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Diskussionsbeitrag Nr. B-26-17

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What drives Performance in the Speculative Market of Short-Term Exchange-Traded Retail Products?* †

S. Baller†, O. Entrop‡, A. Schober††, M. Wilkens‡‡

Abstract

This paper considers the realized returns of individual investors in warrants and leverage certificates. First, we derive a general formula that analytically decomposes the return into several economically meaningful components that are related to investor's trading behavior and the issuers' price-setting strategy. Second, we use a large trade dataset to analyze returns along these components and also link them to investors' risk taking strategy. Our main findings are threefold: (i) The overall performance is poor. (ii) Investors show neutral timing skills, while the main performance driver is the issuers' price-setting. (iii) Higher risk taking by investors diminishes the performance further. Our results imply that retail investors do not achieve a pecuniary benefit from the considered financial innovations.

Keywords: Leverage Certificate; Warrant; Financial Innovation; Retail Investor; Performance

JEL classification: D40, G11, G21, G24

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1 Introduction

Trading and investing was greatly facilitated for individual investors over the last decade by the creation of innovative financial products such as reverse convertibles and leverage certificates, and of exchanges and exchange segments that are specialized in these innovative retail products.[1] By now issuers have introduced a large number of new product types containing a variety of different payoff profiles and product features meeting nearly any trading and investment purpose (e.g., Stoimenov and Wilkens, 2005; Baule, 2011). A key argument for financial innovation in this context is the reduction of market imperfections (Tufano, 2003). The ability of investors to access new payoff profiles through the use of innovative financial products or to trade existing products at significantly lower costs is consistent with this view. However, the wide selection results in a complex choice problem (Entrop et al., 2016b), and remarkable price dispersions among comparable products increase significantly the search costs for individual investors (Dorn, 2012). This is seen as a key explanation for why issuers can overprice products in financial retail markets (Carlin, 2009). Indeed, for exchange-traded retail products it is well-known that issuing banks systematically quote prices clearly above their theoretical fair values.[2] This raises the general question whether potential benefits from financial innovation outweigh these "extra costs".

In fact, little is known about the de facto realized benefits of these innovations for indi-

[1]Prominent retail exchanges in Germany are the Stuttgart EUWAX (European Warrant Exchange) and the Frankfurt Certificate Stock Exchange (formerly Scoach), and in other countries the Swiss SIX Structured Products Exchange and the Nordic Derivatives Exchange. The Italian Equity Derivatives Market of Borsa Italiana and the London Stock Exchange Securitised Derivatives are designed for both retail and institutional investors. Moreover, issuers offer individual investors to trade their products OTC via the issuers' own trading platforms.

[2]For *short-term* exchange-traded financial retail products such as warrants and leverage certificates see, e.g., Muck (2006), Wilkens and Stoimenov (2007), Horst and Veld (2008), Baule and Blonski (2015) and Baller et al. (2016). For *long-term* exchange-traded financial retail products such as discount certificates and reverse convertibles, see, e.g., for the US Baubonis et al. (1993), Benet et al. (2006), Henderson and Pearson (2011), for Germany Stoimenov and Wilkens (2005), Wilkens et al. (2003), Baule et al. (2008), Baule (2011), Baule and Tallau (2011), Entrop et al. (2016a), for Switzerland Wasserfallen and Schenk (1996), Burth et al. (2001), Grünbichler and Wohlwend (2005), Wallmeier and Diethelm (2009), and for the Netherlands Szymanowska et al. (2009).

vidual investors, especially in combination with the observed overpricing. The effect of this overpricing on the individual investors' performance has until now only been investigated for long-term products by Entrop et al. (2016b), who analyze investors' trading in discount and bonus certificates and find negative alphas and a link between higher product complexity and higher underperformance. Not focussing on overpricing, Bauer et al. (2009) report underperformance for the Dutch option market, while Meyer et al. (2014) focus on investors' skills and news trading in German leverage certificates which also show a poor overall performance.[3]

Our study contributes to the existing literature by analyzing for the first time the actual forces driving performance. To do so, we first introduce a general decomposition formula for the return that identifies several economically meaningful return components that are related to the investors' behavior and to the issuers' pricing behavior, respectively. The decomposition formula can easily be applied to products and markets where similar conditions apply and allows us to isolate and analyze several effects that otherwise would be blurred if only the raw return were considered. We furthermore analyze investors' risk taking in detail, where we define risk exposures as products' price elasticities with respect to their respective underlying and volatility. Finally, we study the link between investors' risk taking and their performance, as well as socio-economic characteristics.

In detail, return is divided here into 4 components: (i) The return the investor would achieve if the product was fairly priced (fair value component). This return part is clearly influenced by investors' buying and selling decisions and the development of the underlying, and especially allows us to test investors' potential timing skills. (ii) The effect of overpricing at the point in time the product is bought (markup component). Interestingly, this component does not neces-

[3]A related strand of literature theoretically finds that the high demand by individual investors for many popular long-term, innovative, structured products can hardly be justified under standard preferences, see Breuer and Perst (2007), Branger and Breuer (2008), Bernard et al. (2009), Das and Statman (2013) and Hens and Rieger (2014).

sarily reduce performance but cushions the fair value return, whether positively or negatively, to zero. (iii) The effect of the divergence of the overpricing level over time (markup change component). As issuers usually decrease overpricing until maturity, this component should depress performance. (iv) The effect of the bid/ask spread (spread component) that — of course — also diminishes performance.

This empirical analysis is carried out for warrants and leverage certificates, i.e. for short-term highly speculative retail products. Schmitz and Weber (2012) analyze the trading behavior of individual investors in classical warrants and report that hedging plays an almost negligible role as a possible reason for trading these products. This implies that the key motive for private investors to trade warrants is speculation, which is consistent with findings for the market of options by Lakonishok et al. (2007) and Bauer et al. (2009). Therefore, investors' level of risk taking can be assumed to be a "free" decision rather than motivated by hedging purposes. The very short mean (median) holding periods of 4.25 (0.19) trading days for warrants and 0.46 (0.05) for leverage certificates in our dataset also support this conclusion.

We analyze some half a million trades by more than 3,000 individual investors in classical warrants and leverage certificates on the German DAX index in 2007 and 2008. Compared to warrants, leverage certificates incorporate another layer of complexity by having a knock-out barrier. Both product types considered here are highly speculative investments with a market share of almost 50% of the total for exchange-traded financial retail products. This is equivalent to a turnover on German retail exchanges (one of the biggest markets) of 130 billion euros during 2007 and 2008.[4] While leverage certificates are predominately traded by European investors, similar products, such as contracts for difference (see Brown et al., 2010), are offered by financial institutions in most industrialized countries.

[4]See the website of the German Derivatives Association, available at www.deutscher-derivate-verband.de.

Our main findings are threefold. First, we find an overall poor investor performance throughout all analyzed return measures. For example, when considering net (gross) returns for round-trips, the average return is about -4% (-2%) in the case of warrants and -6% (-4%) for leverage certificates. This poorer performance for the more complex leverage certificates, compared to classical warrants, is consistent with the theoretical work by Carlin (2009) and Kalayci and Potters (2011), implying that banks can use complexity to increase their profits from uninformed investors.

Second, by decomposing the gross return along the lines of the above-mentioned decomposition formula, our results imply that the poor performance is not only caused by transaction costs but also substantially driven by the issuers' pricing policy. Interestingly, on average we find the products showed positive fair value returns during our time frame. However, this is not due to investors' timing skills but to the market development during our observation period. This positive return component is outweighed by the price-setting behavior of the issuer. Especially the markup component and the spread component are the driving forces for the poor performance, whereas the markup change component plays only a minor role.

Third, we find that the average performance decreases with increasing risk taking of the investors, measured by the acquired DAX exposure. This holds for gross returns and even after excluding bid/ask spreads and is again more pronounced for leverage certificates. The fair value return increases for larger quantiles of risk taking in both product groups. The negative influence of the markup, the spread component - and also the markup change component for leverage certificates - increase simultaneously and are again the driving forces behind the overall negative relationship between risk taking and performance. Moreover, the characteristics of traders with a high affinity for risk taking is consistent with findings for gamblers on the stock market, the US lottery (see Kumar, 2009), as well as the option market (see Bauer et al., 2009),

as especially young, unexperienced male investors tend to take more risk.

Using a multivariate analysis approach validates the above findings. Moreover, analyzing two levels of investor experience shows that the findings by Seru et al. (2010) for the stock market also hold for retail derivatives markets. Experienced investors perform better for a particular exposure. However, all results hold regardless of the investor experience level.

All in all our study provides evidence that (positive) fair value returns are on average reduced and even reversed by the issuers pricing policy in the exchange-traded retail products considered here. This is especially done by charging a generally high markup level and setting the spread. Moreover, risk taking results in an even worse performance. Again, this larger return loss is not caused by the trading behavior of the investors but by the price-setting policy of the issuer. However, it is important to note that the loss of the investor cannot be translated one-on-one into the profits earned by the issuer. When offering innovative retail products, issuers face transaction, hedging, service and marketing costs, which decrease their profits. Especially in the case of leverage certificates, the hedging costs increase or the risk even becomes unhedgeable when the underlying is close to the knock-out barrier. Even if issuers were to reduce the markups to a minimum, only covering these costs and accepting zero net earnings, it is highly questionable whether investors would benefit in terms of performance from these speculative products, as they do not show timing skills that could outweigh these costs. Given the poor performance and the investors' characteristics, our findings suggest that if investors do realize benefits from the financial innovations examined here, these benefits are non-pecuniary, such as entertainment and gambling.[5]

The remainder of this paper is structured as follows. Section 2 describes the design of the considered leverage certificates and warrants and portrays the return measures used. Moreover,

[5]Dorn and Sengmüller (2009) show that entertainment and gambling can be significant motives for retail investors' trading when considering stock and mutual funds investments.

we derive the analytical decomposition formula for the return, describe our risk taking measures and the valuation methodology used. Section 3 gives detailed descriptive statistics of our dataset and of the investors trading warrants and leverage certificates. The empirical analysis in Section 4 is divided into three parts: Section 4.1 analyzes the returns, describes the respective return components and compares the results for warrants and leverage certificates. Section 4.2 examines the DAX and volatility exposures acquired by the investors via both product types and their risk taking patterns, and links investors' risk taking to their returns. Section 4.3 provides a multivariate analysis for two different experience levels. Section 5 concludes.

2 Product Design, Return and Risk Measures

2.1 Product Design

As the focus of our analysis is investor performance in warrants and leverage certificates, we characterize their design and payoff profiles in the following and outline their distinctions. We chose these products because warrants are already long-established, whereas leverage certificates represent further developed, more complex innovations. Both products can be traded over exchanges such as the European Warrant Exchange (EUWAX) in Stuttgart or the trading platforms of the respective issuing bank.[6] Classical warrants, i.e. call and put warrants, are option-like securities enabling the investor to participate in the performance of the underlying

[6]Issuers serve as market makers and quote binding bid and ask prices for their certificates. As such, the market is quote-driven and the market maker takes the opposite side of nearly every transaction. Investors cannot arbitrage pricing discrepancies due to explicit exchange rules (Stuttgart Stock Exchange, 2014, Section 53; Frankfurter Wertpapierbörse, 2013, Section 104), or physical limitations on the proprietary trading platforms that prevent short-selling. For a detailed description on the market environment see, for example, Baule (2011) and Baller et al. (2016).

with a low initial investment. The payoff of a warrant at maturity T is given by:

$$\text{call warrant:} \quad call_T = c \max(S_T - X,\ 0), \tag{1}$$

$$\text{put warrant:} \quad put_T = c \max(X - S_T,\ 0), \tag{2}$$

where S_T is the price of the underlying at maturity T, X is the strike and c is the conversion ratio that is usually set to 0.01 for DAX warrants, scaling the value of the certificate to a customer-friendly level. If warrants are American, the premature payoff if exercised is analogous.

