2009 (iTraxx was only available aftre June 2004 and risk premium only after March 2004).

Robustness

In order to check that our findings are consistent, we divide the sample into two sub-samples and run the same regressions for the two periods separately. The sub-samples are February 2003-December 2005 and January 2006- February 2009, ie. approximately three years each. The results of the regressions are presented in table 4 in the appendix.

Firstly, our suspicion about the volatility risk premium is confirmed. Now, we find both positive and negative contributions of volatility risk premium over longer periods (12, 24 months), depending on the subsample and maturity. Still, we generally find positive contributions of implied dividend growth, after adding risk premium-variables.

For the implied dividend growth, without risk-variables, we find that the significance is very high in the first period, but low in the second. With risk premium-variables included, however, we find that the significance is high during both periods. This confirms our conclusion that the added variables increase the explanatory power of implied dividend growth.

For the price-dividend-ratio, which was earlier concluded to be a quite weak predictor across all periods, the sign varies a lot, in contrast to the case over the entire sample (2003-2009) where the effect is negative on short maturities and positive over longer horizons. This means that the conclusions over the whole sample are not consistent.

For the longer maturities (12, 24 months) there are quite few data points (around 60) in each subsample, which should be taken into account. There is risk of small-sample bias in variables that are persistent (such as the 24 month price dividend ratio and implied dividend growth). We make this analysis formal by considering the AR(1) model of the factor that drives returns (equivalent to the one presented above for the log price-dividend ratio):

$$r_{t+1} = a + bx_t + \epsilon_{t+1}$$

$$x_{t+1} = c + \rho x_t + \delta_{t+1}$$

where $|\rho| < 1$. If the errors are normally distributed $\sim N(0, \sigma_\epsilon^2)$ and correlated, then the OLS-estimate of b will be biased. If ρ is close to 1, ie. x is persistent, then the bias will be larger. This is indeed the case for price-dividend ratio, which over longer periods is fairly constant (as is evident from figure 1 in the appendix). Also, correlation between errors is positive, ie. $Corr(\epsilon_t, \delta_t) > 0$. This can potentially cause a bias in both the direction and the variance of the OLS-estimate of b. We can correct for this effect using the procedure of Amihud and Hurvich (2004). If the OLS-estimator is $\hat{\rho}$ and the number of observations is N, then an adjusted estimate of ρ and adjusted errors are given by:

$$\hat{\rho}_{\mathrm{A}} = \hat{\rho} + \frac{1 + 3\hat{\rho}}{N} + 3(1 + 3\hat{\rho})/N^2$$
$$\delta_{\mathrm{t+1}}^{\mathrm{A}} = x_{t+1} - [(1 - \hat{\rho}_{\mathrm{A}})\overline{\mathrm{x_t}} + \hat{\rho}_{\mathrm{A}}\mathrm{x_t}]$$

The new, bias corrected, OLS-regression then becomes:

$$r_{t+1} = a + b_A x_t + k_A \delta_{t+1}^A + \epsilon_{t+1},$$

and the adjusted t-statistics can be obtained in the usual way. The results of the regression with price-dividend ratio and implied dividend growth are presented in table 5 in the appendix, for 12 and 24 month horizons, including values for both subsets in the data. We see that the effect is varying, but does not change any of our previous results regarding the significance of price-dividend and implied dividend growth in the return regressions.

6. Conclusion

The main outcome of this work has been the motivation and introduction of implied dividends for use in return forecasting, which is a novel and intuitive variable in this context. We have seen how it makes sense to use implied dividends to measure expected dividend growth, and discussed some properties and complications of using this variable, such as the time-varying and unobservable risk premium.

Empirically, a number of regressions have been designed and tested on 6-years worth of dividend data on the EURO STOXX 50-index, which is the most liquid underlying for derivative contracts in Europe. Of course, in order to investigate longer term predictability (above 1 years), which actually holds the most promise, we would ideally want to have a longer dataset which spans across at least a few business cycles. This would be the most natural extension to the work in this paper, and will probably have to be made on the S&P 500 because of the limited history of the EURO STOXX 50-index.

