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Diskussionsbeitrag Nr. B-27-17

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Risk Taking in the Market of Speculative Exchange-Traded Retail Products: Do Socio-Economic Factors matter?*

S. Baller†

Abstract

When purchasing a financial product, investors may actively decide upon the risk they take. This paper analyzes the impact of investors' personal characteristics, location-based demographic factors and transaction-specific trading surroundings on their risk taking in the market of speculative exchange-traded retail products. Using a large trade dataset of warrants and leverage certificates on an individual investor level, I find evidence that risk taking behavior is strongly determined by the characteristics examined here: (i) Inexperienced young males with little secure status in their lives take more risk than other traders. (ii) Living in socially less desirable environments or encountering less risky trading conditions also supports risk taking. (iii) Risk taking is highly persistent. (iv) Finally, higher risk taking leads to poorer performance.

Keywords: Leverage Certificate; Warrant; Private Investor; Risk Taking; Performance; Socio-Economic Factors

JEL classification: D40, G11, G21, G24, Z10

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1 Introduction

When buying a financial product, investors may actively decide upon the risk they take. Until now, risk taking has been predominantly investigated in the stock market. However, a large number of retail investors tend to invest in high-risk products and accept amounts to smaller average returns for, in turn, very high but rare gains (e.g. Kumar, 2009). This preference for risky stock investments is usually attributed to a pure love of speculation (Shefrin and Statman, 2000; Barberis and Huang, 2008) and sensation-seeking or to the entertainment aspect of trading (Grinblatt and Keloharju, 2009; Dorn and Sengmueller, 2009), and holds also for the option market (Lakonishok et al., 2007; Bauer et al., 2009; Dorn, 2012).

The research literature focuses mainly on the results of risky trading behavior, e.g., in terms of performance, the risk taking itself being regarded as of only secondary interest: From such studies it is clear that retail investors who make riskier investments in the US stock market do indeed perform on average more poorly than other investors (Barber and Odean, 2000; Han and Kumar, 2013). Only a few authors have investigated the characteristics of risk-takers themselves: Kumar (2009) connects the risk taking behavior of investors on the US stock market to their socio-economic background and social status and finds that these have a significant influence. In particular poor, young and inexperienced, poorly educated, male, Catholic and single investors tend to take more risks and thus perform more poorly than other investors.[1] Moreover, people investing in the stock market are more attracted to taking risks for an improbable but large gain in times of poor economic opportunity (Kumar, 2009). Hence, influences such as residence in a region of higher unemployment, in an urban area or in one with a generally high level of acceptance of gambling (in the form of lotteries, for example) encourage risk taking in the individual trader (Kumar et al., 2011).

[1] See also Barber and Odean (2001), Goetzmann and Kumar (2008), Korniotis and Kumar (2011) and Kumar et al. (2011).

However, little is known about the risk taking of retail investors in the derivatives market, even though derivatives may expose the investor to higher risk than stocks. Indeed, Lakonishok et al. (2007) find that investors' motivation to trade options is mainly an attraction to gambling. A comparably young and unique possibility of becoming involved in high-risk investments is offered on the German market for speculative retail certificates, which has become one of the biggest of its kind during the last decade.[2] In fact, Schmitz and Weber (2012) neglect hedging as a possible reason for trading these products. This suggests that also in this market the key motive for investments is speculation. Retail investors are not only able to easily invest in the entire range of risk possible for one product group, but also to choose between a large variety of complex and highly leveraged product types. The purpose of this paper is to use this special environment for a broad analysis of such investors' risk taking behavior and the impact of socio-economic and market variables. Apart from studies applied to the US stock market (e.g. Kumar, 2009), a similar analysis has not until now — to the best of my knowledge — been performed. For the Dutch option market, Bauer et al. (2009) only hint at the effect of socio-economic characteristics on performance, but not on risk taking, and Baller et al. (2016) use socio-economic characteristics only as control variables for the market of short-term exchange-traded retail products.

For this analysis I focus on two different types of highly speculative, short-term retail products: Classical warrants, which are similar to options and already long-established in the market, and more innovative leverage certificates. Leverage certificates differ from warrants in that they possess an additional knock-out barrier, which enhances both, complexity and risk.[3]

I use a unique dataset of more than a million trades in warrants and leverage certificates

[2]The turnover on exchanges of such certificates on the German retail market rose to EUR 1.5 billion in December 2008 (warrants and knock-out products). See the website of the German Derivatives Association, available at www.deutscher-derivate-verband.de.

