Original Article

The pricing of dividend futures in the European market: A first empirical analysis

Received (in revised form): 13th July 2009

Sascha Wilkens, CFA, FRM

is with the Risk Analytics team (Group Risk Management) for Corporate and Investment Banking at an international banking group in London. Before his current position, he headed the financial risk engineering for equity derivatives at a European commercial bank, and worked as a model validation consultant for an international financial advisory firm. He holds a Doctorate/PhD in Finance and a Master's degree in Business Mathematics. His research concentrates on the pricing and risk management of derivative securities. This article is based solely on private research of the author. It does not represent an official statement of the firm the author is affiliated to.

Jens Wimschulte, CFA

is with the Chair of Financial Services, University of Regensburg, Germany. He holds a Master's degree in Business Management. His research concentrates on empirical capital market studies and energy derivatives.

Correspondence: E-mail: Wilkens@gmx.de

ABSTRACT This article is the first to study empirically the pricing of the Euro Stoxx 50 dividend futures, introduced at the European Exchange (Eurex) in mid-2008. These instruments are an easy means of obtaining exposure to the future dividends of the index constituents for hedging and speculation purposes. Trading figures thus far show a viable interest of market participants in this innovation. Based on straightforward and model-free replication arguments, this study compares prices of the dividend futures to those of hedging portfolios built on exchange-traded index options. The analysis shows substantial pricing imbalances, and hence violations of arbitrage relations between both derivatives markets for a set of contract maturities. This phenomenon cannot be fully explained by transactions costs and other potential trading constraints.

Journal of Derivatives & Hedge Funds (2010) **16**, 136–143. doi:10.1057/jdhf.2009.21

Keywords: dividends; derivatives; futures; arbitrage

INTRODUCTION

Although dividends are vital return and risk factors in equity-related portfolios, there is hardly any possibility to control the corresponding exposure with the help of standardized, listed financial instruments. Equities themselves are usually not well suited

for this purpose, as it is generally difficult to describe the relationship between the spot equity price and the associated dividend, given that the latter is a function of many human decisions rather than just a purely financial relationship.¹ At present, dividends are even widely considered a separate asset class – less volatile than equity

prices, with low correlation to traditional asset classes, and rising with inflation.^{2,3} Against the background of increasing volatilities of dividends, the tradability of dividend expectations in the financial markets is steadily gaining importance.

The over-the-counter (OTC) derivatives market offers dividend-related contracts such as dividend swaps. Such an agreement is similar to a vanilla interest rate swap, but one leg of a dividend swap is determined by the realized (paid) dividends of the underlying, thereby enabling investors to take a view on the cumulative dividends that will be paid by an equity or by the constituents of an equity index in a predetermined time period of typically 1 year.⁴ Typical applications of 'buying' and 'selling' dividends are, for example, hedging existing equity portfolios against dividend risk without changing the portfolio structure, eliminating dividend risk of structured products,⁵ dividend term structure bets, or dividend stripping (see Eurex³ and Pengelly¹ for more details).

Instruments such as dividend swaps have seen dramatic changes in market values in the context of the recent credit crisis owing to anticipated significant cuts in future dividends. In spite of this market trend, derivatives on dividends still attract substantial interest among market participants. Transparency in the OTC dividend market is rather limited for participants except banks, although, for example, the introduction of the Barclays dividend swap index family on main equity indices such as the Euro Stoxx 50 the S&P 500 and the Nikkei 225 in 2008 helped to open the market to a wider range of investors (see Barclays⁶ for details). While OTC contracts such as dividend swaps and, to a lesser extent, dividend options still constitute the main class of instruments, dividend futures as exchange-traded

alternatives have meanwhile drawn the attention of the market.