The main empirical findings are that the implied dividends have generally been cheap relative to realized dividends in Europe, which undermines its value as a predictor of subsequent returns, since this implies that supply-demand effects dominate the fair-value aspect in the market price of the claims. This effect will probably diminish in the future, as more market participants enter the market, helped by more liquid and easy-to-use contracts (like the recently introduced exchange-traded dividend futures). The increased market efficiency will probably increase the appeal of using implied dividends in forecasting, for example for asset-allocation purposes.

Despite the inherent cheapness, it is found that implied dividend growth exhibits some degree of forecastability on returns (R^2 = 21% over two year horizons). This result is found to not be robust in the sample. Also, traditional variables of risk aversion (such as implied volatility spread over realized, iTraxx credit spreads and slope of the yield curve) improve the explanatory power of the implied dividend growth, and makes it robust across the sample. However, these traditional measures of risk premium are, by themselves, very efficient predictors of returns. Hence, one might question the value of using implied dividend growth in return prediction. Specifically, one might question attempts to isolate the *true* expected dividend from the implied dividend for prediction purposes, since the isolation requires some proxy of risk premium. This effect is worth exploring over longer time-periods.

It is also found that the price-dividend ratio performs poorly in predicting the returns, which agrees well with previous studies, which generally finds predictability only over longer horizons, such as 2-5 years.

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8. Appendix

24 Months	r_{t+1}	$(p_t - d_t)$	Δd_{t+1}	iTraxx	Volatility RP	EUR 2-10y
Mean	0.106	3.468	0.056	56.879	0.023	0.779
StDev	0.126	0.259	0.248	43.813	0.055	0.632
Skewness	-1.618	-1.801	-1.320	1.741	-1.150	0.088
Kurtosis	4.647	5.478	4.176	5.033	3.617	1.578
N obs	206	303	270	249	260	312
Unconditional correlation matrix						
r_{t+1}	1					
$(p_t - d_t)$	-0.2121	1				
Δd_{t+1}	-0.4592	0.7909	1			
iTraxx	0.8168	-0.9462	-0.8649	1		
Vol. RP	-0.5609	-0.3642	0.0073	0.3358	1	
EUR 2-10y	0.7976	0.0728	-0.4374	0.0504	-0.7487	1

12 Months	r_{t+1}	$(p_t - d_t)$	Δd_{t+1}	iTraxx	Volatility RP	EUR 2-10y
Mean	0.073	3.409	0.049	56.879	0.028	0.779
StDev	0.218	0.254	0.197	43.813	0.024	0.632
Skewness	-1.622	-1.632	-0.801	1.741	-0.256	0.088
Kurtosis	4.823	5.183	4.863	5.033	4.487	1.578
N obs	257	312	304	249	260	312
Unconditional correlation matrix						
r_{t+1}	1					
$(p_t - d_t)$	0.2933	1				
Δd_{t+1}	-0.0113	0.782	1			
iTraxx	-0.4098	-0.9368	-0.767	1		
Vol. RP	-0.3915	0.2683	0.2302	-0.2281	1	
EUR 2-10y	0.5488	0.203	-0.0709	0.0504	-0.0605	1

6 Months	r_{t+1}	$(p_t - d_t)$	Δd_{t+1}	iTraxx	Volatility RP	EUR 2-10y
Mean	0.047	3.644	0.032	56.879	0.016	0.779
StDev	0.293	0.775	1.371	43.813	0.039	0.632
Skewness	-1.638	0.326	-0.101	1.741	-1.776	0.088
Kurtosis	5.378	1.843	1.869	5.033	8.518	1.578
N obs	283	312	310	249	260	312
Unconditional correlation matrix						
r_{t+1}	1					
$(p_t - d_t)$	0.1332	1				
Δd_{t+1}	0.1187	0.9117	1			
iTraxx	-0.6386	-0.192	0.0111	1		
Vol. RP	0.4668	0.0013	-0.1191	-0.4607	1	
EUR 2-10y	0.5416	0.2317	0.211	0.0504	0.0242	1