The payoff of leverage certificates at maturity[7] is identical to the payoff of warrants. However, they differ by incorporating another layer of complexity. They become immediately worthless if the underlying price S_t reaches or overshoots the continuously monitored barrier B that equals the strike X, i.e. $B = X$, which makes them equivalent to one-sided barrier options. The payoff of a leverage certificate at maturity T is given by:

$$\text{long leverage certificate:} \quad LC_T^{long} = c \max(S_T - X,\ 0)\, 1_{\{\tau^{long} > T\}} \tag{3}$$

$$\text{with} \quad \tau^{long} = \inf\{t > 0 : S_t \leq X\},$$

$$\text{short leverage certificate:} \quad LC_T^{short} = c \max(X - S_T,\ 0)\, 1_{\{\tau^{short} > T\}} \tag{4}$$

$$\text{with} \quad \tau^{short} = \inf\{t > 0 : X \leq S_t\},$$

where $1_{\{.\}}$ is the indicator function and $\tau^{\cdot}$ represents the respective first-passage time, i.e. the time when the underlying first hits or crosses the barrier.

In the following we will subsume call warrants and long leverage certificates under "long positions", and put warrants and short leverage certificates under "short positions". The mon-

[7]This paper focusses on leverage certificates with a fixed maturity. For open-end leverage certificates see Entrop et al. (2009) and Rossetto and van Bommel (2009).

eyness for long positions is defined as the fraction of the underlying price in t and the strike, i.e. S_t/X. For short positions we define the moneyness by X/S_t.

2.2 Return Measures

As usual when dealing with short-term products, the actual performance is defined as the return of a round-trip in one specific product (see, e.g., Schmitz and Weber, 2012; Dorn, 2012). A round-trip always starts with a purchase and can either end through the sale of the complete accumulated portfolio of one product or passively through holding this product until maturity. In the case of leverage certificates, the third way for a round-trip to end is a knock-out. Consequently, the number of warrants or certificates in an investor's portfolio for one round-trip is always zero at the beginning and at the end, while it is strictly positive in-between.[8]

We use three different return definitions to examine the realized returns. The gross relative return (GRR) neglects any transaction costs other than the bid/ask spread already included in the purchase and sales price:

$$GRR = \frac{\sum_{k=1}^{S} N_k^s \, p_k^s - \sum_{i=1}^{B} N_i^b \, p_i^b}{\sum_{i=1}^{B} N_i^b \, p_i^b}, \tag{5}$$

where N_i^b are the numbers of warrants or certificates bought at B points in time t_i. N_k^s are the numbers of warrants or certificates sold at S points in time t_k. p_i^b and p_k^s are respective purchase and sales prices.

We further compute a gross relative return additionally excluding the bid/ask spreads (GRR^+):

[8] In our later empirical analysis, we assume that those positions not closed at the end of our time frame, i.e. the end of the year 2008, (295 for warrants and 185 for leverage certificates) have hypothetically been sold with a sales price equaling their respective closing price according to the dataset at the last day.

$$GRR^{+} = \frac{\sum_{k=1}^{S} N_k^s \ (p_k^s + \frac{sp_k}{2}) - \sum_{i=1}^{B} N_i^b \ \left(p_i^b - \frac{sp_i}{2}\right)}{\sum_{i=1}^{B} N_i^b \ (p_i^b - \frac{sp_i}{2})}, \tag{6}$$

where sp_i are the respective bid/ask spreads.[9] Thus, the GRR^{+} always has to be equal to or greater than the GRR.

The net relative return (NRR) takes all transaction costs into account:

$$NRR = \frac{\sum_{k=1}^{S} N_k^s \ (p_k^s - tf_k^s) - \sum_{i=1}^{B} N_i^b \ \left(p_i^b + tf_i^b\right)}{\sum_{i=1}^{B} N_i^b \ (p_i^b + tf_i^b)}, \tag{7}$$

where tf_i^b and tf_k^s are the respective transaction fees for purchases and sales. It holds that the NRR always has to be equal or smaller than the GRR.

2.3 Decomposing the Return

Previous literature based their analyses on similar return measures as defined in the previous section. In general, systematic returns in trading warrants and certificates could be a result of the overall market development, of investors' behavior — especially selection and timing — as well as of the banks' price-setting behavior. Since we only compare derivatives on the DAX index in the following, underlying selection cannot explain these returns by definition. However,

[9] We extract the bid/ask spreads using the Thomson Reuters Tick History. More precisely, in our later empirical analysis we do not extract the bid/ask spread at the exact time a trade is made, but rather extract four bid/ask spreads per day (9.30 a.m., 12.30 p.m., 3.30 p.m. and 6.30 p.m.) for each single warrant and certificate. As the majority of these bid/ask spreads (approximately 99% for certificates and 92% for warrants) remains constant over the course of one day, we use the average of these four bid/ask spreads and generate one bid/ask spread per product per day. Since we do not have the bid/ask spreads for all product days, we proxy the bid/ask spread for those non-matched transactions (20,445 of the 337,833 transactions for certificates and 25,895 of the 148,610 transactions for warrants) with regard to the price of the product at trade using the average extracted bid/ask spreads per product type for this price and day. Further, we only adjust the prices for the bid/ask spreads if the price of the product at the time of the trade is greater than 12 cents.

to separate the remaining potential effects we decompose the gross relative return from Eq. (5) into several economically meaningful components. To do so we define the following variables:

b	buy transaction
s	sell transaction
x	buy or sell transaction ($= b$ or s)
v^x	fair value
m^x	markup
m^{*x}	spread-adjusted markup
m^{**x}	transaction costs-adjusted markup
sp^x	spread

First assuming that the round-trip consists of only one purchase and one sale we get the following representation for the gross relative return:

$$\begin{aligned} GRR &= \frac{p^s - p^b}{p^b} = \frac{v^s + m^s - v^b - m^b}{v^b + m^b} \\ &= \frac{v^s - v^b}{v^b} + \frac{m^b\left(v^b - v^s\right)}{v^b\left(v^b + m^b\right)} + \frac{m^s - m^b}{v^b + m^b}, \end{aligned} \tag{8}$$

where v^b and v^s are the respective fair purchase and sales values and m^b and m^s are the markups set by the issuer on the respective fair purchase and sales values at the points in time where the respective transaction occurs. The realized prices, $p^b = v^b + m^b$ and $p^s = v^s + m^s$, are combinations of the fair values and the respective markups. As the spread can be an important profit source for the issuer at the expense of the investor's return, we furthermore exclude a separate spread component from Eq. (8).[10] We assume that the resulting spread-adjusted

[10]This can be done equivalently for the net relative return NRR by additionally extracting a transaction costs component from the markups similar to Eq. (7). The markups then are set to $m^{*s} = m^{**s} - tf^s$ and

markups m^{*i} are located in the middle of the spread:

$$GRR = \underbrace{\frac{v^s - v^b}{v^b}}_{\substack{fair\ value \\ component}} + \underbrace{\frac{m^{*b}\left(v^b - v^s\right)}{v^b\left(v^b + m^b\right)}}_{\substack{markup \\ component}} + \underbrace{\frac{m^{*s} - m^{*b}}{v^b + m^b}}_{\substack{markup\ change \\ component}} + \underbrace{\frac{\frac{sp^b}{2}\left(v^b - v^s\right) - v^b\left(\frac{sp^s}{2} + \frac{sp^b}{2}\right)}{v^b\left(v^b + m^b\right)}}_{\substack{spread \\ component}}, \quad (9)$$

where $m^{*b} = m^b - \frac{sp^b}{2}$ and $m^{*s} = m^s + \frac{sp^s}{2}$ are the spread-adjusted markups and sp^b and sp^s the respective bid/ask spreads.

Fair value component

The first component in Eq. (9) is the return induced by a change in the fair value of the product and is therefore caused by market movements. If $v^s > v^b$, i.e. the fair value increases from the point in time of the purchase to the sales time, this return part is strictly positive, in the case of a decrease in the fair value, i.e. $v^s < v^b$, it is negative and if the fair value does not change at all this return component becomes zero. A positive fair value return can either be the effect of timing skills, as the investors are able to predict the future direction of the market; or it comes about by chance due to the market phase.

Markup component

The markup component results from the fact that the issuer always surcharges a markup on the fair theoretical value of the respective product. Interestingly, this return part is reversely related to the fair value return, assuming that the buy markup is positive, i.e. $m^{*b} > 0$. The latter is a plausible assumption, because a rational issuer will never offer his products below the theoretical fair value. If the fair value return is positive, the markup return is negative and vice versa. Thus, this component cushions the return generated by the fair value, whether up or down, and exists even if the ask and the bid markups are identical, i.e. if $m^{*b} = m^{*s}$.

$m^{*b} = m^{**b} + tf^b$, respectively. We refrain from doing this exercise here, as the transaction costs can be highly dependent on the broker.

Markup change component

The markup change component is the return part induced by a divergence of the markups at the points in time the product is bought and sold by the investor. If the fair value return is zero, i.e. $v^b = v^s$, the overall return results only from a potential markup change and the set spread. Normally, the markups decrease over the product's lifetime, i.e. $m^{*b} > m^{*s}$, which is well-known as the "life cycle hypothesis" (e.g., Stoimenov and Wilkens, 2005; Baule, 2011; Baule and Blonski, 2015). This implies that the markup change component is expected to be negative.

The markup change component may also have a positive sign however. If issuers calculate markup levels as a relative surcharge to the fair value, for example increasing fair value, i.e. $v^s > v^b$, may result in increasing markups, $m^{*s} > m^{*b}$, which would result in a positive markup change component.

Spread component

The spread component is the return part induced by the spread-setting behavior of the issuer. A generally set spread level cushions the fair value return component similarly to the markup component (see the first part in the numerator of the spread component in Eq. (9)). However, this relation is dominated by an additional effect of the spread of the purchase and of the sales price (see second part), which is strictly negative. Thus, the total spread component is expected to be negative.

All in all, the above decomposition reveals that the investor's return is driven by the fair value return of the product plus the elements of the issuer's price-setting policy. Interestingly, the fact that a product is overpriced does not necessarily lead to lower returns. In fact, the markup component serves as a symmetric cushion for fair value returns and reduces fair value gains but also respective losses. The disadvantage of overpricing rather arises when issuers decrease markups over time, represented by the markup change component. Of course, the

spread additionally decreases the return.

The above decomposition is based on the assumption that there is only one buy and one sell transaction. It can easily be extended to represent a round-trip consisting of several buys and sells. The respective general formula is provided in Appendix A.

2.4 Exposures and Sensitivities

When purchasing a warrant or a leverage certificate investors are able to choose actively the risk level inherited in the bought product. As the premature knock-out possibility has a strong impact on the probability of a positive payoff for leverage certificates at maturity, the risk exposures of leverage certificates and warrants can differ strongly. To analyze the risk taking we define two exposure measures, namely the product's price elasticity with respect to changes in the underlying price and the volatility of the underlying:

$$\text{Underlying Exposure } LP\text{: } EXP^{S}_{LP} = \frac{\frac{dLP_t}{LP_t}}{\frac{dS_t}{c\,S_t}} = \underbrace{\frac{dLP_t}{dS_t}}_{\text{Delta}} \underbrace{\frac{c\,S_t}{LP_t}}_{\text{Leverage}}, \tag{10}$$

$$\text{Volatility Exposure } LP\text{: } EXP^{Vola}_{LP} = \frac{\frac{dLP_t}{LP_t}}{\frac{dVola_t}{c\,Vola_t}} = \underbrace{\frac{dLP_t}{dVola_t}}_{\text{Vega}} \frac{c\,Vola_t}{LP_t}, \tag{11}$$

where LP_t is the value of the considered leveraged product (LP) and $Vola_t$ is the volatility of the underlying. The underlying exposure can be calculated as the delta of the structured product times its leverage. The volatility exposure is calculated as the vega times the quotient of the volatility $Vola_t$ times the conversion ratio c over the value of the leveraged product LP_t itself.

As shown in more detail in Appendix B, warrants are less sensitive towards changes in the underlying and more sensitive towards changes in the underlying's volatility than leverage cer-

tificates. When the underlying price approaches the barrier, the underlying exposure of leverage certificates becomes extremely high. However, leverage certificates are almost independent of the underlying's volatility and almost linear with the underlying price. Because of this, banks often call leverage certificates "delta-one" products, i.e., products which have a delta of nearly one, with almost no sensitivity to volatility. Therefore, many banks promote them as "simpler substitutes" for warrants.

2.5 Valuation

In order to calculate the return components and the risk measures described in Sections 2.3 and 2.4, we need to identify the fair value of the products at the purchase and at the sales time. With the exception of American put warrants, we use the analytical solutions from Black and Scholes (1973) and Rubinstein and Reiner (1991) to compute the respective values of warrants and leverage certificates. As our analysis focuses on products on the DAX, which is a performance index, we do not have to account for dividend payments. Therefore only the values for American put warrants are extracted using the Cox-Ross-Rubinstein tree (Cox et al., 1979).