Previously, the South African Futures Exchange (SAFEX) was the only exchange in the world that listed dividend futures. These contracts on single equities were launched in 2002 and were hardly traded until about 2006. Since then, trading figures have surged to several million contracts per year^{7,8} – with the market remaining rather 'exotic' for typical investors from North America, Europe and Asia. In mid-2008, the European Exchange (Eurex), as the world's largest derivatives exchange, introduced dividend futures on the Euro Stoxx 50 index, which constitutes the most actively traded equity index in Europe. Dividend swaps on its constituents make up the majority of trades in the OTC market. This new trading opportunity has attracted a broad investor base thus far.⁹ Especially against the background of the recent turmoil across financial markets and the deteriorating credit quality of many institutions, the fact that transactions in dividend futures are cleared by a reliable clearing house and thus bear significantly less counterparty risk is highly appreciated among market participants.³

Given the limited availability of dividend futures in the past, their pricing has not been studied so far. There is loosely related research in the literature that focuses, for example, on the predictability of future dividends based on information derived from option prices via put–call parity. For instance, using American-style options, Brooks¹⁰ concludes that implied dividends are very noisy estimators and generally not rich enough to extract the market's expectations of the next dividend. Chance *et al*¹¹ analyze the suitability of dividend forecasting models in option pricing. Without comparison

to real-world option prices, they conclude that index option prices generated with the actual dividends are unbiased with respect to those generated using the forecasted dividends, although forecast errors are sufficiently large to be of general concern.

This article aims at closing a research gap by assessing the pricing of the Euro Stoxx 50 dividend futures contracts in their first months of trading at the Eurex. Based on model-free replication arguments, it compares the prices of the dividend futures to those of hedging portfolios built on exchange-traded index options. In particular, the study does not rely on any forecasting model for the future dividends,¹² but is rather a purely relative, arbitrage-related analysis. The investigation shows substantial pricing imbalances between both derivatives markets at least for a subset of contract maturities. Transactions costs and other potential trading constraints cannot fully explain these peculiarities.

The article is organized as follows. The next section provides a brief introduction to the Euro Stoxx 50 dividend futures and their valuation relative to equity index options. The empirical application and its results are described in the subsequent section. The last section summarizes and provides an outlook for further research.

DIVIDEND FUTURES: CHARACTERISTICS AND VALUATION

The Eurex dividend futures contracts reflect all ordinary gross dividends on the constituents of the Euro Stoxx 50 index within a given reference year. Special dividends, return of capital payments or similar distributions are excluded to the extent that adjustments are

made to the underlying index. All dividend payouts are translated into index dividend points, with the final settlement price at contract maturity equivalent to the cumulative gross dividends distributed by the index constituents over the reference year. Contract values of the dividend futures comprise EUR 100 per index dividend point, with a minimum tick size of 0.1 points (equivalent to EUR 10). Seven different contracts are available for trading at any time, covering the current year and the subsequent six yearly periods. The contract maturities on the third Friday in December are thereby in line with those of the Euro Stoxx 50 index futures (see Eurex¹³ for more details on the product specifications).

In order to derive information on expected future dividends as a basis for valuing dividend futures, the corresponding options market is a suitable source. From put–call parity it is known that, by arbitrage arguments, the following relation must hold at any time:

$$PV_t(Div_{t,T}) = S_t + P_t - C_t - K(1 + r_{t,T})^{-(T-t)} \quad (1)$$

with S_t as the price of the underlying at time t , C_t and P_t as the prices of a European-style call and put option with maturity in T and strike K , $PV_t(Div_{t,T})$ as the present value of the dividends paid on the underlying in $[t, T]$, and $r_{t,T}$ as the risk-free interest rate in that period.

The fair value at time t of a dividend futures contract on the dividends paid on the underlying during a period $[t, T]$ can be written as (see also Eurex³)¹⁴

$$FV_t(DivFut_{t,T}) = PV_t(Div_{t,T})(1 + r_{t,T})^{T-t}. \quad (2)$$

In the absence of arbitrage opportunities, one would expect that dividend futures prices,

following equation (2), are in line with the options market and relation (1). Consider, for example, a case where the dividend futures are overvalued, trading at a value above $FV_t(DivFut_{t,T})$. Shorting the futures contract and replicating its payoff by going long in S_t and P_t , going short in C_t and $K(1 + r_{t,T})^{-(T-t)}$ and having the overall proceeds earning interest at a rate $r_{t,T}$ will create a sure profit at T . The analogue holds for a dividend futures trading below $FV_t(DivFut_{t,T})$.