Table 1. **Summary statistics over 6-month, 1-year and 2-year horizons.**
r_{t+1} - total annualized return over the horizon, $(p_t - d_t)$ is the log price-dividend ratio, Δd_{t+1} is the implied dividend growth. Also included are the corresponding volatility risk premium, and iTraxx EUR 5y-index and the EURO 2y-10y term spread, which are independent of horizon. Weekly observations on the SX5E-index between February 2003 and February 2009.

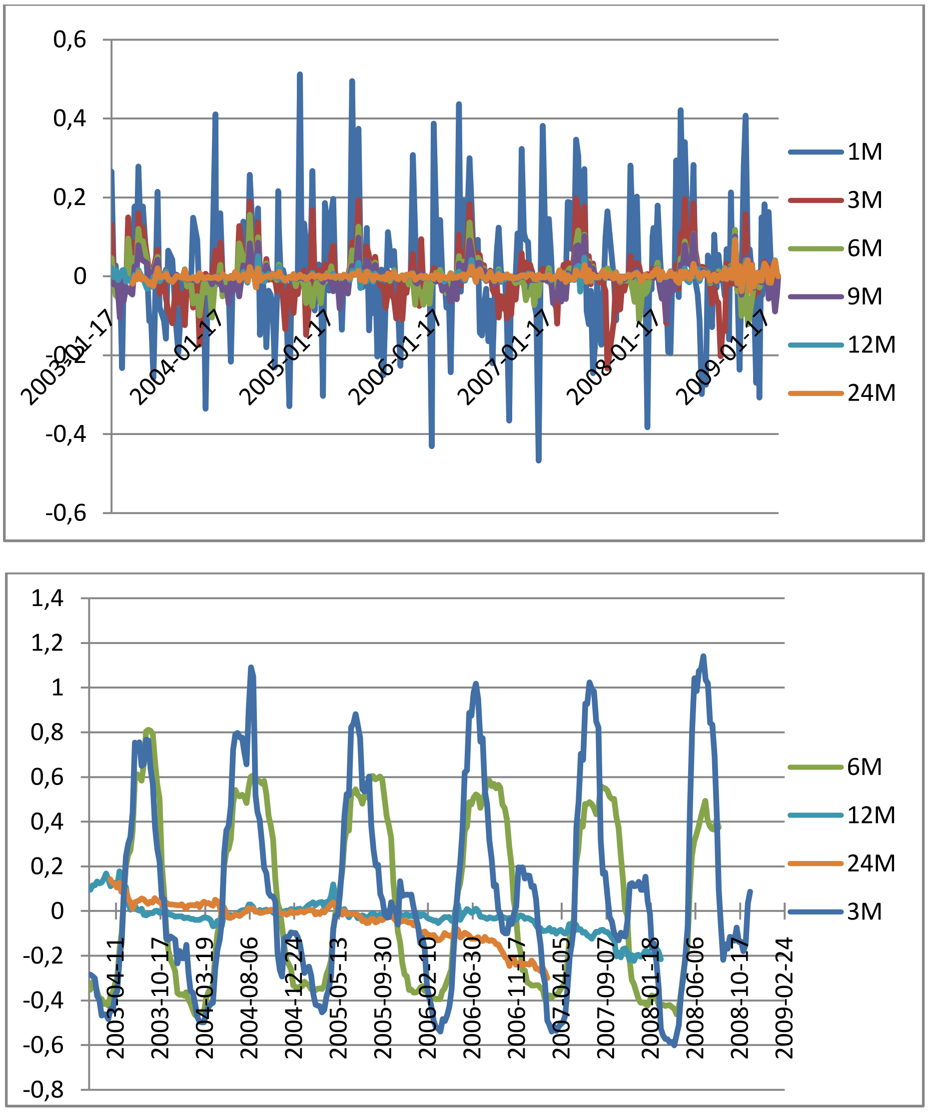

Figure 1. (a) Weekly changes in the log-price dividend ratio, using (overlapping) realized dividends over the generic periods 1, 3, 6, 9, 12, 24 months. (b) Changes in the log-price dividend ratio between non-overlapping periods, ie. $(p_{t+1} - d_{t+1})/(p_t - d_t) - 1$ for 3,6,12,24 months.

Return	6 months Whole	2005-	2003-2005	9 months Whole	2005-	2003-2005	12 months Whole	2005-	2003-2005	24 months Whole	2005-	2003-2005
Mean Return	30.6%	66.6%	-4.2%	12.9%	22.0%	4.9%	5.1%	3.7%	6.3%	22.8%	12.9%	28.2%
StDev	228.2%	320.8%	30.4%	43.6%	55.7%	26.9%	15.4%	16.0%	14.9%	17.1%	11.5%	17.3%
Perc wins %	**53.7%**	**65.9%**	**42.0%**	**65.7%**	**73.6%**	**58.3%**	**69.1%**	**63.4%**	**73.7%**	**98.2%**	**100.0%**	**97.2%**
Max Ret.	3222.0%	3222.0%	188.0%	400.9%	400.9%	205.7%	133.3%	133.3%	59.8%	99.1%	60.2%	99.1%
Min Ret.	-65.6%	-65.6%	-59.1%	-45.5%	-43.7%	-45.5%	-32.9%	-32.9%	-30.6%	-14.5%	0.9%	-14.5%
Observations	281	138	143	268	125	143	249	112	137	164	58	106
Absolute P&L (Index points per year)												