[3]Leverage certificates are a predominately European phenomenon. Products with similar features, such as contracts for difference, are also traded in other countries (see Brown et al., 2010).

on the German DAX index from 2006 until 2008, which allows me to discriminate between several investor groups and to analyze the risk taking behavior on a private investor level. The explanatory variables used include investors' personal characteristics, such as gender, age or income, and investor location-based factors, e.g. unemployment rate or population density, which are thought to have an impact on the risk taking decisions of investors. Moreover, I analyze how the direct circumstances of each trade, such as the trade volume of a transaction or the portfolio composition of investors, effect the risk taking. As a measure for investors' risk taking I use the sensitivity of the price with respect to the underlying (compare Baller et al., 2016).

The main findings are fourfold. First, personal characteristics of investors affect their risk taking behavior to a large degree. Similar to analyses in the stock market, I find evidence that the traders with the highest risk taking are indeed inexperienced young males with little secure status in their lives. Additionally, several investor groups show differences in their risk taking behavior regarding warrants and leverage certificates. Females and people who trade in both products tend to take more risk than other traders in the dataset when trading in warrants.

Second, investors in short-term retail certificates generally take more risk if they live in more undesirable environments, i.e. in regions with higher unemployment, less educational opportunity or less wealth. The characteristics of an investor's portfolio and the market situation also have significant influences on risk taking behavior. Traders take more risk in a less risky trading environment or if the possible losses are smaller or (potentially) limited.

Furthermore, investors are highly persistent in their behavior with regard to risk. The risk persistence is very similar for investors in warrants and leverage certificates and throughout investor subgroups. Regarding investor subgroups, traders who take more risk also tend to adapt their risk taking behavior more often than other investors, whereas older, more experienced and

wealthy traders are more tied to their behavior regarding risk.

Finally, to close the circle, I also analyze the results of risk taking. I find a clearly negative correlation between investors' performance and their acceptance of high risk taking. Thus, on the one hand, investors and also investor subgroups who take more risks also perform more poorly. However, on the other hand, it is only possible to get an extraordinary positive return by taking high risks, which leads to a U-shaped form of risk-performance relationship.

The remainder of this paper is structured as follows. Section 2 gives a detailed description of the products analyzed and outlines their assignment into risk categories. Detailed descriptive statistics on the investor base and the trade dataset are shown in Section 3. The empirical analysis in Section 4 is divided into three parts: Section 4.1 sketches the design of the empirical analysis and the variables used and provides the results of the risk regression analyses, Section 4.2 analyzes risk taking persistence and Section 4.3 draws the link between risk taking and performance. Finally, Section 5 concludes.

2 Product Design, Risk Taking and Measuring Performance

2.1 Market and Products

Germany is one of the biggest markets for speculative exchange-traded retail products, with more than 150,000 leveraged retail certificates, including warrants and leverage certificates, outstanding in December 2008 on the respective exchanges, which are the European Warrant Exchange (EUWAX) in Stuttgart and the WarrantsExchange Frankfurt.[4] In addition to these exchanges, such products can also be traded on the issuers' own trading platforms. Predominantly large investment banks offer a large variability of payoff structures that can be easily purchased by retail investors. Issuers function as market makers, quote continuously bid and ask prices and

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

act as the only counterparty once the product has been purchased. This market structure in combination with non-existing short-sellings[5] leads to an issuer-controlled price-setting.[6]

Even though it is possible to trade various underlying types, the most popular underlying for high-risk exchange-traded retail products in Germany is the DAX. Moreover, investors have the choice between a large number of products with different strikes and maturities. In this paper I concentrate on warrants and leverage certificates, which are comparatively similar products. Both can be traded at low cost, as the value is scaled normally to a customer-friendly level, i.e. 0.01 for plain-vanilla warrants and leverage certificates (conversion ratio).

Warrants are already long established and known products on the market. They are very similar to options and also appear in two versions: Long warrants gain in value if the underlying value increases and short warrants participate in a decrease of the underlying. About 95 % of the warrants analyzed here are American-style warrants, i.e. they may be exercised at any time before the expiration date, whereas European warrants may be exercised only at the expiration date of the warrant. The payoff at maturity T is given by:

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

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

where S_T denotes the price of the underlying at maturity T, X is the strike and c is the conversion ratio.

Leverage certificates can be seen as innovations of warrants. In fact, both product types have the same payoff at maturity. What differentiates them is a knock-out barrier inherited by

[5]Either explicit exchange rules (Stuttgart Stock Exchange, 2014, Section 53; Frankfurter Wertpapierbörse, 2013, Section 104), or physical limitations on the proprietary trading platforms prevent short-sellings.