For a market-consistent calibration we basically follow Baule (2011) and Baller et al. (2016). We match the time corresponding risk-free rate[11] and the DAX or X-DAX level[12] at the same time-to-the-second of each trade. For the volatility we calculate and use the implied volatilities from settlement quotes of DAX-options traded on the EUREX.[13] To control for volatility

[11]Throughout the paper we use linearly interpolated Eurepo rates as risk-free rates for up to one year. We prefer the Eurepo to the Euribor as the latter was significantly distorted during the financial crisis. For risk-free rates over one year we use interest rates estimated by the Deutsche Bundesbank from German governmental bonds.

[12]For the time periods outside the trading hours of the DAX, we use the X-DAX as a substitute. The X-DAX is a DAX-proxying index derived from DAX-future contracts with the shortest time to maturity. It is calculated on each trading day for the time periods from 8 a.m. until 9 a.m. and from 5.45 p.m. until 10 p.m. As the X-DAX is often not calculated for each second, we interpolate the available X-DAX quotes to obtain an adjusted X-DAX on a second-by-second basis.

[13]The EUREX is Europe's leading options exchange for institutional investors and regularly serves as a benchmark for retail derivatives when fair values are to be calculated. Option data was provided by Karlsruher Kapitalmarktdatenbank.

anomalies, we use the method according to Hentschel (2003), which puts more weight on out-of-the-money options and thus overcomes the biases of other methods. If there is no perfect match of quote and EUREX option, the values are interpolated two-dimensionally via maturity and strike (see, e.g., Baule, 2011).

3 Dataset

3.1 General Trade Characteristics

The dataset used for the analysis is provided by a large German online broker with a huge base of several hundred thousand retail customers. Such online brokers are the first choice for investors trading retail derivatives. The dataset includes a total of 3,032 different investors who have traded a leverage certificate at least once and a classical warrant at least once during our observation period, meaning that they are familiar with both financial products. In this section we focus on the general trade dataset, while we provide statistics on the individual investors in Section 3.2.

We exclude 1% of the buying and associated transactions with the highest absolute underlying exposure. The resulting final dataset consists of 148,610 buying and selling transactions in 7,377 different warrants and 337,833 buying and selling transactions in 13,652 different leverage certificates on the DAX from April 2007 to December 2008. We know the specific trade characteristics of each transaction, such as the date and time of the trade, whether it was a buy or a sell, as well as the price and the volume. 5% and 7% of the transactions in warrants and leverage certificates, respectively, were executed via exchanges and the remaining number via the issuers' trading platforms.

Table 1 illustrates the dataset separated for warrants and leverage certificates as well as buying and selling transactions for each quarter of our observation period. The mean remaining

time to maturity for leverage certificates of 47 (buys) and 46 (sells) days is significantly shorter than the one for classical warrants with 96 (buys) and 87 (sells) days. Moreover, the distribution of the remaining time to maturity is wider and more volatile over time for classical warrants than for leverage certificates. A different analysis not reported here reveals that the mean holding period for certificates with 0.46 trading days is significantly shorter than for warrants with 4.25 trading days. The median is even smaller with 0.05 and 0.19 trading days. Hence, both product types indeed serve as very short-term investment opportunities for individual investors.

[Table 1 about here.]

Considering the similar long-ratios of about 0.48, the tendency of investors to speculate on rising or falling markets is comparable for the two products. In contrast, investors show different patterns with regard to the amount invested in these products. Whereas the overall average traded price is almost identical for both product types (slightly lower than EUR 2.00), the average buying (selling) transaction volume in EUR, defined as traded price, p_{traded}, times the number of certificates or warrants traded, amounts to EUR 4,588 (EUR 5,586) for warrants and to EUR 3,293 (EUR 3,579) for leverage certificates. Considering the different mean buying and selling volumes, the aggregated values for purchases and sales are only slightly different for warrants (EUR 0.7 billion) and certificates (EUR 1.2 billion). For both product types, the distributions for the traded price and the traded volumes are positively skewed. Similar patterns with regard to the higher selling volumes and the positive skewness of the distributions were detected for common stock investments by Barber and Odean (2000).

Furthermore, there are slightly more buying (82,017 in warrants and 177,984 in certificates) than selling (66,593 in warrants and 159,849 in certificates) transactions during our observation period. This pattern is consistent with other findings in the literature, e.g., Barber and Odean (2007) for stock transactions, and describes the fact that investors have a marginal tendency

to increase their portfolio with more than one purchase, whereas they tend to close an existing position all at once. Given the higher number of leverage certificate transactions, it is not surprising that the average number of transaction per investor is around twice as high for leverage certificates as for warrants, with a mean of 22 for purchases in leverage certificates and 11 for purchases in warrants. Further, the distribution is positively skewed for both product types.

On the basis of the knock-out feature embedded in the leverage certificates, their moneyness has to be greater than one. The results in Table 1 illustrate that the investors tend to trade certificates close to this contractual boundary with a mean moneyness for purchases of 1.0295 and for sales of 1.0297. The moneyness for warrants, which has no theoretical restriction other than being greater than zero, lies at a mean of 0.9532 and 0.9565 for purchases and sales, respectively, which is just below one.

The small moneynesses underline the speculative short-term investment scope of individual investors trading warrants and leverage certificates. The shorter holding period, larger trading frequency and smaller volume traded in leverage certificates compared to warrants identify the former as even riskier investment strategies.

3.2 Investors' Characteristics

To gain a better understanding of the investor group in our dataset, it is worth analyzing their personal characteristics. Summary statistics of the individual investor base and their activities in leverage certificates and warrants are provided in Table 2.

[Table 2 about here.]

Male (87.66%) and female investors (11.81%) of all ages invest in warrants or leverage certificates (we have no information for the remaining shares of investors). The average investor

was 43.5 years old at the beginning of the observation period. These numbers are very similar to findings of Bauer et al. (2009), who report on traders with an average age of 45 years and 78% male traders in a dataset for the Dutch option and equity market. Furthermore, the data exhibits that about 3.69% of investors hold a doctoral degree or professorship, 2.01% of investors are retired and 37.43% of investors are married. Moreover, about half of the investors in the dataset have 5 to 10 years of experience as investors. Only 15.24% have held their accounts for more than 10 years.

Striking is that only about 4.5% of the investors in warrants and leverage certificates are employed in the financial sector, i.e. work for a credit or financial institution or for other financial service providers. Moreover, we only have information on the income of little more than half of the investors. Most of them, i.e. 34.76% have a medium income of between 25,000€ and 75,000€ per year, whereas 14.64% earn less and only 4.95% more than 75,000€.

Looking at trading activities, we note only a few differences in the average investment behavior of the investor subgroups in our dataset, which we mainly attribute to personal characteristics. For instance, the results reveal that older investors, investors holding a doctoral degree and retired investors, investors with a higher income and more experience, put higher volumes in warrants and leverage certificates, which is presumably due to greater personal wealth and/or time.

Interestingly, female investors in the dataset trade much more often in warrants than their male counterparts, similarly often in leverage certificates, and buy (sell) a larger (smaller) average volume in warrants (leverage certificates). This pattern seems not to reflect individual investors' behavior on the Dutch option market (see Bauer et al., 2009) or on the equity market, where a greater trading activity on the part of men is typically ascribed to male investors having more confidence in their financial competency (see, e.g., Barber and Odean, 2001). Nevertheless, we

have no reason for thinking that our dataset was not representative for derivative retail investors.

4 Empirical Findings

4.1 Analysis of the Return

4.1.1 Overall Investors' Performance

We first analyze the three return measures as defined in Section 2.2 for warrants and leverage certificates separately. The results are shown in Table 3.[14] Next to the equally-weighted statistics, it provides capital-weighted statistics ($CWGRR$ and $CWNRR$) for the gross relative return (GRR) and the net relative return (NRR) based on Eq. (5) and Eq. (7).

[Table 3 about here.]

Meaningful is the fact that almost all means indicate a significant negative return for leverage certificates and warrants. On average, investors lost 3.82% per round-trip (NRR, all warrants) when speculating with warrants. The average loss for investors in leverage certificates even amounts to 5.93% per round-trip (NRR, all leverage certificates).

Even after excluding transaction fees, investments in warrants and leverage certificates still result in an on average highly negative return. The mean GRR is again negative for leverage certificates (-3.72%) and warrants (-1.91%). When considering the capital-weighted return, the returns are still negative, but less so. The mean $CWGRR$ equals -2.07% for leverage certificates and -0.99% for warrants, respectively. Transaction fees thus decrease the already negative returns per round-trip by an average of more than 2% for certificates and slightly less than 2% for warrants. The pattern of a better return for warrants holds for all other return

[14] In the following we eliminate 183 (469) round-trips in warrants (leverage certificates) which have a higher GRR than 2, to avoid large outliers when decomposing the return. However, this exclusion does not affect our results.

measures. After additionally excluding bid/ask spreads, the gross relative returns increase by around 1.8% (GRR^+ for warrants and leverage certificates is -0.11% and -1.97% respectively).

The mean returns for long positions (GRR of -4.03% for call warrants and -5.14% for long certificates) are significantly worse than for short positions (GRR of 0.06% for put warrants and -2.37% for short certificates). This is likely to be driven by the generally declining market during our observation period. All distributions of the returns are positively skewed. The medians are strictly positive and very similar for long and short positions within each product and return measure. This implies that more than half of all trades resulted in a positive return for the investors. This could lead to a "false attractiveness" of the products from a private investor's perspective.

In summary we find a poor performance for both warrants and leverage certificates for all examined returns. However, these negative realized returns are not only due to transaction costs as they are also found after excluding transaction fees. In the following we decompose the GRR as shown in Section 2.3 to extract the driving forces for this poor performance.

4.1.2 Decomposing Investors' Performance

As done analytically in Section 2.3, we calculate the components of the return in order to separately analyze the effects of timing and issuers' price-setting behavior. Table 4 reports the median, mean and standard deviation of the gross relative return and the four return components for the round-trips in warrants and leverage certificates separately.

[Table 4 about here.]

In Table 5 we additionally show the results separately for increasing and decreasing DAX developments from the time of the purchase until the selling time. By doing so we are better able to separate the effect of each component, as bullish or bearish market conditions have diverging

effects on the return components and their interactions.

[Table 5 about here.]

Fair value component

The means for warrants and leverage certificates indicate a positive and significant fair value return, though for leverage certificates only at a 10% level. On average, investors earned 2.77% per round-trip when trading in warrants and 0.88% in leverage certificates. This positive return is mainly driven by the traded short positions, which add up to 4.98% for warrants and 2.44% for leverage certificates, while the fair value return in the long positions is slightly negative and significant at a 5% level (-0.75%) for leverage certificates and a zero sum game for warrants.

Moreover, by definition, the fair value return (and also the gross relative return) is strongly positive (negative) for long products during an increasing (decreasing) market phase, and for short products during a decreasing (increasing) one. In our sample we find more trades in long products during a rising DAX and more trades in short products during a falling DAX. The result is the above-mentioned overall positive average fair value return. Whether this is the effect of individual investors' timing skills is analyzed in Section 4.1.3.

Markup component

The positive fair value return is decreased or rather dominated by the negative significant means of the markup component. The loss in return due to the general markup level of the issuer is on average 3.28% and 1.34% for warrants and leverage certificates, respectively, as shown in Table 4. The markup return does not differ strongly for short and long positions and always has the opposite sign of the fair value return. This effect is even more pronounced when the market phase is considered, see Table 5. For example, the markup return is positive if the fair value return is negative, which is the case for long positions in declining market phases and for short positions in upward market phases. Therefore, the general markup level does not in general

decrease, but cushions the fair value returns as predicted by the theoretical considerations in Section 2.3.

Markup change component

The markup change component is the only one that differs in sign for leverage certificates and warrants. For warrants the average markup change return is 0.69% and -1.25% for leverage certificates. For leverage certificates and warrants in bullish markets the markup change return is negative, which is consistent with the life cycle hypothesis (e.g. Baule, 2011). In bearish markets however the markup change component for warrants is positive. The overall value of the component for warrants becomes positive due to this positive relationship for warrants in declining market phases.