Mean PnL	9.43	19.84	-0.48	10.76	18.20	4.34	3.68	3.11	4.15	19.74	15.35	22.14
StDev	37.95	45.03	26.22	27.32	32.21	20.30	14.74	16.09	13.57	10.76	10.28	10.29
Max	196.59	196.59	160.35	139.84	139.84	120.59	83.34	83.34	35.11	50.84	50.84	47.65
Min	-107.28	-107.28	-46.17	-72.70	-72.70	-42.15	83.34	-60.13	-33.88	-15.71	1.42	-15.71

Table 2. **Implied dividends as a trading strategy.** There appears to be a persistent bias with cheap dividends, especially at longer maturities (9 months and longer). This effect is not necessarily disappearing. However, there is a low amount of data points from the last year (2008 and onwards). All values are annualized (ie. returns are measured as percentage of annualized implied dividends in index points, and absolute profits are measured as index points per years)

T	Cons	Volatility RP	iTraxx	EUR 2y10y	Obs	R^2
12	0.219 (3.42)	-5.1848 (-1.63)	-	-	205	0.153
12	0.3121 (2.53)	-	-0.0072 (-2.41)	-	194	0.168
12	-0.0977 (-0.74)	-	-	0.1968 (2.09)	257	0.301
12	0.3504 (2.38)	-3.5641 (-1.33)	-0.0051 (-1.53)	-	194	0.223
12	0.1772 (1.7)		-0.0093 (-8.6)	0.3396 (4.17)	194	0.629
12	0.1931 (2.23)	-1.139 (-0.63)	-0.0085 (-5.46)	0.3305 (4.69)	194	0.634
24	0.0833 (2.12)	-1.3565 (-3.04)	-	-	154	0.315
24	-0.5536 (-3.17)	-	0.0184 (4.11)	-	143	0.667
24	-0.0831 (-1.41)	-	-	0.1814 (4)	206	0.636
24	-0.4639 (-2.45)	-0.6701 (-2.57)	0.0159 (3.14)	-	143	0.711
24	-0.3652 (-2.74)		0.009 (2.37)	0.17 (8.7)	143	0.807
24	-0.3635 (-3.21)	1.3829 (3.57)	0.0049 (1.28)	0.3386 (6.93)	143	0.856