[6]For a detailed description on the market environment see for example Baule (2011).

leverage certificates that is already defined at the purchase time of the product. If this knock-out barrier is touched or even overshot during the lifetime of the product, it becomes worthless immediately. Leverage certificates are basically identical to down-and-out calls (long position) and up-and-out-puts (short position). In this analysis I only concentrate on leverage certificates with a fixed maturity and equal strike price and barrier, i.e., $B = X$.[7] The payoff of a leverage certificate at maturity T is given by:

$$\begin{aligned} \text{Long Leverage certificate:} \quad LC_T^{long} &= c \max\left(S_T - X,\ 0\right) 1_{\left\{\tau^{long} > T\right\}} \qquad (3) \\ \text{with} \quad \tau^{long} &= \inf\left\{t > 0 : S_t \leq X\right\}, \\ \text{Short Leverage certificate:} \quad LC_T^{short} &= c \max\left(X - S_T,\ 0\right) 1_{\left\{\tau^{short} > T\right\}} \qquad (4) \\ \text{with} \quad \tau^{short} &= \inf\left\{t > 0 : X \leq S_t\right\}, \end{aligned}$$

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

2.2 Measuring Risk Taking

The value and the risk of leverage certificates are especially influenced by their knock-out characteristic and thus by the movement of the underlying. Also in the case of warrants, the underlying level is the important factor for the value and the risk of the product. Therefore I use the product's price elasticity with respect to changes in the underlying price (delta exposure) as used by Baller et al. (2016) to analyze the impact of a movement in the underlying on the product's value:

[7] For analyses on open-end leverage certificates see Entrop et al. (2009) and Rossetto and van Bommel (2009).

$$\text{Delta exposure } LP\text{: } EXP^S_{LP} = \frac{\frac{dLP_t}{LP_t}}{\frac{dS_t}{c\ S_t}} = \underbrace{\frac{dLP_t}{dS_t}}_{\text{Delta}} \underbrace{\frac{c\ S_t}{LP_t}}_{\text{Leverage}}, \tag{5}$$

where LP_t is the value of the considered leveraged product (LP), warrant or leverage certificate, and S_t is the value of the underlying at time t.[8] The delta exposure can be calculated as the delta of the product times its leverage.[9]

Figure 1 shows the delta exposure and the value of a call warrant (left) and of a long leverage certificate (right) in relation to the moneyness of the products. The moneyness is defined as S_t/X for long products and X/S_t for short products. The moneyness of leverage certificates always has to be larger than one, otherwise the underlying of the product moves beyond the barrier and the product is knocked out. For warrants however the moneyness is not limited by unity.

[Figure 1 about here.]

The relationships shown hold equally for short warrants and leverage certificates, with the only difference being that the value increases and the delta exposure decreases with decreasing values of the underlying. As already mentioned, warrants are less sensitive towards changes in the underlying than leverage certificates. The underlying exposure increases for decreasing levels of moneyness. The relation between the product value and the moneyness is the reverse. It increases with increasing moneyness and becomes higher, the more the underlying quotes in-the-money. The value of a long leverage certificate is a nearly linear function of the moneyness. Beginning at a very small certificate value, it increases with increasing moneyness. This linear

[8] Other variables considered as measures for the risk taking of investors are the moneyness and the price of the product at the time of the purchase. In general, the value and the moneyness are highly negatively correlated with the delta exposure. Thus, a small value and a small moneyness are an indicator for a higher willingness to take risk. Robustness checks with those two measures show similar results.

[9] The valuation is addressed in Section 2.4.

shape does not hold for the delta exposure. If the underlying approaches the barrier, the delta exposure increases towards infinity, as a small relative movement of the underlying might result in a complete loss. Here it becomes obvious that an investment in leverage certificates is far more risky than an investment in warrants. However, if the time to maturity decreases further, the graphs of warrants and leverage certificates become more and more similar, while they diverge more for increasing times to maturity.

I use the delta exposure as my main measure for the risk taking preference of the private investors in the dataset. More specifically, I take the logarithm of the delta exposure for all following calculations to scale, especially the large values of leverage certificates to a more practicable value.[10] Moreover, taking the logarithm causes a 'linearization' of the delta exposure values. The logarithm of the delta exposure behaves in a reverse direction to the value and also the moneyness of the products. Hence, a high delta exposure goes together with a high willingness to take risk, because the probability of a small loss is large, i.e. the knock-out or the general probability that the product is out-of-the-money at maturity is large. Moreover, the probability of a large gain is small and only possible if the product stays in-the-money, and the price is small. This is also consistent with Kumar (2009), who characterizes the speculative risk taking degree of investors in the stock market as the higher, the smaller the probability of a high gain, the larger the simultaneous probability of a small loss and the smaller the price.