It should be noted that (2) assumes the dividend futures contract to represent the dividends paid from t on. In practice, however, one also has to deal with dividend futures that refer to a (1-year) period that starts in the future. An example would be the Euro Stoxx 50 dividend futures maturing in December 2012, which is based on the realized dividends between December 2011 and December 2012. In order to judge on the pricing of this futures contract, one would have to consider two sets of option strips – namely, those maturing in December 2011 and December 2012, respectively – derive $PV_t(Div_{t,T})$ from (1) in both cases and use the difference between them as a basis for (2).

Furthermore, if a dividend futures contract is valued after the start of the respective dividend period, the known realized dividends have to be taken into account. Consider, for example, the Euro Stoxx 50 dividend futures contract maturing in December 2008 and its valuation in July 2008. All the dividends that have been paid on the index members from December 2007 through July 2008 already constitute an ‘intrinsic value’ of the futures.

Upon combining (1) with (2), $PV_t(Div_{t,T})$ represents only the future dividend payments, so that realized past dividends have to be added and compounded at a rate $r_{t,T}$.

EMPIRICAL ANALYSIS

The empirical investigation is based on data from July through November 2008, covering the first 5 months of trading in Euro Stoxx 50 dividend futures. The data set consists of daily closing prices (representing 17:30 CET) of the Euro Stoxx 50 index, Euro Stoxx 50 call and put options, and Euro Stoxx 50 dividend futures at the Eurex. The dividend futures cover contract maturities between December 2008 and December 2014 on each day. Notably, their open interest varied between 2300 (December 2012) and 22 400 contracts (December 2009) as of end of November 2008. For the December 2008 dividend futures maturity, the realized – paid – dividends on the index constituents up to the valuation point are tracked with the help of the Euro Stoxx 50 DVP (Dividend Points) Index.¹⁵ The source for all market data is *Bloomberg*.

On each day, $PV_t(Div_{t,T})$ is derived from (1) for each December maturity between 2008 and 2014.¹⁶ With S_t and option prices C_t and P_t for different strikes given, $r_{t,T}$ is left as a second unknown (and hence a potential source of noise). Therefore, $r_{t,T}$ is implicitly estimated by employing at least ten pairs of call and put options on each day, all of which should fulfill (1) with the same values of $PV_t(Div_{t,T})$ and $r_{t,T}$. Minimizing the standard deviation of $PV_t(Div_{t,T})$ across all option pairs leaves the average of the resulting values for $PV_t(Div_{t,T})$ as a reliable option-implied dividend estimate.¹⁷

Following the description in the previous section, time series of differences between the prices of dividend futures contracts and those of option-based replication strategies are then derived for each December maturity. The resulting statistics are shown in Table 1.

Table 1: Differences between prices of dividend futures contracts and option-based replication strategies

	Contract maturity						
	2008 (%)	2009 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)	2014 (%)
Average	−4.3	−3.2	5.8	0.3	0.8	−0.1	−3.6
Median	−3.6	−3.1	4.9	−0.1	0.4	0.4	−4.3
SD	5.6	2.5	5.0	4.0	4.5	5.8	6.5
Minimum	−29.5	−12.3	−2.4	−8.4	−7.1	−26.2	−17.9
Maximum	6.7	6.1	27.8	27.3	28.0	17.1	18.0

The table provides the statistics ($N=109$ for each contract maturity) of the daily relative differences between the prices of the dividend futures contracts (P_{DivFut}) and those of the replication strategies based on corresponding index options (P_{Repl}), defined as $(P_{DivFut} - P_{Repl}) / P_{Repl}$. All averages except for the December 2011 and December 2013 contracts are significantly different from zero at least at a 5% level of confidence, based on two-sided t -tests.