Table 3. **Risk premium variables as predictor of returns:** Variables of risk premium as predictors of total returns on the SX5E: volatility risk premium, iTraxx Europe 5 year index and Euro 10y-2y yield spread, and various combinations of the three. Data consists of over-lapping weekly periods of 12 months and 24 months between February 2003 and February 2009. iTraxx data is only available from June 2004 and implied volatility only available from March 2004.

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T	Period	Const, β_0	$(p_t - d_t)$	Δd_{t+1}	Volatility RP	iTraxx EUR	Obs	R^2
1	2003-2005	0.1493 (0.75)	0.0113 (0.25)	-0.023 (-0.5)	-	-	116	0.0039
	2006-	-0.1399 (-0.43)	0.0001 (0)	0.0769 (1)	-	-	147	0.0291
	2003-2005	0.3206 (0.42)	-0.014 (-0.28)	0.0255 (0.5)	-3.583 (-1.1)	0.0001 (0)	70	0.0492
	2006-	0.1118 (0.33)	-0.0189 (-0.21)	0.1014 (1.4)	2.518 (1.8)	-0.0031 (-1.2)	147	0.1276
3	2003-2005	0.0633 (0.29)	0.0372 (0.74)	-0.0295 (-0.7)	-	-	142	0.0205
	2006-	0.172 (0.38)	-0.081 (-0.7)	0.1266 (2.2)	-	-	151	0.1091
	2003-2005	-0.7914 (-3.53)	0.0827 (1.91)	-0.0083 (-0.3)	1.4614 (1)	0.0177 (3.2)	80	0.3014
	2006-	0.559 (1.69)	-0.1048 (-1.32)	0.1325 (2.8)	0.1737 (0.1)	-0.0055 (-2.7)	151	0.3316
6	2003-2005	0.7444 (2.19)	-0.1499 (-1.54)	0.0571 (1.4)	-	-	143	0.1591
	2006-	-0.646 (-0.97)	0.1492 (0.98)	-0.0099 (-0.2)	-	-	138	0.0856
	2003-2005	0.4494 (0.96)	-0.0473 (-0.44)	0.0183 (0.4)	3.2329 (2.2)	-0.0041 (-0.9)	80	0.1917
	2006-	0.2128 (0.47)	-0.0094 (-0.11)	0.0612 (2.2)	2.4766 (0.9)	-0.0067 (-2.8)	138	0.5318
9	2003-2005	0.062 (0.22)	0.034 (0.41)	-0.0188 (-0.5)	-	-	143	0.0086
	2006-	-0.7167 (-0.9)	0.1807 (0.88)	-0.0843 (-0.6)	-	-	125	0.0263
	2003-2005	-0.0811 (-0.28)	0.0264 (0.35)	0.0218 (0.4)	-0.8686 (-1.3)	0.0056 (3.1)	80	0.2495
	2006-	0.4103 (0.59)	-0.0445 (-0.26)	0.1154 (1.5)	0.103 (0.1)	-0.008 (-6.9)	125	0.5232
12	2003-2005	2.1812 (15.94)	-0.5706 (-14.75)	0.161 (2.7)	-	-	137	0.594
	2006-	-6.2715 (-4.03)	1.7927 (4.18)	-0.2991 (-4.2)	-	-	112	0.421
	2003-2005	1.7009 (3.64)	-0.427 (-3.52)	0.1184 (2.1)	0.1586 (0.6)	-0.0002 (-0.2)	79	0.2381
	2006-	-4.0818 (-2.56)	1.2108 (2.85)	-0.1276 (-1.2)	-2.1406 (-1.1)	-0.0031 (-1.1)	112	0.4803
24	2003-2005	0.4336 (3.25)	-0.0736 (-1.95)	0.0584 (5.8)	-	-	106	0.1385
	2006-	-0.5929 (-0.52)	0.1603 (0.51)	-0.2043 (-1.1)	-	-	58	0.0348
	2003-2005	1.458 (6.56)	-0.3658 (-5.76)	0.1344 (9.9)	-0.3489 (-13.1)	0.0005 (1.6)	62	0.6539
	2006-	-1.1462 (-2.08)	0.079 (0.5)	0.1109 (2.1)	3.3926 (3.9)	0.0209 (7.3)	58	0.8222