2.3 Measuring Performance

To measure the performance of the investors in my dataset, I use the return of a round-trip in one specific product (Schmitz and Weber, 2012; Dorn, 2012; Baller et al., 2016). At the beginning and in the end of each round-trip, the investor's position in a warrant or a leverage certificate is always zero. As short-sellings do not exist in the market for speculative exchange-traded retail

[10]The only exception are the summary statistics in Table 1, as absolute values are easier to interpret.

products, the accumulated position during a round-trip always has to be strictly positive. A round-trip can either end through a sell or by the closure of the position by reaching maturity or by knocking out, if the product is a leverage certificate.[11]

More specifically, the gross relative return (GRR) is used as a measure of investors' performance:

$$GRR = \frac{\sum_{k=1}^{S} N_k^s \, p_k^s - \sum_{i=1}^{B} N_i^b \, p_i^b}{\sum_{i=1}^{B} N_i^b \, p_i^b}, \tag{6}$$

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. The respective purchase and sales prices are p_i^b and p_k^s.

By using the GRR, all transaction costs and also the bid/ask spreads are neglected in the purchase and sales price and thus the calculation of the return. Using alternative measures, i.e. including transaction costs or the bid/ask spread, leads to similar results.

2.4 Valuation

In order to calculate the delta exposure as described in Section 2.2, the fair value of every transaction in the dataset needs to be determined. To do so, I use the closed form solutions from Rubinstein and Reiner (1992) for down-and-out calls and up-and-out puts for the valuation of long and short leverage certificates, and I use the model from Black and Scholes (1973) for the valuation of call warrants. As the DAX is a performance index, dividend payments are neglected and only put warrant values and deltas need to be calculated via the Cox-Ross-Rubinstein Tree (Cox et al., 1979).

[11] I assume that the positions not closed at the end of our observation period in 2008 (295 for warrants and 185 for leverage certificates) have hypothetically been sold with a sales price equaling their respective quoted closing price according to the dataset at the last day.

For the calibration, I extract reasonable, implied volatilities for the analyzed products from options traded on the EUREX, which are assumed to be fairly priced.[12] Moreover, I apply the method published by Hentschel (2003), who uses the synthetic underlying level calculated by the Put-Call-Parity to extract the implied volatility and then interpolates two-dimensionally via strike and time to maturity.[13] As interest rate I take the (if necessary) interpolated Eurepo rate for times to maturity of less than one year and the spot rates estimated by the Deutsche Bundesbank from German governmental bonds for longer times to maturity. I utilize the DAX as underlying value; for trades beyond the trading times of the DAX, i.e. 9:00 a.m. until 5:30 p.m., the X-DAX, extracted from futures with the DAX as underlying, is used as a substitute. If the X-DAX does not match perfectly to the second, the values are again interpolated.

3 Dataset

3.1 Trade Data

The dataset originates from a large German online broker with several hundred thousand retail investors as customers. It consists of a total of 15,327 investors who traded (buys and sells) 318,991 times in warrants and 833,404 times in leverage certificates with the DAX as underlying, which comes to 118,011 and 357,046 round-trips respectively during the observation period from 1/2006 until 12/2008.[14] This observation period includes both downturn as well as rising market phases; the evolvement of the DAX during this time is shown in Figure 2.

[12] Index-options on the EUREX are European-style.

[13] Hentschel (2003) and Baule (2011) provide further information.

[14] In total, I eliminated 234,855 and 68,640 transactions in leverage certificates and warrants respectively including positions with a cover ratio different from 0.01, where the underlying level would have to be estimated via interpolation over a time interval larger than 15 seconds, where the accumulated position during a round-trip became negative or where inconsistencies during the valuation process occurred. Moreover, data on non-German residents is excluded, as no comparable information on location-based characteristics for these traders is available. Positions lacking location-based data are also excluded.

[Figure 2 about here.]

Summary statistics are shown for each quarter of the observation period and separately for warrants and leverage certificates in Table 1.

[Table 1 about here.]

During 2006 and 2007, the number of round-trips increased sharply, reaching a peak of 22,529 and 44,593 in Q3 2007 for warrants and leverage certificates, respectively. The number decreased again from this date onwards. This is consistent with the overall increasing popularity of the market of speculative short-term products for retail investors during these years and the following decrease due to the financial crisis.[15] The buy volume for warrants and the absolute delta exposure for both product groups also show this structure over time, whereas the buy volume of leverage certificates continuously increased throughout the whole observation period.[16] Moreover, the moneyness for both warrants and leverage certificates, increased in direction over the observation period. In general, the investors' risk taking increased over the first part of the dataset and investors traded less riskily throughout the last quarters of the dataset, which is consistent with the approaching economic crisis, i.e. high volatility in the market and the general downward sloping market conditions, as shown in Figure 2.

Each round-trip consists on average of 1.47 buys and 1.23 sells in warrants and 1.22 buys and 1.11 sells in leverage certificates. As these numbers are close to unity, investors seem to have sold the products immediately after purchase rather than increasing their position by buying again. This characteristic is more pronounced for leverage certificates and consistent with the observation that leverage certificates are traded much more often and have a much shorter holding period (Baller et al., 2016).

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

[16] The values of the first buy transactions in each round-trip are used for the calculation of both measures.