Spread component

The spread always effects the return negatively, regardless of the market movements or long and short positions. The effect is around -2% for leverage certificates and warrants and long and short positions. Keeping in mind that the mean traded price in both product types is about 2 euros and that the spread is nearly constant and about 2 cents, especially in leverage certificates, this effect seems to be twice as large as expected. The reason lies in the group of products with small traded prices. Here the return component has a proportionally higher effect. When calculating the values, excluding the smallest prices or regarding the median, the value becomes larger and is, as expected, around -1%.

In summary, the overall negative performance is a result of the banks' pricing policies. This is consistent — although they do not analyze realized returns — with Henderson and Pearson (2011), who report that overpricing in the market for specific retail structured equity products in the United States is so high that it results in negative expected returns for investors under reasonable assumptions on expected underlying returns. Moreover, more negative returns for

leverage certificates than for warrants is also consistent with theoretical considerations, implying that firms can intentionally use complexity (Carlin, 2009; Kalayci and Potters, 2011) and shroud certain information on their products (Gabaix and Laibson, 2006) in order to keep investors uninformed and to exploit buyers who lack an understanding of these products. Bringing this into the context of leverage certificates, banks that promote these products as "simplified substitutes" for warrants, can exploit higher margins for these actually more complex products, because investors still know little about their "true" (risk) characteristics.[15] The medians of the return components are absolutely smaller than the means and very similar for long and short positions within each product and return component. This implies again that more than half of all trades resulted in a positive return for the investors. This could again lead to a "false attractiveness" of the products from a private investor's perspective.

4.1.3 Fair Value Component and Market Timimg

There are several possible reasons for the at least slightly positive fair value returns on warrants and leverage certificates already mentioned in Section 4.1.2: First such returns may indicate that investors have some timing skill. This may be especially pronounced for short positions, because the long position fair value return in warrants is not significantly different from zero and for leverage certificates it is even negative, which may actually hint at perverse timing. However, the movement of the market may also have an effect in this context, the market showing a declining tendency in the dataset time period. Therefore, in this section we take a closer look at the declining market in question for more insight into whether the positive fair value returns were due to investor skill.

To determine whether the investors' positive fair value returns could be driven by investors'

[15] For example, Rieger (2012) provides experimental evidence for a systematic underestimation of the probability of hitting a barrier.

timing in buying and selling, i.e. market timing, we perform the following tests. The results can be found in Table 6.

[Table 6 about here.]

First, we calculate hypothetical returns by buying and selling one DAX-unit at the same time the investors in our dataset either bought or sold one leverage certificate or warrant. The hypothetical returns are calculated according to Formula (5) (GRR), where we assume that, for short positions, the investors profit from a declining DAX. However, as this procedure explicitly neglects bid/ask spreads, these returns reflect hypothetical GRR^+ returns. The resulting average mean returns are only slightly positive and very similar for warrants (0.014% and not significant) and leverage certificates (0.009% and significant at the 5% level).

Second, we calculate hypothetical (randomized) returns by buying one DAX-unit at randomized purchase times. Then we calculate three return measures: First for a holding period of one day, second for a holding period exactly equal to the corresponding holding period of the original dataset and third for a randomized holding period drawn from the distribution of holding periods in the original dataset. Hence, rather than taking the exact data from our dataset, as done for the first timing check, we proxy here both distributions drawn from the actual holding periods and long-ratios for each product. Moreover, we exclude the round-trips with the smallest and highest 1% of the returns. None of these randomized hypothetical DAX returns differ significantly from zero for any product. To summarize, none of the two tests found any evidence that the investors' average positive fair value returns were due to their market timing skill.

Third, the same calculation as in the second test is also done for hypothetical warrants and leverage certificates. For every moneyness, long/short and time to maturity combination from the original dataset, we choose randomized purchase times of the product. Then the strike is

amended according to the respective moneyness level at the purchase time. Again, we calculate three selling times according to a one-day holding period, the actual holding period from the original dataset and a randomized holding period drawn from the respective distribution in the original sample. To compute the fair theoretical values for these hypothetical products we follow the methodology described in Section 2.5. We exclude the round-trips with the smallest and highest 1% of returns. For these round-trips we then calculate the respective fair value returns, comparable to the results in Section 4.1.2. Because the negative returns of the already knocked-out leverage certificates have a proportionally high effect on the average returns, we furthermore randomly exclude as many knock-outs as possible until the ratio between knock-outs and overall observations is the same as in the original dataset.

The results show a positive mean of around 2% for the three calculated return measures for warrants and more diverging, non-significant means of 0.12% to 1.59% for leverage certificates. Via an (unpaired) mean comparison t-test, these returns are tested against the actual fair value returns from Section 4.1.2. The results support our previous findings. Except for the random holding period returns (10% level) for leverage certificates, none of the randomly calculated average returns are different from the original mean fair value returns. Hence, even if the investors had chosen the purchase times and the holding periods for their products randomly the returns would have been at the same level average. This supports the notion that the positive fair value returns do not depend on any timing skills of the investors, but are rather driven by the falling market situation. Moreover, this procedure controls for investors' behavioral biases such as the disposition effect.

4.2 Analysis of Risk Taking

As speculation is the key reason for private investors to trade short-term financial products such as leverage certificates and warrants (e.g., Schmitz and Weber, 2012; Bauer et al., 2009), the aim of this section is to analyze how investors' risk taking behavior, as manifested at the time of the purchase, influences their performance.[16] In Section 4.2.1 we begin by calculating the acquired DAX and volatility exposures as introduced in Section 2.4. We then evaluate the risk taking behavior of different groups of investors in Section 4.2.2, and finally we link the DAX exposure to the investors' realized returns (Section 4.2.3).

4.2.1 Risk Taking: DAX and Volatility Exposure

To calculate the DAX exposure and the volatility exposure according to Eq. (10) and Eq. (11), we use the same previously calculated fair theoretical values for leverage certificates and warrants, the DAX or X-DAX levels at the time of each purchase and the implied volatilities as for the decomposition of the return in Section 4.1.2. Descriptive statistics of the acquired DAX and volatility exposure are shown in Table 7.

[Table 7 about here.]

In general the acquired DAX exposure is clearly higher for leverage certificates than for warrants. The mean DAX exposure for long and short certificates is 112.50 and -94.91, respectively, whereas it is only 26.39 for call warrants and -24.51 for put warrants. This implies that on average a marginal change of $x\%$ in the DAX will increase the value of a long leverage certificate

[16] As described by Barber and Odean (2007), the decisions to buy or to sell a product are fundamentally different. First of all, the selling decision of investors is limited to those products they have previously bought. Further, their selling behavior is usually triggered or at least influenced by the actual performance of the product, resulting in, e.g., the disposition effect (see Shefrin and Statman, 1985, and for the case of warrants Schmitz and Weber, 2012). In contrast, the spectrum of products available for purchases is unrestricted. Thus, we concentrate on the purchase decisions.

by roughly 110 times this marginal change and the value of a classical call warrant by roughly $25x\%$.[17]

During the Lehman crisis in the last quarter of 2008, investments in warrants and certificates showed a significantly decreased DAX exposure. Interestingly, the absolute mean exposure for long positions (call 21.41 and long certificate 51.75) is higher than the exposure for short positions (put -13.43 and short certificate -48.14). Thus, although the investors show an overall bearish risk sentiment during this period, those speculating on rising markets have a relatively greater appetite for risk compared to those speculating on declining markets.

As illustrated by the numerical exercise in Appendix B, leverage certificates show an almost negligible volatility exposure. For call and put warrants, the mean volatility exposure amounts to 2.16 and 1.90, respectively. This size is much smaller than the DAX exposure, implying — even after taking the broader return distribution of implied volatilities compared to the DAX into account — that on average investors expose themselves to DAX risk to a much higher extent than to volatility risk.

In summary, investors generally acquire much more DAX risk via leverage certificates than via warrants. Compared to the DAX exposure, the volatility exposure is small or, in the case of leverage certificates, negligible.

4.2.2 Investors' Characteristics and Risk Taking

Based on its dominating relevance — compared to the volatility exposure — we use the DAX exposure as a proxy for the risk taking of individual investors. We examine a regression approach to analyze the effect of the socio-economic characteristics of traders in our sample on

[17] Since our pricing models are based on continuous movements of the underlying, the risk that the underlying under- or overshoots the barrier of a leverage certificate due to a jump is ignored. For certificates with a distance of more than 0.05% to the barrier, the resulting bias in the exposure is almost negligible, as found in a simulation study not reported here. Using only those certificates by excluding 741 of the 177,984 buying transactions did not change the results shown.

their risk taking. To eliminate the convex curvature of the DAX exposure as shown in Section 2.4 and Appendix B, we use the logarithm as dependent variable. Moreover, to eliminate an overweighting of investors trading at a high frequency, the DAX exposure is averaged for each investor in the dataset. The following characteristics are used as independent variables: Age and experience are divided into three subgroups and income into 4 subgroups, equivalently to Section 3.2. Moreover, several dummies for male, retired, married, foreign born and professional traders are included into the analysis. A dummy for traders with a doctorate or professorship is also inserted. The regression is computed for warrants and leverage certificates separately. The results are shown in Table 8.

[Table 8 about here.]

Risk taking is less in both older and more experienced traders than in young and less experienced ones. The same holds for traders with higher income although this effect is not always significant. Moreover, married and retired investors are more risk averse. This holds for both product groups, warrants and leverage certificates. Male investors tend to take more risk in leverage certificates. For the other characteristics the coefficients are not significant. Nevertheless, the structure of traders with a high affinity for risk taking is consistent with findings for gamblers on the stock market, on the US lottery (see Kumar, 2009) and also on the option market (see Bauer et al., 2009), as especially young, unexperienced male investors tend to take more risk.

4.2.3 Investors' Performance and Risk Taking

The last step to close the circle is to analyze the relation between the realized returns and risk taking. To do so, we split the sample into 20 quantiles according to the DAX exposure for each product. Figure 1 illustrates the average gross relative returns (GRR) in the left two subfigures

and the gross relative returns without bid/ask spreads (GRR^+) in the right two subfigures for these quantiles, where panel A reports the returns for warrants and panel B for leverage certificates — both distinguishing for long and short positions. Solid bars denote significance at the 1% level. Regarding the gross relative returns, all four investment categories analyzed show a descending slope along the DAX exposure. This implies that the average return decreases as the risk taking of the investor increases. As this holds for long and short positions simultaneously and as the GRR explicitly excludes any transaction fees, neither past market returns during our observation period nor transaction fees can explain this relation.

[Figure 1 about here.]

However, as the absolute bid/ask spreads are nearly constant they tend to increase in relative terms for lower price levels. Therefore, it is probable that at least parts of this negative relation between risk taking and return are caused by the approximately fixed absolute bid/ask spreads. To verify if this affects our results, the right two subfigures illustrate the gross relative returns without bid/ask spreads (GRR^+) for the different quantiles. Even these returns reveal the same relation as above. Although it is moderate, the relation is still highly observable. This suggests that the above findings are the result of the issuers' markup policy.

Regardless of the product group, the return type and also almost the acquired DAX exposure, short positions resulted in an average higher return than long positions. This is subject to the special market phase during our observation period and consistent with our previous results.

To analyze the above findings more deeply, we divide the dataset into four quantiles of risk taking and calculate the average gross relative return and the four return components for the round-trips separately for short and long warrants and leverage certificates. The results are shown in Table 9.

[Table 9 about here.]

The overall gross relative return per round-trip is slightly positive at 0.9% for warrants (a zero sum game for leverage certificates) for the lowest risk taking quantile and decreases to -4.88% (-9.56%) for the highest risk taking quantile.[18] For both warrants and leverage certificates and for short and long positions, the investors earned a positive fair value return, which adds up to 4.99% for warrants and 4.32% for leverage certificates in the highest exposure quantile. The values for the lowest quantile are only half as high, 2.31% for warrants and 0.52% for leverage certificates. The negative gross relative returns are driven by the negative markup (-6.22% and -4.87% in the highest risk taking quantile for warrants and leverage certificates) and spread components (-4.39% and -4.40%). The markup change return component is under 1% for warrants and a zero sum game for leverage certificates. The only exception is the highest quantile for leverage certificates, where the markup change return is -4.61%.

Especially the influence of the three pricing policy components in the highest risk taking quantile is impressive. The fair value return is reduced by nearly 10 percentage points for warrants and nearly 15 percentage points for leverage certificates, whereas for the lowest quantile the reduction comes to 1.5 and 0.6 percentage points for warrants and leverage certificates, respectively. One reason for the proportionally high markup return and the spread return in the highest quantile is the low price when the products are traded near the strike price in the case of leverage certificates and out-of-the-money in the case of warrants. All in all the influence is not linear but concave over the exposure quantiles.