Table 4. **Time robustness:** Returns on price-dividend and implied dividend growth, with the period split into two (Feb 2003-Dec 2005 and Jan 2006-Feb 2009), including variables to proxy risk premium. iTraxx data is only available from June 2004 and implied volatility only available from March 2004.

$$r_{t+1} = a + \beta \Delta \mathrm{d}_{t+1} + \epsilon_{t+1} \ (Regular)$$

$$r_{t+1} = a + b_A \Delta \mathrm{d}_{t+1} + k_A \delta_{t+1}^A + \epsilon_{t+1} \ (Amihud - Hurvich)$$

$$r_{t+1} = a + \gamma(p_t - d_t) + \epsilon_{t+1} \ (Regular)$$

$$r_{t+1} = a + b_A (p_t - d_t) + k_A \delta_{t+1}^A + \epsilon_{t+1} \ (Amihud - Hurvich)$$

T	Period	$\Delta \mathrm{d}_{t+1}$	Const, *a*	Obs	$(p_t - d_t)$	Const, *a*	Obs
12	Whole period	-0.0169 (-0.1)	0.0686 (0.83)	249	0.573 (0.83)	-1.9372 (-0.78)	257
	.. Amihud-Hurvich	-0.0116 (-0.14)	0.0706 (2.29)	246	0.5793 (6.15)	-1.8817 (-5.55)	257
	2003-2005	-0.0593 (-0.64)	0.1822 (11.63)	137	-0.432 (-8.09)	1.7052 (9.19)	145
	.. Amihud-Hurvich	-0.0597 (-0.78)	0.1728 (12.34)	134	-0.4307 (-6.12)	1.6463 (6.41)	145
	2006 - 2009	0.431 (1.1)	-0.1251 (-0.75)	112	1.5906 (3.76)	-5.6073 (-3.63)	112
	.. Amihud-Hurvich	0.4474 (11.38)	-0.0017 (-0.05)	112	1.624 (22.31)	-5.1906 (-19.44)	112
24	Whole period	-0.3363 (-1.9)	0.1243 (4.38)	164	-0.2885 (-2.05)	1.1364 (2.45)	197
	.. Amihud-Hurvich	-0.3365 (-16.43)	0.0959 (13.67)	158	-0.2877 (-4.76)	1.1181 (5.08)	197
	2003-2005	0.0353 (2.06)	0.1714 (33.44)	106	-0.001 (-0.03)	0.1773 (1.6)	136
	.. Amihud-Hurvich	0.0423 (2.78)	0.15 (11.81)	100	-0.0004 (-0.02)	0.1623 (2.05)	136
	2006 - 2009	-0.2276 (-1.31)	-0.0059 (-0.27)	58	0.1417 (0.47)	-0.5726 (-0.53)	61
	.. Amihud-Hurvich	-0.2265 (-3.44)	0.0423 (2.77)	58	0.1613 (14.37)	-0.3379 (-8.03)	61

Table 5. **Small sample robustness:** Coefficients of the regular and Amihud-Hurvich adjusted regressions, for comparison (presented in the equations above). Left side corresponds to the regression for implied dividend growth and the right side to the price-dividend regression. The results are presented for the whole sample, as well as the dividend sample (Feb 2003-Dec 2005 and Jan 2006-Feb 2009). The horizons are 12 and 24 months respectively, using weekly overlapping data.