The fraction of limit orders in total trades is shown separately for buys and sells. Overall, 9.24 % of all sells and 6.43 % of all buys in warrants are limit orders. Leverage certificates were bought in 4.11 % of all purchases via a limit order, but in more than 1 out of 10 cases the products were sold by means of a limit order. For both warrants and leverage certificates, the number of limit orders in all buys or sells decreased, whereas it increased again slightly for warrants during the last quarters of the observation period. Especially during 2006, the investors of warrants used many more limit orders: Up to 25 % for sells and 20 % for buys.

The gross relative return increases for leverage certificates over time, whereas it remains negative on average. For warrants on the other hand, the GRR decreases over time. From Q3 2007 until Q2 2008 it even became negative. This effect is also present when controlling for the bid-ask-spread and after transaction costs (which are not shown here). Thus, on average, the investors lost 3.10 % when investing in leverage certificates and 0.57 % by investing in warrants. However, the median is slightly positive, i.e. 1.45 % for warrants and 2.08 % for leverage certificates. This implies that more than half of all trades resulted in a positive return for the investors, which may have enhanced their attraction.

3.2 Investor Data

The main focus of this paper is on individual investors' characteristics as linked to their risk taking behavior, this section therefore describes the investor base. Our dataset contains circa 1 million decisions made by 15,327 individual investors to acquire or sell one of the above-mentioned warrants or leverage certificates. Table 2 provides summary statistics on the investor base and their activities.

[Table 2 about here.]

Overall, the investor bases for warrants and for leverage certificates are similar. Male (87.37 % for warrants, 87.67 % for leverage certificates) and female (12.09 %, 11.78 %) investors regardless of age invested in warrants and leverage certificates. No information is available for the remaining percentage of investors. The average investor (not in the table) was 41.96 years (42.75, 41.31) old at the beginning of the observation period. Thus, investors in leverage certificates averaged about 1.5 years less in age than investors of warrants. Furthermore, the data exhibits that about 5.01 % (3.78 %) of investors in warrants (leverage certificates) hold a doctoral degree or professorship, 1.89 % (1.61 %) of investors are retired and 40.45 % (36.11 %) of investors are married. Hence, if leverage certificates are regarded as the riskier alternative, a larger percentage of investors who are younger, without a doctorate or professorship, and unmarried participate in riskier trades in terms of the product type.

Only about 4 % of the investors in warrants and leverage certificates are employed in the financial business. Moreover, information on the income of only somewhat more than half of the investors is available. Most of them, i.e. 33.09 % (33.92 %), have a medium income of between 25,000 and 75,000 € per year, whereas 13.11 % (16.71 %) earn less and only 5.33 % (4.36 %) more than 75,000 €. Nearly 50 % of investors trading warrants hold a months-end average securities portfolio of between 12,000 € and 27,000 € and one-quarter each holds larger or smaller portfolios. For leverage certificates, a slightly smaller number, i.e. 44.03 %, hold the medium portfolio size, whereas only 17.45 % are invested in a larger and more than one-third in a smaller portfolio size. Hence, on average wealthier investors prefer warrants to leverage certificates.

About half of the investors in the dataset have 5 to 10 years of experience as investors.[17] Investors in leverage certificates have less experience than investors in warrants and only 11.5

[17] Following Seru et al. (2010), we define experience as the cumulative number of trades per investor.

% of the former hold their account for more than 10 years while about 6 % more investors in warrants do so.

Looking at investors' trading activities, I find that they invested in leverage certificates three times more often than in warrants. The average purchased volume of leverage certificates or warrants as a share of the overall volume purchased during the observation period is over one-fourth for leverage certificates and only 14.93 % for warrants. The purchased volume is about 400 € higher for warrants than for leverage certificates.

I note only a few differences in the average investment behavior of the presented investor subgroups, which I mainly attribute to their socio-economic characteristics. For instance, the results reveal that older investors, investors holding at least a doctoral degree, investors with a higher income and more experience put higher volumes in leverage certificates, which is presumably due to greater personal wealth and time. Also this does not automatically coincide with a higher share of all their purchases during the observation period. On the contrary, for those groups of investors, the portfolio share is actually even smaller.

Interestingly, female investors in the dataset trade more often in warrants and leverage certificates than their male counterparts with nearly the same average volume and portfolio share. This pattern seems to be contradictory to individual investors' behavior in the equity market, where the greater trading activity of men is typically ascribed to the higher confidence of male investors in their financial competency (see, e.g., Barber and Odean, 2001). Finally, investors who trade in both leverage certificates and warrants, trade much more often and, on average, at the same volumes. The portfolio share during the observation period is, however, again much smaller.