[18] We executed unpaired mean comparison tests for the first and the fourth quartile, which supported all of the described findings. The only exceptions are the markup change component in the case of warrants and the fair value component for short products, where no significant difference for the exposure quartiles could be observed.

4.3 Multivariate Analysis

By applying univariate analyses in the previous sections we illustrated that investors show a significantly poorer performance with the more complex leverage certificates compared to warrants. Moreover, we found that the investors' performance becomes worse with higher risk taking. In this section we combine these analyses in a multivariate setting to test the robustness of our results.

As an additional control measure we use investors' experience in the following regression analysis. Seru et al. (2010) and Feng and Seasholes (2005) have shown that the more investors trade on the stock market, the more they learn. Bringing this into context with our short-term retail products, we would expect that investors get better at trading over time, which would increase their overall performance. Following Seru et al. (2010), we define experience as the past cumulative number of trades per investor.

To perform a regression analysis of the gross relative returns, we first split the dataset in half according to the experience of the investor.[19] One half contains 96,775 round-trips of investors with the least experience and the other one contains 96,474 round-trips of investors with the most experience in each product type. This is done for warrants and leverage certificates separately, which guarantees that the ratio of leverage certificates to warrants is identical within both experience groups. We then form 500 quantiles according to the acquired DAX exposure for each product type and each half and calculate the mean DAX exposure and the mean relative return per quantile. This will leave us with 1,000 observations for warrants (with approximately 50 round-trips per observation) and 1,000 observations for leverage certificates (with approximately 140 round-trips per observation). By applying this procedure we eliminate to a large extent the impact of the market returns on the performance. Hence, we are able to isolate the effect of the

[19] We also performed this regression using the gross relative return excluding the bid/ask spreads GRR^{+}. The results remain qualitatively the same.

risk taking on the performance of the investor and ensure that the regression is not biased due to the omitted market performance variable. We run the following regression for each experience half:

$$\begin{aligned} Mean\ Return\ Measure_i = const &+ \beta\ 1_{\{CertificateDummy_i=0\}} Mean|EXP_i^{DAX}| \\ &+ \gamma\ 1_{\{CertificateDummy_i=1\}} Mean|EXP_i^{DAX}| \\ &+ \delta\ CertificateDummy_i + \epsilon_i, \end{aligned} \tag{12}$$

where the certificate dummy is one if the round-trip was performed with a leverage certificate, otherwise the dummy is zero and the trade was performed with a warrant.

[Table 10 about here.]

The results from Table 10 support all findings from the univariate analyses and the visual inspection from above. First, we find a significant and negative coefficient for the certificate dummy. This implies that the performance in this more complex kind of product is worse than the performance in less complex warrants. Second, the DAX exposure has a strong negative impact on the performance. This can be observed regardless of the product type. Although the coefficients for warrants are significantly higher, having in mind that the mean DAX exposure of certificates is roughly 4 to 5 times as high as the DAX exposure of warrants, the overall impact of relative changes in the DAX exposure seems to be very similar for both product types. Moreover, all these relations are less pronounced for more experienced investors. However, even if experienced investors perform better for a given exposure, the statement "the higher the exposure the worse the performance" still holds for them. Also, the higher constant for the more experienced investors supports the notion that investors learn over time and thus increase their performance.

5 Conclusion

Remarkable innovations in recent year have been that retail investors have easier access to new payoff profiles and can trade existing products at significantly lower cost. This paper analyzes the benefits to investors in the form of realized returns and what determines these when trading in speculative warrants and leverage certificates. We do so by analyzing the actual forces driving performance by introducing a decomposition formula for the return that allows us to assign certain return fractions explicitly to investors' behavior and to issuers' pricing policies, respectively. The resulting general concept can easily be applied to products for which similar market conditions apply.

On average for one round-trip, private investors lost almost 2% with warrants and more than 4% with leverage certificates. After excluding transaction fees, we also find negative returns (though for warrants only in the case of capital-weighted returns) and for leverage certificates even after additionally excluding bid/ask spreads. While the returns for both products are negative, they are significantly lower for the more complex leverage certificates that banks promote as a "simpler substitute" for warrants. Our results imply that investors in leverage certificates contribute more to the banks' economic rents, meaning they earn lower returns.

By decomposing the gross relative returns we find that fair value returns are positive for warrants and leverage certificates. Hence, the negative performances are not only due to transaction costs, but are also substantially driven by the banks' pricing policies. Especially the spread- and the markup-policies transform a possible positive fair value return into a negative return for the investor. Further tests show that the positive fair value return was driven by a falling market during the observation period rather than timing skills on the part of investors. A randomized investment strategy would have led to an equally fair value return.

We further analyze the impact of investors' risk taking — as measured by the acquired DAX

exposure — on their performance. Leverage certificates are bought with a DAX exposure of four to five times that for warrants, indicating that speculation is the only motive for investing in these. We find that investors with exceptional risk taking behavior are similar to those gambling on the US stock market and the lottery. On average, investors' returns decrease with higher risk taking. The reason for this decreasing relationship between risk taking and returns is the proportionally high impact of the markup and the spread component in higher risk taking quantiles. This impact reverses even the highly positive fair value returns. Furthermore, the trading experience of investors has a positive effect on their returns in both warrants and leverage certificates. Less experienced investors lose more money and thus contribute more to the banks' earnings than experienced traders.

In summary, our results suggest that (positive) fair value returns are reduced or even reversed by the pricing policy of issuers' in exchange-traded retail products. This is especially done by charging a generally higher markup and setting the spread. Moreover, risk taking results in even poorer performance. Hence, the market for speculative exchange-traded retail certificates is one prominent example of financial innovation failing to contribute to the benefits of investors if benefits are measured by performance.

Appendix A Decomposing the Returns: General Case

Eq. (9) is calculated for the respective round-trips. Therefore, the finally analyzed version is the following:

$$
\begin{aligned}
GRR \;=\; & \underbrace{\frac{\sum_{k=1}^{S} N_k^s\, v_k^s - \sum_{i=1}^{B} N_i^b\, v_i^b}{\sum_{i=1}^{B} N_i^b\, v_i^b}}_{\substack{fair\ value \\ component}} \\
& + \underbrace{\frac{\sum_{i=1}^{B} N_i^b\, m_i^{*b} \left(\sum_{i=1}^{B} N_i^b\, v_i^b - \sum_{k=1}^{S} N_k^s\, v_k^s \right)}{\sum_{i=1}^{B} N_i^b\, v_i^b\, \left(N_i^b\, v_i^b + N_i^b\, m_i^b \right)}}_{\substack{markup \\ component}} + \underbrace{\frac{\sum_{k=1}^{S} N_k^s\, m_k^{*s} - \sum_{i=1}^{B} N_i^b\, m_i^{*b}}{\sum_{i=1}^{B} N_i^b\, \left(v_i^b + m_i^b \right)}}_{\substack{markup\ change \\ component}} \\
& + \underbrace{\frac{\sum_{i=1}^{B} N_i^b\, \frac{sp_i^b}{2} \left(\sum_{i=1}^{B} N_i^b\, v_i^b - \sum_{k=1}^{S} N_k^s\, v_k^s \right) - \sum_{i=1}^{B} N_i^b\, v_i^b\, \left(\sum_{k=1}^{S} N_k^s\, \frac{sp_k^s}{2} + \sum_{i=1}^{B} N_i^b\, \frac{sp_i^b}{2} \right)}{\sum_{i=1}^{B} N_i^b\, v_i^b\, \left(N_i^b\, v_i^b + N_i^b\, m_i^b \right)}}_{\substack{spread \\ component}},
\end{aligned}
\tag{13}
$$

where N_i^b is the number of warrants or certificates bought at B points in time t_i. N_k^s is the number of warrants or certificates at S points in time t_k. v_i^b and v_k^s are the respective fair purchase and sales values and m_i^b and m_k^s are the markups set by the issuer on the respective fair purchase and sales values. The realized prices, $p_i^b = v_i^b + m_i^b$ and $p_k^s = v_k^s + m_k^s$, consist of a combination of the fair values and the respective markups. Finally, $m_i^{*b} = m_i^b - \frac{sp_i^b}{2}$ and $m_k^{*s} = m_k^s + \frac{sp_k^s}{2}$ are the spread-adjusted markups and sp_i^b and sp_k^s the respective bid/ask spreads.

Appendix B Sensitivities

Figure 2 shows the results of our sensitivity analysis. It reports changes in the value (solid lines) of a call warrant[20] and a long certificate as well as in their respective underlying and volatility exposures (dashed lines) due to changes in the moneyness and the volatility.

[Figure 2 about here.]

The respective values are calculated using the standard Black and Scholes (1973) model for warrants and the well-known analytical solution for down-and-out calls and up-and-out puts (Rubinstein and Reiner, 1991) for long and short leverage certificates. The moneyness in t for call warrants and long certificates is defined as the fraction of the underlying price in t and the strike (that equals the barrier in the case of leverage certificates) S_t/X. For put warrants and short certificates we define the moneyness by X/S_t. Panels A and B report the sensitivities for a remaining time to maturity T of 30 days, or of three days.

Panel A illustrates the non-linear positive dependence of the value of a warrant with the underlying price. The underlying exposure of warrants decreases slightly with the moneyness. In contrast, for leverage certificates this panel reports that the value of the certificate is approximately linear with the underlying price. Further, the underlying exposure goes to infinity as the moneyness approaches one, i.e., when the certificate is close to knock-out.

Panel A also reports a strong positive dependence between the value and the volatility exposure of classical warrants. This well-known relation is mainly driven by the asymmetric payoff profile of warrants. Although leverage certificates have the same payoff structure at maturity as classical warrants, both the value and the exposure for leverage certificates are almost indifferent to changes in the volatility. In contrast to classical warrants, the risk of

[20] In this numerical exercise we assume a dividend yield of zero. This implies that the value of European and American call warrants coincide.

a premature knock-out for leverage certificates increases with the volatility of the underlying, and so offsets the positive influence of the asymmetric payoff profile. Banks often argue that leverage certificates can be seen as "delta-one" products, i.e., products which constantly have a delta of one, with no sensitivity to volatility. Therefore, many banks promote them as "simpler substitutes" for warrants.

Panel B reports the same sensitivity analysis as panel A for a shorter remaining time to maturity $T = 3$ days. For leverage certificates the impact is not perceptible. However, classical warrants show a significant impact with regard to the remaining time to maturity. The sensitivities become strongly similar to the ones of a leverage certificate for a decreasing time to maturity. A shorter time to maturity increases the probability that a drop in the underlying will result in a negative inner value at maturity and thus corresponds with an implicit knock-out feature.

The relations for put warrants and short leverage certificates are analogous. The value and the volatility exposure for a put warrant increase with the volatility, while short leverage certificates are almost independent of these changes. Also with regard to changes in the moneyness, except for a negative relation, short positions show the same characteristics as long positions.

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Figures

Figure 1: Gross Relative Returns with and without Bid/Ask Spread: Classical Warrants vs. Leverage Certificates.

The figure reports the distribution of the average performance according to Eq. (5) and Eq. (6) depending on the acquired DAX exposure. The DAX exposures for the point in time of the first purchase of a round-trip are separated into 20 different quantiles. The upper figures (N = 53,919) show the mean gross relative returns GRR and GRR^{+} per quantile of call and put warrants separately. The lower figures (N = 139,330) show the same for long and short certificates. Solid bars show means that are at the 1% level significantly different from zero.