Notably, with the exception of the December 2011 and December 2013 contracts, the mean price differences between the dividend futures and the options market are significantly different from zero. While, according to (1) and (2), on average, the dividend contracts for the years 2008, 2009 and 2014 are underpriced relative to the corresponding dividend expectations in the options market, the opposite is true for the 2010 and 2012 contracts. The magnitude of the price differences is found to be surprisingly high for some maturities: relative to the replication portfolios, the overpricing (underpricing) of the dividend futures contracts reaches averages over time of up to 5.8 per cent (4.3 per cent). Looking at the minimum and maximum differences across the contract maturities, one finds outliers that reach values of up to ± 30 per cent. Such values are more likely to be associated with data quality issues in the closing prices rather than with real-world pricing imbalances.

An investigation of the price differences over time (not displayed here) reveals that for the first two maturities up to 2009, the observed underpricing of the dividend futures contracts exhibits a rather stable pattern that is only slightly perturbed by outliers. The analogue observation holds for the overpricing of the 2010 contracts. For the 2011 through 2013 maturities, no clear pattern over time can be identified. In the case of the longest maturity, a rather steady underpricing of the dividend futures contracts in the first 4 months is followed by a more volatile pattern and a tendency toward overpricing in the last month of the study period.

Overall, with the theoretical relationships put forward in the previous section, one empirically finds substantial violations that suggest exploitable arbitrage opportunities, at least for a subset of the dividend futures contracts. These findings should be seen, however, in the light of

the following possible limitations of the replication approach:

- *Representativeness of daily closing prices.* Given that closing prices at the Eurex are non-tradable (mid) prices, they might not necessarily be employed to carry out real-world trading strategies. Nevertheless, given a usually very active trading in Euro Stoxx 50 index options, corresponding closing prices should constitute a good estimator of prevailing market levels. Although dividend futures are still not as liquidly traded as other Euro Stoxx 50 derivatives at the Eurex,¹⁸ at least a significant non-zero open interest can serve as an indicator that closing prices are a valid reflection of current market prices.^{19,20}
- *Limited tradability of the index.* The proclaimed arbitrage relation relies on the underlying being tradable during the contract's lifetime. As Euro Stoxx 50 index futures contracts are only available up to three quarters ahead, exposure to the index can usually not be achieved by the most obvious and most cost-efficient means in all cases. Trading the index via exchange-traded funds might serve as an alternative. Given the usual high liquidity of the Euro Stoxx 50 members, going long or short in the index constituents should generally be feasible as well.
- *Large bid-ask spreads in the market for dividend futures.* The idealized arbitrage relation based on (1) and (2) neglects trading costs such as bid-ask spreads.²¹ While trading the instruments in (1) should be possible at fairly low spreads, the dividend futures are (still) traded with significant spreads, as shown in the statistics in Table 2, based on all intraday quotes in the study period. Although the availability of quotes for the dividend contracts during the entire study period indicates tradability itself, the size of the bid-ask spreads implies, for instance, that going short the 2010 futures contracts involves an average premium over the mid-price (as the assumed 'fair value') of approximately 2.5 per cent. But even this cannot explain the large average price differences in replication

Table 2: Bid-ask spreads of dividend futures contracts

	Contract maturity						
	2008 (%)	2009 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)	2014 (%)
Average	1.7	3.6	5.0	5.4	4.7	5.5	5.4
Median	1.6	3.2	4.0	4.4	3.9	4.6	4.5
SD	0.2	1.6	2.2	2.5	2.0	2.3	2.3
Minimum	1.0	0.0	0.1	0.0	0.0	0.0	0.0
Maximum	3.2	17.4	13.9	18.8	20.0	11.1	11.5

The table provides the statistics (N between 2419 and 15 068, depending on contract maturity) of the intraday bid-ask spreads for the dividend futures contracts, referring to the mid-spreads defined as

$$(P_{DivFut}^{Ask} - P_{DivFut}^{Bid}) / \frac{1}{2} (P_{DivFut}^{Ask} + P_{DivFut}^{Bid}).$$

portfolios of approximately up to 6 per cent – substantial arbitrage profits would still be feasible.²²

In conclusion, in spite of the previous arguments and even bearing in mind other potential market frictions,²³ the hypothesis of relative mispricing of the dividend futures contracts in their first months of trading cannot be invalidated.