All in all this analysis underlines the notion that investors indeed seem to regard leverage certificates as the riskier product type as compared to warrants, as they are traded more fre-

quently, at less volume and the resulting returns are smaller. Moreover, a larger percentage of younger, less experienced investors, investors without a doctorate, as well as less wealthy investors are more active in trading leverage certificates, i.e. the riskier product type compared to warrants, which is consistent with findings for the stock market (Kumar, 2009).

4 Empirical Analysis

4.1 Risk Taking

4.1.1 Analysis Design

To characterize the heterogeneity of individual investors' risk taking behavior when trading warrants and leverage certificates, I examine several correlations between risk taking and a set of individual characteristics of the investors in the dataset. As measures of the risk taking by investors, I use the logarithm of the delta exposure of the products calculated in Equation (5).

For ease of interpretation, I group the independent variables into four broad categories. The main focus of this analysis is on the coefficient estimates of socio-economic variables, i.e. several key personal characteristics and location-based characteristics of the investors in question. The third set contains a number of transaction-specific, portfolio and market environmental characteristics. Moreover, some control variables are used in this analysis.

Table 3 provides a detailed description of the independent variables used in the analysis, their abbreviations and their data sources.

[Table 3 about here.]

Investors' Personal Characteristics

Summary statistics on the investors' personal characteristics are provided in Section 3.2 above.

First of all, I use age and experience of the investors to explain their risk taking behavior. Moreover, I include several dummies in the analysis, i.e. a male dummy and additional dummies for retired, married and foreign traders. I also distinguish between professionals and non-professionals in the financial sector, i.e. investors who work in credit and other financial institutions, according to their volunteered information. Moreover, I set dummies for investors who have at least a doctorate, investors who are active in trading both products (warrants and leverage certificates), and for people who earn less than 25,000 € or more than 75,000 € per year. To measure the personal wealth of the investor, I additionally include the aggregated month-end portfolio holdings.

Investors' Location-Based Characteristics

Data for the location-based measures are drawn from the Regional Database Germany (GENESIS) of the Federal Statistical Office and the Statistical Offices of the *Länder*. These variables are called location-based characteristics as they categorize the investors according to their social-geographical surroundings. These data are available at the municipal, regional, state (*Länder*) and national levels. I always use the smallest unit available of the data, which is the investor's administrative district or city. The only exception is the lottery tax dummy, where only data at the state level is available. The location-based characteristics are connected to the individual investors in the dataset by the respective zip code of their place of residence. To every investor is attributed one value per location-based characteristic, i.e. the average of the respective characteristic over the observation period.[18] As a first categorical variable defining a location-based characteristic, I use information on population density, i.e. number of inhabitants per square kilometer, using the new urbanization classification as approved by the Eurostat Labor Market

[18]Religious data is a one-off dataset from the EU population and housing census 2011, lottery tax data is published quarterly, whereas the other data is published annually.

Working Group in 2011[19], which distinguishes three types of areas: Densely, moderately and thinly populated areas. The investors are sorted accordingly into subgroups of less than 300, 300 to 1,500 or more than 1,500 inhabitants per square kilometer.

I also include a Catholic dummy, which is set to one if the share of Catholics is larger than the share of Protestants in the investors' administrative district or city.[20] To measure the general wealth level of the investors' area of residence, I use the logarithm of GDP per person employed in the respective region or district.

The percentage of school-leavers who lack a basic secondary school certificate and moreover the percentage of school-leavers with A-levels provide measures of the general education level of an investor's area of residence. I assume here, that the education of the investor is highly correlated with the overall level of his or her area of residence. As other measures characterizing the investor's region of residence, I use the unemployment rate of that area as a percentage of the entire civilian working population and also the percentage of the foreign citizens of the total population. To capture the overall gambling behavior in the region of the investor's residence, a lottery tax dummy is included, which measures whether the respective tax payments per person to public lotteries in the investor's *Land* is larger than that of the country's overall average.

Transaction-Specific Trading Environment

First of all, I use a long dummy to evaluate the risk taking difference between investing in long and short products. Moreover, different risk taking profiles when trading on exchanges instead of directly at the issuers trading platforms are depicted by an exchange dummy. Investors might use limit orders as a way of controlling risk, as a limit order is executed when the limit is

[19] See EUROSTAT RAMON metadata server, available at `http://ec.europa.eu/eurostat/ramon/miscellaneous/index.cfm?TargetUrl=DSP_DEGURBA`.

[20] Unlike with the other variables, data on religious affiliation was only available in the EU population and housing census from 2011. The smallest percentage of people being either Catholics or Protestants among the *Länder* is 5,5 %, whereas the mean percentage is 67 %. Excluding regions with small percentage numbers does not change the results from the respective calculations.

reached. Therefore I include a dummy of one if, during the round-trip, a limit order was used.[21] I further include a measure which represents the general risk affinity of the investor. To do so, I calculate the value invested in highly speculative knock-out products as a share of the investor's total invested amount during the observation period. The trade number per investor and the log volume of the purchase are also included as variables. Frequent traders are thought to take more risks, whereas larger trade volumes are thought to correlate negatively with risk taking behavior (Kumar, 2009).