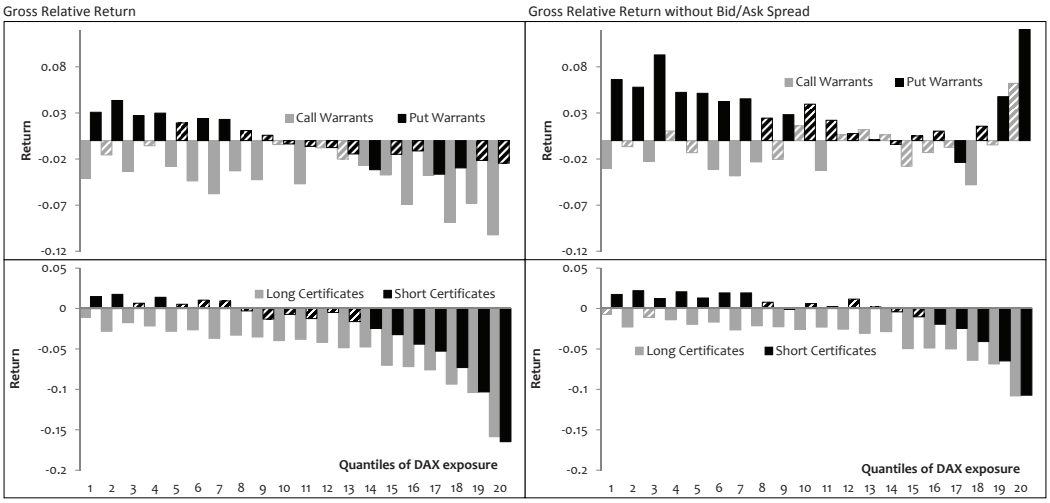
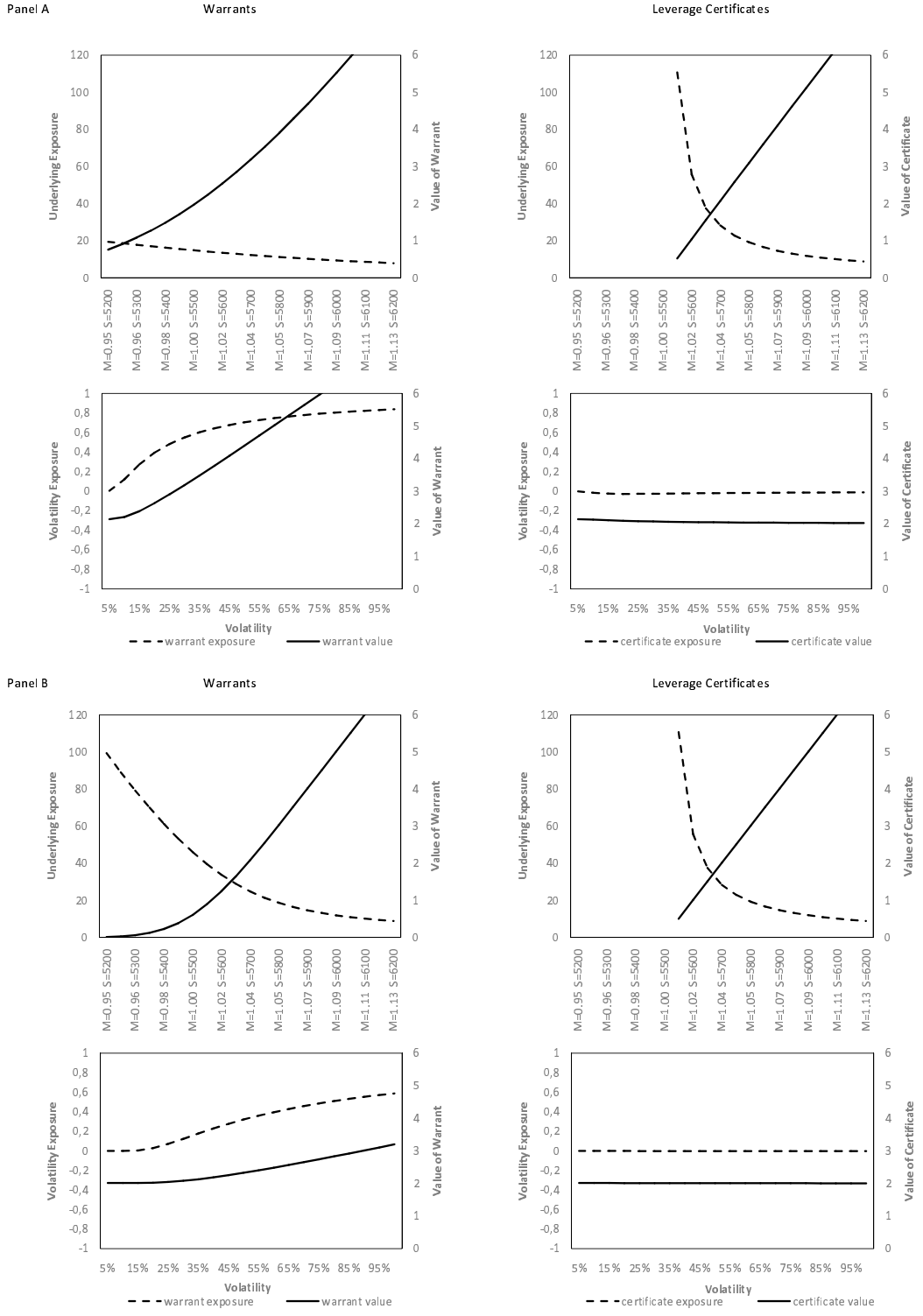


Figure 2: Sensitivities: Classical Warrants vs. Leverage Certificates.
The figure reports the different sensitivities for call warrants and long leverage certificates with a remaining time to maturity T of 30 days (panel A) and three days (panel B). Within each panel we show the sensitivities with regard to changes in the underlying price and therefore the moneyness (upper figures) and in the volatility (lower figures). The moneyness (M) is defined as $S/Strike$. The values of the products (given in euro) are indicated by solid lines and the exposure measures are indicated by dashed lines. The initial parameters are: Risk-free rate $r_f = 3\%$, strike X $(=B) = 5{,}500$, dividend yield $q = 0$; volatility $\sigma = 0.3$ for the upper figures and price of the underlying $S = 5{,}700$ for the lower figures within each panel.



Tables

Table 1: Traded Warrants and Leverage Certificates

Panel A: Warrants

Quarter	MaT		T_{Trade}		$N_{Transaction}$		V_{traded}		P_{traded}		**Long**	**N**
Bought	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Sum
Q2-2007	0.9574	0.9739	127	69	11.0	3	5,979	1,709	2.03	1.20	0.586	14,105
Q3-2007	0.9651	0.9882	76	29	14.9	3	4,957	3,471	1.91	1.57	0.442	20,050
Q4-2007	0.9647	0.9891	85	37	9.6	2	4,098	2,907	1.74	1.32	0.517	9,826
Q1-2008	0.9382	0.9587	113	57	8.4	3	3,663	1,337	2.06	1.24	0.525	9,900
Q2-2008	0.9647	0.9840	97	28	8.7	2	4,316	1,559	1.74	1.12	0.473	7,176
Q3-2008	0.9690	0.9800	77	34	12.7	2	4,481	1,607	1.70	0.99	0.413	10,453
Q4-2008	0.9049	0.9192	100	54	10.4	3	3,640	1,463	2.55	1.40	0.508	10,507
Total	0.9532	0.9775	96	44	11.0	3	4,588	2,003	1.97	1.32	0.495	82,017
Sold												
Q2-2007	0.9618	0.9768	116	61	9.2	3	7,639	1,943	1.99	1.19	0.600	10,677
Q3-2007	0.9665	0.9880	73	28	11.7	3	6,630	3,435	1.89	1.50	0.445	14,992
Q4-2007	0.9673	0.9898	72	30	7.8	2	4,771	3,155	1.61	1.28	0.487	8,254
Q1-2008	0.9469	0.9646	102	51	7.2	3	4,294	1,553	2.11	1.27	0.490	8,305
Q2-2008	0.9697	0.9864	79	23	7.1	2	4,863	1,694	1.69	1.05	0.468	6,220
Q3-2008	0.9740	0.9846	77	33	10.9	2	5,087	1,901	1.82	1.07	0.387	9,254
Q4-2008	0.9051	0.9227	95	50	7.7	2	4,352	1,741	2.62	1.41	0.503	8,891
Total	0.9565	0.9798	87	38	8.9	2	5,586	2,138	1.97	1.28	0.483	66,593

Panel B: Leverage Certificates

Quarter	MaT		T_{Trade}		$N_{Transaction}$		V_{traded}		P_{traded}		**Long**	**N**
Bought	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Sum
Q2-2007	1.0190	1.0136	52	33	24.5	7	2,850	1,109	1.49	1.18	0.526	28,915
Q3-2007	1.0200	1.0147	42	33	22.9	7	3,209	1,195	1.66	1.30	0.498	30,456
Q4-2007	1.0161	1.0116	40	30	18.8	5	2,758	1,089	1.41	1.09	0.538	20,056
Q1-2008	1.0270	1.0191	46	35	21.3	5	2,885	1,127	1.99	1.50	0.496	25,093
Q2-2008	1.0266	1.0175	53	35	23.4	6	3,175	1,295	1.90	1.34	0.468	23,983
Q3-2008	1.0317	1.0223	54	35	22.7	5	4,112	1,247	2.06	1.53	0.428	24,203
Q4-2008	1.0665	1.0469	44	35	20.8	5	4,055	1,352	3.31	2.53	0.420	25,278
Total	1.0295	1.0179	47	34	22.1	6	3,293	1,199	1.97	1.43	0.482	177,984
Sold												
Q2-2007	1.0189	1.0135	51	33	21.7	6	3,134	1,143	1.43	1.14	0.527	25,419
Q3-2007	1.0198	1.0145	41	32	20.8	6	3,423	1,161	1.58	1.24	0.502	27,475
Q4-2007	1.0162	1.0117	39	30	17.2	5	2,901	1,074	1.36	1.04	0.537	18,366
Q1-2008	1.0270	1.0191	46	34	19.2	5	3,090	1,111	1.91	1.44	0.497	22,641
Q2-2008	1.0267	1.0174	51	34	20.6	5	3,529	1,344	1.87	1.31	0.473	21,334
Q3-2008	1.0320	1.0224	53	34	20.4	5	4,534	1,295	2.02	1.50	0.429	21,754
Q4-2008	1.0675	1.0476	43	34	18.8	4	4,429	1,405	3.26	2.50	0.425	22,860
Total	1.0297	1.0178	46	33	19.8	5	3,579	1,211	1.92	1.38	0.484	159,849

This table reports summary statistics on the dataset for our observation period from April 2007 to December 2008. The moneyness at trade MaT is defined as $Underlying/Strike$ for long and $Strike/Underlying$ for short positions where the underlying is the DAX (during its opening hours) or the X-DAX (beyond the opening hours of the DAX) taken at the time of the transaction. The remaining time to maturity at trade T_{Trade} is given in calendar days. The long-ratio is the number of call warrants (long certificates) in relation to the number of all warrants (certificates) traded. The traded price P_{traded} per product type and transaction is net of fees in EUR and traded volume V_{traded} is the transaction volume of each transaction in EUR. N denotes the number of transactions. Results are shown for buying (bought) transactions and transactions which have either been sold or held until maturity (sold) separately.

Table 2: Summary Statistics on Investor Base

			Panel A: Warrants			Panel B: Leverage Certificates		
	%	N	Ø Number of Trades	Ø Buy Volume	Ø Sell Volume	Ø Number of Trades	Ø Buy Volume	Ø Sell Volume
Gender								
Male	87.66	2,658	44	2,270	2,617	111	2,117	2,178
Female	11.81	358	82	2,518	2,564	108	1,765	1,796
n/a	0.53	16	133	5,859	6,238	232	5,479	5,691
Age								
0 to 25 year	5.61	170	22	1,570	1,627	49	1,196	1,124
26 to 40 years	35.82	1,086	59	2,180	2,495	100	2,070	2,077
41 to 55 years	39.91	1,210	41	2,364	2,700	120	2,191	2,326
56 to 100 years	18.67	566	55	2,713	3,043	136	2,198	2,235
Doctoral degree								
Doctorate or professorship	3.69	112	43	3,405	3,970	97	3,824	4,163
No doctorate	96.31	2,920	49	2,277	2,578	112	2,027	2,077
Retired								
Retired	2.01	61	48	2,949	3,290	160	2,765	2,795
Not retired	97.99	2,971	49	2,306	2,617	111	2,079	2,139
Marrital status								
Married	37.43	1,135	42	2,289	2,559	104	2,191	2,264
Not married	62.57	1,897	53	2,336	2,673	116	2,034	2,085
Finance professional								
Professional	4.58	139	59	2,594	3,221	146	1,977	2,184
Not professional	95.42	2,893	49	2,305	2,602	110	2,098	2,150
Income								
<25,000€	14.64	444	28	1,649	1,789	80	1,435	1,442
25,000€ to 75,000€	34.76	1,054	48	2,023	2,323	108	1,757	1,748
>75,000€	4.95	150	65	2,903	3,487	163	3,832	4,542
n/a	45.65	1,384	54	2,695	3,043	119	2,371	2,431
Experience								
0 to 1 year	13.03	395	48	1,954	2,113	98	1,623	1,669
1 to 5 years	22.10	670	49	2,414	2,723	119	2,044	2,117
5 to 10 years	49.64	1,505	50	2,184	2,458	111	2,052	2,161
More than 10 years	15.24	462	45	2,929	3,495	112	2,698	2,590
Total	100.00	3,032	49	2,319	2,630	111	2,093	2,152

This table exhibits information on personal characteristics of all 3,032 individual investors in our data sample. Investors are clustered according to their gender, age, doctorate or professorship, retirement, marital status, finance professional, income and experience. The average experience per investor is calculated as the average of the difference between each trade and the opening date of the brokerage account. The age is that at the beginning of the observation period. The average number of trades are the buy and sell trades per investor in warrants or leverage certificates during the observation period and the buy and sell volume in € is the average volume per trade.