SUMMARY AND OUTLOOK

This article presents a first exploratory analysis of the empirical pricing of the newly available Euro Stoxx 50 dividend futures at the Eurex. Generally, the introduction of dividend futures on widely traded equity indices provides improved possibilities for investors with regard to trading dividend exposure as a separate asset class. From a pricing perspective, it is shown that based on replication arguments the fair values of the dividend futures in their first months of trading, at least for a subset of contracts, deviate substantially from those of hedging portfolios built on exchange-traded index options. Usual real-world limitations such as trading costs in the form of bid-ask spreads cannot fully explain these observations – encouraging the search for arbitrage opportunities in practice.

In spite of a currently bad economic climate and outlook for the coming years, with likely further decreases in earnings and dividends, the still young market for dividend futures bears a lot of potential, especially considering the significantly reduced counterparty risk of exchange-cleared contracts. Against the background of the experience with recent extreme market moves, not only large institutions have realized that former ‘secondary

risks’ arising from dividends can no longer be neglected, thus stimulating prospects for the further development of the dividend market (see also Manley and Mueller-Glissmann²⁴ and Pengelly¹). Single-name dividend futures on large European names would be a logical future development, provided that enough liquidity can be assured. Further investigation of the pricing patterns of dividend futures, and, in a next step, their informational content regarding future realized dividends, seems promising, possibly in conjunction with data from the OTC dividend derivatives market.

REFERENCES AND NOTES

- 1 Pengelly, M. (2008) Gambling on dividends. *Risk* 21(December): 21–23.
- 2 Blees, W. (2008) Dividend option market tipped for growth. *Risk News*, 30 April.
- 3 Eurex (2008) *Eurex Dow Jones Euro Stoxx 50 Index Dividend Futures – Pricing & Applications for the Institutional Investor*. Frankfurt/Main, Germany.
- 4 See Barclays Capital (2008) Dividend Swap Indices: Access to Equity Income Streams Made Easy. Research Report, April; and Eurex (2008) *Eurex Dow Jones Euro Stoxx 50 Index Dividend futures – Pricing & Applications for the Institutional Investor*. Frankfurt/Main, Germany for more details and examples on dividend derivatives. For a comprehensive review of markets for dividends and problems of trading dividends confer Manley, R. and Mueller-Glissmann, C. (2008) The market for dividends and related investment strategies. *Financial Analysts Journal* 64(May/June): 17–29. A general discussion on designated dividend claims for equity indices is provided by Brennan M.J. (1998) Stripping the S&P 500 index. *Financial Analysts Journal* 54(January/February): 12–22.
- 5 For example, in products such as reverse convertibles investors implicitly sell (out-of-the-money) put options to the issuing institution, creating a long dividend position for the latter – that increases in case stock prices fall. See Pengelly, M. (2008) Sunk by correlation risk. *Risk* 21(July): 20–24, and Pengelly M. (2008) Gambling on dividends. *Risk* 21(December): 21–23 for details.