In addition, I include some variables that map the market movements: I set a dummy for a positive two-month market movement and interact the DAX return one day before the trade with the long dummy to control for the reaction to short-term market movements. Finally, I use the DAX volatility[22] to analyze whether a higher market volatility influences the active risk taking of the investors.

Control Variables

As control variables I use dummies for each quarter where the products have been traded to control for a changing trading behavior over time.

4.1.2 Univariate Results

Investors decide actively upon the risk they take when they buy a financial product. To analyze the influence of investors' characteristics on their willingness to take risks, I first visualize the possible relationship between degree of risk taking and some key personal characteristics – age, investment experience, gender, marital status, doctorate degree, retirement, wealth, employment

[21] One might be concerned about possible endogeneity of the limit order dummy: Therefore I perform the following robustness checks: First I exclude the limit order dummy from the regression, second I calculate the regression for observations, where the limit order dummy is (i) one and (ii) zero. The results are similar to the original regression.

[22] I include a dummy which is set to one if the value belongs to the highest volatility quintile of the 30-day mean VDAXNEW return. Using level values of the VDAXNEW instead does not change the result.

in the financial branch and whether the investors are engaged in trading both product types, i.e. warrants and/or the riskier leverage certificates – in Figures 3 and 4.

[Figure 3 about here.]

[Figure 4 about here.]

For each month I calculate the (equally weighted) average logarithmized DAX exposure per investor and divide the values into risk taking deciles. For each year of the observation period and risk taking decile I then calculate the average age, experience and portfolio holdings of the investors, as well as the percentage of the investors who are male, married, retired traders, traders with a doctorate or professorship, employed in a finance-related field, and who invest in both product groups. Grey dotted lines denote the year 2006, dashed lines 2007 and solid lines 2008. The mean over the whole observation period, is shown as a black solid line.

On average, the percentage of married traders and traders with a doctoral degree or professorship decreases with increasing deciles of risk taking and both products considered in the analysis. This holds also for traders with lower average experience, age and smaller portfolio holdings, i.e. wealth. The proportion of male traders who take more risks increases with increasing deciles of risk taking in leverage certificates, whereas it stays nearly constant for warrants. On the other hand, I observe a decreasing percentage of retirees linked to an increasing risk taking, and investors who trade both products, i.e. warrants and leverage certificates, take more risks with warrants.

My findings are consistent with observations from the American stock market. Similar to findings by Kumar (2009), which show that the most risk taking traders are rather inexperienced young males without a secure status in their lives, our graphical analysis here gives a first hint that high-risk taking investors might have the same characteristics with regard to the German

market for retail certificates.

4.1.3 Risk Taking and Socio-Economic Variables

For the regression analysis, I first calculate the monthly average of the logarithmized risk taking levels for each investor in the dataset as defined in Equation (5). The monthly average in this context is used to smoothen the potential influence of frequently trading investors and to minimize the potential bias due to the large amount of data for these traders. The average logarithm of the delta exposure is used as the dependent variable. First, I aim to test the influence of the socio-economic variables, i.e. personal and location-based characteristics, of investors in warrants and leverage certificates. All variables used for this analysis are explained in Section 4.1.1. I apply a two-stage procedure according to Heckman (1979) to control for self-selection in the trading decision when analyzing the risk taking. In the first stage, I use the estimates from a probit regression to calculate the inverse Mills ratio. The dependent variable in this regression is one if a specific investor traded in a specific month and zero otherwise. The independent variables for the regression are identical and explained in Table 4. Moreover, the DAX return of the previous month is included. The resulting inverse Mills ratio is afterwards used as an additional regressor in the main regression to obtain consistent estimates. Three regressions are computed for the analysis: (1) A pooled approach, (2) a random effect[23] and (3) a Fama-McBeth approach.[24] The results are shown in Table 4 separately for warrants and leverage certificates.

[Table 4 about here.]

[23] By using dummies for a large variety of investors characteristics, a fixed individual effect is already absorbed.

[24] Running the regressions without non-reported information on personal characteristics (for example income or gender) does not change the results. This holds also for inserting interaction terms, i.e. unemployment rate × gender or income × unemployment rate and for excluding observation from 2006, where only a few observations are available.

Investors' Personal Characteristics

Generally, the appetite for risk decreases with age and experience for both product groups. Older and more experienced people have less risk exposure. This is consistent with the findings of Kumar (2009) and Bauer et al. (2009) for the stock market and the option market.