Table 3: Returns

	Median	Mean	Std.Dev.
All Warrants (N = 53,919)			
GRR: Gross relative return per round-trip	0.91 %	-1.91 %***	0.33
GRR^{+}: Gross relative return per round-trip w/o bid/ask spread	1.83 %	-0.11 %	0.34
NRR: Net relative return per round-trip	0.47 %	-3.82 %***	0.33
$CWGRR$: Capital-weighted gross relative return per round-trip	0.33 %	-0.99 %***	0.22
$CWNRR$: Capital-weighted net relative return per round-trip	0.22 %	-1.46 %***	0.22
Call Warrants (N = 25,948)			
GRR: Gross relative return per round-trip	0.94 %	-4.03 %***	0.35
GRR^{+}: Gross relative return per round-trip w/o bid/ask spread	1.95 %	-1.99 %***	0.36
NRR: Net relative return per round-trip	0.50 %	-5.95 %***	0.34
$CWGRR$: Capital-weighted gross relative return per round-trip	0.26 %	-1.86 %***	0.23
$CWNRR$: Capital-weighted net relative return per round-trip	0.19 %	-2.28 %***	0.23
Put Warrants (N = 27,971)			
GRR: Gross relative return per round-trip	0.89 %	0.06 %	0.31
GRR^{+}: Gross relative return per round-trip w/o bid/ask spread	1.75 %	1.63 %***	0.32
NRR: Net relative return per round-trip	0.45 %	-1.85 %***	0.31
$CWGRR$: Capital-weighted gross relative return per round-trip	0.38 %	-0.20 %	0.21
$CWNRR$: Capital-weighted net relative return per round-trip	0.24 %	-0.70 %*	0.22

	Median	Mean	Std.Dev.
All Leverage Certificates (N = 139,330)			
GRR: Gross relative return per round-trip	1.92 %	-3.72 %***	0.38
GRR^{+}: Gross relative return per round-trip w/o bid/ask spread	3.17 %	-1.97 %***	0.39
NRR: Net relative return per round-trip	1.00 %	-5.93 %***	0.37
$CWGRR$: Capital-weighted gross relative return per round-trip	1.84 %	-2.07 %***	0.27
$CWNRR$: Capital-weighted net relative return per round-trip	1.59 %	-2.53 %***	0.27
Long Leverage Certificates (N = 67,927)			
GRR: Gross relative return per round-trip	1.78 %	-5.14 %***	0.39
GRR^{+}: Gross relative return per round-trip w/o bid/ask spread	3.03 %	-3.42 %***	0.40
NRR: Net relative return per round-trip	0.88 %	-7.26 %***	0.38
$CWGRR$: Capital-weighted gross relative return per round-trip	1.31 %	-3.27 %***	0.28
$CWNRR$: Capital-weighted net relative return per round-trip	1.02 %	-3.77 %***	0.28
Short Leverage Certificates (N = 71,403)			
GRR: Gross relative return per round-trip	2.08 %	-2.37 %***	0.37
GRR^{+}: Gross relative return per round-trip w/o bid/ask spread	3.30 %	-0.59 %***	0.38
NRR: Net relative return per round-trip	1.11 %	-4.66 %***	0.36
$CWGRR$: Capital-weighted gross relative return per round-trip	2.11 %	-1.13 %***	0.25
$CWNRR$: Capital-weighted net relative return per round-trip	1.97 %	-1.56 %***	0.25

This table reports the mean, median and standard deviation for five different return measures, separately listing certificates and warrants. The gross relative return (GRR) neglects any transaction fees other than the bid/ask spreads already included in the purchase and sales price. The GRR^{+} is the GRR adjusted for the bid/ask spreads. The net relative return (NRR) explicitly takes all additional transaction fees into account. The $CWGRR$ and the $CWNRR$ are the capital-weighted statistics for the gross and net relative returns. ***/**/* denote significance at the 1%/5%/10% level.

Table 4: Components of the Return

	Median	Mean	Std.Dev.
All Warrants (N = 53,919)			
GRR: Gross relative return per round-trip	0.91 %	-1.91 %***	0.33
FR: Fair value return	1.00 %	2.77 %***	1.07
MR: Markup return	-0.02 %	-3.28 %***	0.93
MCR: Markup change return	0.40 %	0.69 %***	0.23
SR: Spread return	-0.89 %	-2.09 %***	0.10
Call Warrants (N = 25,948)			
GRR: Gross relative return per round-trip	0.94 %	-4.03 %***	0.35
FR: Fair value return	1.01 %	0.38 %	0.53
MR: Markup return	-0.01 %	-2.95 %***	0.35
MCR: Markup change return	0.31 %	0.87 %***	0.26
SR: Spread return	-1.04 %	-2.33 %***	0.05
Put Warrants (N = 27,971)			
GRR: Gross relative return per round-trip	0.89 %	0.06 %	0.31
FR: Fair value return	0.99 %	4.98 %***	1.40
MR: Markup return	-0.03 %	-3.59 %***	1.24
MCR: Markup change return	0.46 %	0.53 %***	0.19
SR: Spread return	-0.79 %	-1.86 %***	0.12
	Median	Mean	Std.Dev.
All Leverage Certificates (N = 139,330)			
GRR: Gross relative return per round-trip	1.92 %	-3.72 %***	0.38
FR: Fair value return	2.93 %	0.88 %*	1.33
MR: Markup return	-0.22 %	-1.34 %***	0.62
MCR: Markup change return	-0.08 %	-1.25 %***	1.17
SR: Spread return	-1.39 %	-2.01 %***	0.30
Long Leverage Certificates (N = 67,927)			
GRR: Gross relative return per round-trip	1.78 %	-5.14 %***	0.39
FR: Fair value return	2.72 %	-0.75 %**	0.65
MR: Markup return	-0.23 %	-1.30 %***	0.49
MCR: Markup change return	-0.09 %	-1.19 %***	0.34
SR: Spread return	-1.41 %	-1.90 %***	0.03
Short Leverage Certificates (N = 71,403)			
GRR: Gross relative return per round-trip	2.08 %	-2.37 %***	0.37
FR: Fair value return	3.13 %	2.44 %***	1.75
MR: Markup return	-0.21 %	-1.38 %***	0.73
MCR: Markup change return	-0.07 %	-1.31 %*	1.60
SR: Spread return	-1.37 %	-2.11 %***	0.41

This table reports the mean, median and standard deviation for the gross relative return (GRR) and the four return components according to Eq. (14). The fair value return is the return induced by a change in the fair value of the product, the markup return results from the general overpricing level, the markup change return is induced by the divergence of the markup over time and the spread return is the effect of the spread-setting behavior of the issuer. All results are shown separately for long and short warrants and leverage certificates. ***/**/* denote significance at the 1%/5%/10% level.

Table 5: Components of the Return by Market Phase

	Increasing DAX			Decreasing DAX		
	Median	Mean	Std.Dev.	Median	Mean	Std.Dev.
All Warrants (N = 53,919)		(N = 26,797)			(N = 27,122)	
GRR: Gross relative return per round-trip	0.69 %	-1.79 %***	0.31	1.13 %	-2.02 %***	0.35
FR: Fair value return	0.71 %	3.22 %***	1.13	1.26 %	2.33 %***	1.02
MR: Markup return	0.01 %	-1.91 %***	0.95	-0.10 %	-4.64 %***	0.91
MCR: Markup change return	0.19 %	-0.89 %***	0.22	0.60 %	2.25 %***	0.24
SR: Spread return	-0.94 %	-2.21 %***	0.10	-0.85 %	-1.97 %***	0.09
Call Warrants (N = 25,948)		(N = 16,485)			(N = 9,463)	
GRR: Gross relative return per round-trip	4.31 %	9.22 %***	0.27	-12.00 %	-27.11 %***	0.35
FR: Fair value return	5.74 %	16.71 %***	0.54	-12.19 %	-28.07 %***	0.38
MR: Markup return	-0.03 %	-4.40 %***	0.38	0.01 %	-0.44 %	0.28
MCR: Markup change return	0.16 %	-0.43 %*	0.23	0.68 %	3.13 %***	0.31
SR: Spread return	-1.20 %	-2.67 %***	0.06	-0.80 %	-1.73 %***	0.03
Put Warrants (N = 27,971)		(N = 10,312)			(N = 17,659)	
GRR: Gross relative return per round-trip	-6.67 %	-19.39 %***	0.28	4.35 %	11.42 %***	0.27
FR: Fair value return	-6.51 %	-18.36 %***	1.66	5.50 %	18.62 %***	1.20
MR: Markup return	0.16 %	2.06 %	1.45	-0.23 %	-6.88 %***	1.11
MCR: Markup change return	0.25 %	-1.62 %***	0.20	0.57 %	1.78 %***	0.19
SR: Spread return	-0.69 %	-1.46 %***	0.15	-0.87 %	-2.09 %***	0.10
	Median	Mean	Std.Dev.	Median	Mean	Std.Dev.
All Leverage Certificates (N = 139,330)		(N = 68,362)			(N = 70,968)	
GRR: Gross relative return per round-trip	1.69 %	-3.58 %***	0.37	2.14 %	-3.85 %***	0.39
FR: Fair value return	2.61 %	0.89 %***	0.63	3.22 %	0.88 %	1.76
MR: Markup return	-0.22 %	-1.83 %***	0.69	-0.22 %	-0.87 %***	0.55
MCR: Markup change return	-0.03 %	-0.69 %**	0.60	-0.12 %	-1.79 %**	1.53
SR: Spread return	-1.44 %	-1.95 %***	0.03	-1.35 %	-2.06 %***	0.41
Long Leverage Certificates (N = 67,927)		(N = 39,063)			(N = 28,864)	
GRR: Gross relative return per round-trip	8.45 %	16.64 %***	0.25	-21.88 %	-34.61 %***	0.35
FR: Fair value return	12.56 %	27.80 %***	0.66	-25.72 %	-39.38 %***	0.36
MR: Markup return	-1.58 %	-8.17 %***	0.52	3.56 %	8.00 %***	0.43
MCR: Markup change return	-0.04 %	-0.84 %***	0.23	-0.19 %	-1.66 %***	0.44
SR: Spread return	-1.54 %	-2.15 %***	0.04	-1.27 %	-1.57 %***	0.01
Short Leverage Certificates (N = 71,403)		(N = 29,299)			(N = 42,104)	
GRR: Gross relative return per round-trip	-18.67 %	-30.54 %***	0.33	8.55 %	17.24 %***	0.26
FR: Fair value return	-21.30 %	-34.98 %***	0.34	12.60 %	28.48 %***	2.23
MR: Markup return	2.58 %	6.63 %***	0.86	-1.38 %	-6.96 %***	0.61
MCR: Markup change return	-0.01 %	-0.49 %	0.87	-0.09 %	-1.88 %*	1.95
SR: Spread return	-1.30 %	-1.69 %***	0.02	-1.43 %	-2.40 %***	0.54

This table reports the mean, median and standard deviation for the gross relative return (GRR) and the four return components according to Eq. (14). The fair value return is the return induced by a change in the fair value of the product, the markup return results from the general overpricing level, the markup change return is induced by the divergence of the markup over time and the spread return is the effect of the spread-setting behavior of the issuer. All results are shown separately for long and short warrants and leverage certificates and increasing and decreasing DAX developments. ***/**/* denote significance at the 1%/5%/10% level.