- 6 Barclays Capital (2008) Dividend Swap Indices: Access to Equity Income Streams Made Easy. Research Report, April.
- 7 Ferry, J. (2007) An unusual existence. *Risk South Africa* 20(October): 77–78.
- 8 Dividends are much more volatile in the South African market than in other market places. Missing standardized rules on how corporate actions are to be treated caused a special dividend uncertainty in the South African equity market. See Ferry, J. (2007) An unusual existence. *Risk South Africa* 20(October): 77–78, for more background information.
- 9 The Eurex has encouraged this development by waiving the trading fees in these contracts until the end of 2008. See Eurex (2008) *Eurex Dow Jones Euro Stoxx 50 Index Dividend Futures – Pricing & Applications for the Institutional Investor*. Frankfurt/Main, Germany.
- 10 Brooks, R. (1994) Dividend predicting using put-call parity. *International Review of Economics and Finance* 3(4): 373–392.
- 11 Chance, D., Kumar, R. and Rich, D. (2000) Dividend forecast biases in index option valuation. *Review of Derivatives Research* 4: 285–303.
- 12 For an overview of deterministic and stochastic equity dividend models used in the pricing and hedging of derivative contracts see Bakstein, D. and Wilmott, P. (2006) *Equity Dividend Models*. University of Oxford. Working Paper, October.
- 13 Eurex (2008) *Products*. Frankfurt/Main, Germany.
- 14 Note that (1) and (2) are expressed with discretely instead of continuously compounded interest rates, with the latter being the usual text book notation aligned with option pricing formulas. The approach chosen here follows suggestions from the Eurex based on their settlement procedure for option prices and conventions in the OTC dividend derivatives market. We are thankful to Byron Baldwin from Eurex for advice on this point. It turns out in the later analysis that results are not affected qualitatively by the choice of the compounding frequency.
- 15 The DVP represents the ordinary unadjusted gross cash dividends declared and paid by the individual components of the Euro Stoxx 50, covering a 1-year period from the third Friday in December of the previous year and including the third Friday in December of the current year; see Stoxx (2008) *Dow Jones Euro Stoxx 50 Dividend Points Calculation Guide*, October for details. The ongoing value of the index is the summation of dividend points up to that point in time, that is, the index represents the cumulative dividends and is therefore non-decreasing by construction. The DVP can essentially be considered the underlying of the Eurex dividend futures.
- 16 In the following, Act/360 is employed as a day count convention, in accordance with a proposal in Eurex. (2008) *Eurex Dow Jones Euro Stoxx 50 Index Dividend Futures – Pricing & Applications for the Institutional Investor*. Frankfurt/Main, Germany.
- 17 It turns out that this fit is very tight, with the standard deviations across the daily implied values of $PV_t(Div_{t,T})$ generally not exceeding 0.05% of the average. While two daily pairs of calls and puts would theoretically be sufficient to estimate the tuple $(PV_t(Div_{t,T}), r_{t,T})$, at least 10 pairs were employed in order to reduce potential noise in the data. The option pairs for each contract maturity were chosen across a fixed set of strikes at the beginning of the investigation period.
- 18 As a means of increasing liquidity the Eurex supports designated market making for selected futures contracts. The Eurex member(s) agree(s) to quote prices within a certain response time and at least for a minimum contract size and within a maximum spread. In exchange, at least parts of the trading and clearing fees for the traded contracts are refunded to the market maker. For the dividend futures contracts a period with designated market making has been granted until end of 2012, but no Eurex member has accepted this role so far.
- 19 Since market participants are charged margins based on the daily closing prices, any material deviation from prevailing market rates would likely be challenged by either the long or the short parties.
- 20 Note that the procedure to derive closing prices is essential to the study provided here. An immediate speculation consists in the observed pricing imbalances being driven to a large extent – if not exclusively – by potential differences in ways the Eurex settles index options on the one side and dividend futures on the other side. Insightful discussions with Byron Baldwin from Eurex helped abandon this theory.
- 21 It should be borne in mind that the replication approach is static in nature, that is, no dynamic rebalancing is required. Direct trading costs thus only occur at inception of the arbitrage portfolio. Exceptions might result, for example, from changes in the index composition over time if S_t is replicated by positions in the actual index members.
- 22 In this context, no statistically significant relationship between the price difference and the average size of the bid-ask spread on each trading day could be detected.
- 23 Such as funding needs for margin requirements and exchange/clearing fees, which should be of minor importance, especially for active market participants.
- 24 Manley, R. and Mueller-Glissmann, C. (2008) The market for dividends and related investment strategies. *Financial Analysts Journal* 64(May/June): 17–29.