Table 6: Randomized Returns

	Median	Mean		N
DAX (Leverage Certificates)				
Exact dates	0.06 %	0.01 %**		139,799
Daily holding period	0.00 %	-0.01 %		136,285
Same holding period	0.00 %	0.00 %		137,050
Random holding period	0.00 %	0.00 %		136,834
DAX (Warrants)				
Exact dates	0.09 %	0.01 %		54,102
Daily holding period	0.00 %	0.00 %		50,715
Same holding period	0.00 %	0.00 %		51,494
Random holding period	0.00 %	0.00 %		49,360
	Median	Mean	Mean comparison test t-value	N
Leverage Certificates				
Daily holding period	0.00 %	1.59 %***	-1.73880	127,104
Same holding period	0.00 %	0.59 %***	0.78580	133,451
Random holding period	0.00 %	0.12 %	2.00770 *	132,454
Warrants				
Daily holding period	0.00 %	2.35 %***	0.85820	50,553
Same holding period	0.07 %	2.05 %***	1.44970	51,318
Random holding period	0.06 %	2.17 %***	1.23080	49,185

This table reports the mean, median, number of observations and, for leverage certificates and warrants, the mean comparison test statistic with respect to the fair value return from Table 4 for different randomized return measures, separated for leverage certificates and warrants and the DAX. First, we calculate the DAX returns at the exact purchase and selling times as in the dataset. Second, for warrants and leverage certificates the time of each purchase is chosen randomly from the time period of the dataset. We use the same moneyness as in the original observation and calculate an implicit strike. Then we evaluate the products and measure the fair value returns for a holding period of one day, the same holding period from the dataset and a random holding period from the distribution of the dataset. We also calculate DAX returns for randomized purchase times and respective holding periods. ***/**/* denote significance at the 1%/5%/10% level.

Table 7: Acquired DAX and Volatility Exposure

	DAX Exposure				Volatility Exposure				N
Quarter	P25	Mean	Median	P75	P25	Mean	Median	P75	Sum
Panel A: Warrants									
Call Warrants									
Q2-2007	11.89	24.88	18.94	29.38	0.84	1.57	1.31	2.05	8,259
Q3-2007	14.84	25.99	20.56	28.67	1.03	1.86	1.32	2.47	8,861
Q4-2007	13.03	28.39	20.35	34.61	1.00	1.72	1.35	2.08	5,083
Q1-2008	11.87	25.26	18.56	31.07	1.29	2.65	2.19	3.60	5,193
Q2-2008	12.37	27.90	20.91	35.13	1.06	1.78	1.55	2.15	3,394
Q3-2008	14.99	34.11	24.54	45.21	1.27	2.29	2.04	2.90	4,320
Q4-2008	9.48	21.41	14.86	25.02	1.65	3.66	3.03	4.76	5,340
Total	12.61	26.39	19.76	31.26	1.07	2.16	1.63	2.75	40,450
Put Warrants									
Q2-2007	-36.27	-28.73	-20.10	-12.09	1.34	2.49	1.95	3.07	5,846
Q3-2007	-28.10	-24.19	-18.72	-11.98	0.95	1.66	1.23	1.90	11,189
Q4-2007	-37.41	-29.88	-23.62	-14.49	0.85	1.62	1.20	1.87	4,743
Q1-2008	-26.65	-21.74	-14.36	-9.02	0.96	2.13	1.53	2.63	4,707
Q2-2008	-32.90	-27.15	-21.73	-11.33	0.83	1.63	1.31	1.96	3,782
Q3-2008	-35.74	-26.77	-17.63	-10.05	0.88	1.73	1.35	2.08	6,133
Q4-2008	-16.51	-13.43	-9.45	-5.15	0.83	2.18	1.59	2.80	5,167
Total	-30.24	-24.51	-17.81	-10.30	0.95	1.90	1.40	2.29	41,567
Panel B: Leverage Certificates									
	DAX Exposure				**Volatility Exposure**				**N**
Quarter	P25	Mean	Median	P75	P25	Mean	Median	P75	Sum
Long Certificates									
Q2-2007	42.17	112.92	70.33	115.34	-0.07	-0.05	-0.05	-0.03	15,205
Q3-2007	44.53	126.75	74.28	130.37	-0.07	-0.05	-0.05	-0.04	15,164
Q4-2007	54.67	145.98	90.87	160.64	-0.08	-0.06	-0.06	-0.04	10,786
Q1-2008	35.87	126.84	63.29	122.44	-0.07	-0.05	-0.05	-0.03	12,458
Q2-2008	35.73	119.89	63.60	110.83	-0.07	-0.05	-0.05	-0.03	11,234
Q3-2008	31.22	93.23	53.06	91.36	-0.07	-0.05	-0.05	-0.03	10,368
Q4-2008	14.56	51.75	25.65	47.99	-0.03	-0.02	-0.02	-0.01	10,627
Total	34.62	112.50	63.12	112.93	-0.07	-0.05	-0.05	-0.03	85,842
Short Certificates									
Q2-2007	-140.30	-129.63	-78.87	-47.00	0.08	0.13	0.12	0.18	13,710
Q3-2007	-112.53	-107.71	-62.10	-35.19	0.06	0.08	0.08	0.11	15,292
Q4-2007	-149.83	-135.14	-80.49	-43.60	0.06	0.09	0.08	0.12	9,270
Q1-2008	-79.81	-82.86	-44.66	-26.17	0.04	0.07	0.07	0.10	12,635
Q2-2008	-97.66	-96.11	-51.56	-28.10	0.05	0.09	0.08	0.12	12,749
Q3-2008	-72.55	-78.85	-40.01	-22.87	0.04	0.08	0.07	0.11	13,835
Q4-2008	-35.77	-48.14	-19.24	-11.34	0.01	0.03	0.02	0.03	14,651
Total	-96.14	-94.91	-49.35	-25.51	0.04	0.08	0.07	0.11	92,142

This table reports the DAX and volatility exposure for the different quarters within our trade dataset. P25 and P75 denote the lower and upper quartile, respectively. Results are shown for long positions (i.e., call warrants or long certificates) and short positions (i.e., put warrants or short certificates) separately.

Table 8: Investors' Characteristics and Risk Taking

	Panel A: Warrants	**Panel B: Leverage Certificates**
Intercept	2.92 ***	4.10 ***
Age		
26 to 40 years	0.02	-0.03
41 to 55 years	-0.08	-0.21 ***
>55 years	-0.11 *	-0.26 ***
Experience		
1 to 5 years	-0.06	-0.03
5 to 10 years	-0.10 **	-0.15 ***
>10 years	-0.18 ***	-0.27 ***
Others		
Male	0.01	0.11 *
Retired	-0.21 **	-0.24 *
Married	-0.07 ***	-0.07 *
Foreign	0.08	0.00
Academic title	-0.06	-0.05
Finance professional	0.08	-0.06
Income		
25,000€ to 75,000€	-0.05	0.00
>75,000€	-0.09	-0.18 *
n/a	-0.09 **	-0.10 *
R^2	3.03	3.37
N	3,032	3,032

This table exhibits results of a regression on individual risk taking in the form of the underlying exposure defined in Eq. (10). To eliminate the convex curvature of the risk measure, we take the logarithm of the DAX exposure as dependent variable and take the average for each investor. Age and experience are divided into 3 subgroups and income into 4 subgroups as in Section 3.2. We use dummies for male, retired, married, foreign born, persons with a doctorate or professorship and finance professionals. The regression is computed for warrants and leverage certificates separately. ***/**/* denote significance at the 1%/5%/10% level where t-statistics are derived from a robust estimate of the covariance matrix according to White (1980).

Table 9: Return Components by Exposure

Quartiles	Mean per Quartile of Exposure 1 (lowest)	2	3	4 (highest)
All Warrants (N = 53,919)				
GRR: Gross relative return per round-trip	0.90 %***	-1.68 %***	-1.97 %***	-4.88 %***
FR: Fair value return	2.31 %***	1.17 %***	2.61 %***	4.99 %***
MR: Markup return	-1.20 %***	-2.53 %***	-3.19 %***	-6.22 %***
MCR: Markup change return	0.55 %***	0.94 %***	0.53 %***	0.74 %***
SR: Spread return	-0.77 %***	-1.26 %***	-1.92 %***	-4.39 %***
Call Warrants (N = 25,948)				
GRR: Gross relative return per round-trip	-2.45 %***	-3.61 %***	-2.76 %***	-7.30 %***
FR: Fair value return	-1.10 %***	-1.23 %**	1.36 %**	2.50 %**
MR: Markup return	-1.15 %***	-2.00 %***	-2.63 %***	-6.03 %***
MCR: Markup change return	0.60 %***	1.10 %***	0.79 %**	0.98 %**
SR: Spread return	-0.80 %***	-1.48 %***	-2.28 %***	-4.75 %***
Put Warrants (N = 27,971)				
GRR: Gross relative return per round-trip	3.01 %***	1.20 %***	-1.49 %***	-2.46 %***
FR: Fair value return	4.21 %***	4.52 %***	4.11 %**	7.10 %**
MR: Markup return	-1.14 %***	-2.81 %***	-4.20 %***	-6.21 %**
MCR: Markup change return	0.70 %***	0.56 %***	0.18 %	0.67 %**
SR: Spread return	-0.77 %***	-1.07 %***	-1.58 %***	-4.02 %***

Quartiles	1 (lowest)	2	3	4 (highest)
All Leverage Certificates (N = 139,330)				
GRR: Gross relative return per round-trip	-0.07 %	-1.82 %***	-3.42 %***	-9.56 %***
FR: Fair value return	0.52 %***	-0.41 %**	-0.88 %***	4.32 %***
MR: Markup return	-0.04 %	-0.08 %**	-0.38 %***	-4.87 %***
MCR: Markup change return	0.04 %	-0.16 %***	-0.28 %*	-4.61 %***
SR: Spread return	-0.60 %***	-1.16 %***	-1.87 %***	-4.40 %***
Long Leverage Certificates (N = 67,927)				
GRR: Gross relative return per round-trip	-2.12 %***	-3.42 %***	-4.93 %***	-10.08 %***
FR: Fair value return	-1.50 %***	-1.99 %***	-2.68 %***	3.18 %***
MR: Markup return	-0.01 %	0.14 %**	-0.48 %	-4.83 %***
MCR: Markup change return	0.04 %	-0.37 %***	0.08 %	-4.51 %***
SR: Spread return	-0.65 %***	-1.20 %***	-1.85 %***	-3.92 %***
Short Leverage Certificates (N = 71,403)				
GRR: Gross relative return per round-trip	1.16 %***	-0.07 %	-1.80 %***	-8.76 %***
FR: Fair value return	1.72 %***	1.33 %***	0.92 %***	5.79 %**
MR: Markup return	0.00 %	-0.30 %***	-0.44 %***	-4.80 %***
MCR: Markup change return	0.00 %	0.02 %	-0.39 %***	-4.88 %**
SR: Spread return	-0.55 %***	-1.12 %***	-1.88 %***	-4.87 %***

This table reports the mean, median and standard deviation for the gross relative return (GRR) and the four return components according to Eq. (14) for four different risk taking quantiles. Risk taking is measured by the DAX exposure of the first buying transaction in each round-trip. The fair value return is the return induced by a change in the fair value of the product, the markup return results from the general overpricing level, the markup change return is induced by the divergence of the markup over time and the spread return is the effect of the spread-setting behavior of the issuer. ***/**/* denote significance at the 1%/5%/10% level.

Table 10: Regression Results: Explaining Gross Relative Returns

Level of Experience	Low (1)	High (2)
DAX exposure × warrant	-0.00155 ***	-0.00033 **
DAX exposure × certificate	-0.00021 ***	-0.00011 **
Certificate dummy	-0.03149 ***	-0.01709 ***
Constant	0.00141	0.00581 *
Ancillary Statistics		
R^2	0.3000	0.2021
Number of quantiles	1,000	1,000
Number of round-trips	96,787	96,462
Warrant - mean DAX exposure per quantile	23.45	26.97
Certificate - mean DAX exposure per quantile	103.85	96.07
% of trades in certificates	72 %	72 %

This table reports the results of the regression of the gross relative returns (GRR). We form 500 quantiles according to the acquired DAX exposure for each product and calculate the mean DAX exposure and the mean relative return per quantile. The dependent variable is the mean return per quantile. The certificate dummy is one if the trade was performed with a certificate, otherwise zero. ***/**/* denote significance at the 1%/5%/10% level where t-statistics are derived from a robust estimate of the covariance matrix according to White (1980).

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