Moreover, married people and traders with at least a doctorate take less risk than single or non-married people or traders without a doctorate, whereas non-German traders take more risk in both product groups. Traders with larger portfolio holdings, i.e. wealthier investors, also invest in a less risky way in warrants and leverage certificates. For the other personal characteristics the picture is diverse. Investors with a large income invest less riskily in leverage certificates, whereas investors with a particularly low income take more risks in warrants. Males take more risk in leverage certificates, whereas for warrants there is no significant difference with respect to gender. This holds also for professionals. Traders who are engaged in trading both products take more risk in warrants. They additionally behave with less risk in leverage certificates. I do not find significant results for retirees who invest.

Hence, although females and people who trade in both product groups take higher or equivalent risks in warrants, they take much less risky positions in leverage certificates. When comparing both product types, investment in warrants is less risky due to the lack of the knock-out possibility. Hence, investors in warrants seem to prefer taking controllable risks, whereas they do take less risk in products that are per se highly leveraged.

In general, the above findings indicate that risk taking behavior in the market of short-term exchange-traded retail products is strongly correlated with the personal characteristics of the traders. Results in the univariate analysis in Section 4.1.2 and the US stock market (e.g., Kumar, 2009) are corroborated, as younger, less wealthy, non-German, single men take on average higher risk by investing especially in leverage certificates. Moreover, for females and people who trade

in both product groups, the risk evaluation differs for the two product types. Compared to the other investor subgroups, they take more risk in warrants than in leverage certificates.

Investors' Location-Based Characteristics

This part focusses on the effect of investors' location-based characteristics. These are not connected personally to the individual investor, but are retrieved from the region the investor is living in. For leverage certificates the influence of investor location-based characteristics on the risk taking is more pronounced. For warrants the respective characteristics have hardly any significant influence on the risk taking behavior of investors. I would only like to remark that risk taking increases for the Catholic dummy and the unemployment rate, which holds also for leverage certificates. Hence, investors living in regions that are Catholic and that suffer from high unemployment tend to take more risk. Moreover, risk taking in leverage certificates is more prevalent in regions with a larger foreign-born population, a smaller general level of wealth and also a larger no graduation rate.

Hence, traders in warrants and leverage certificates take more risk if they live in less socially advantaged areas. This finding is consistent with Kumar (2009) and Korniotis and Kumar (2011) for the American stock market. Risk taking decreases, on the other hand, for leverage certificates with higher population density and larger lottery tax revenues. Hence, lottery involvement and trading in leverage certificates seem to be linked in the areas studied, and people living in urban areas invest less riskily.

4.1.4 Risk Taking and Trading Environment

To investigate the influence of the market conditions on risk taking I again use the logarithm of "degree of investor risk taking" as defined in Equation (5) as dependent variable. However, I do not aggregate the dataset for this analysis to a monthly average, but use the whole range

of first-buy-transactions in each round-trip. The reason is that most of the variables that might have an influence on risk taking are linked directly to one transaction, i.e. whether the investor wants to invest 100 € or 1000 € might have a large influence on the respective trade, but this effect might be fully diluted if monthly averages are used. As independent variables I use the transaction-specific, portfolio and market characteristics as already defined in Section 4.1.1. The results are shown in Table 5 for warrants and leverage certificates separately.

[Table 5 about here.]

Traders take more risk when investing in long products, if limit orders are used for a purchase, and when the overall trade frequency in warrants and leverage certificates is larger and the portfolio share of risky assets is larger. Moreover, if the general trading behavior in risky assets defined as the share of bought knock-out instruments in all instruments bought over the observation period is high, the risk taking behavior also increases. This also holds for the trading frequency of some investors, as high frequency of trading is a possible indication of overconfidence (Barber and Odean, 2001).

Larger trades are not as risky as smaller trades, which conforms with the definition of gambling by Kumar (2009). Moreover, traders observe the market conditions and take risks accordingly. If the lagged daily return of the DAX was positive, investor risk taking increases for short certificates and decreases for long certificates. This also holds true for the long run: If the DAX return over the last two months has been positive, this leads also to higher exposure, though, the effect on risk taking in warrants is not significantly different from zero. Finally, if market volatility is high, exposure decreases. This is especially relevant for leverage certificates, which are more likely to be knocked out if the volatility is high.

Hence, trade factors, including portfolio contents and market situation, also have an influence on the risk taking behavior of traders. In this study I find that in a less risky environment, and

if possible losses are smaller or (potentially) limited, traders take more risks. This differs from observations regarding the US stock market, where investors invest more riskily during economic downturns (Kumar, 2009).

4.2 Risk Taking Persistence

The next step is to analyze whether investors are persistent in their risk taking behavior. To do so, I apply parametric (regression-based) and non-parametric tests for the trading data: First, the basic regression approach described in Section 4.1 is extended by including lagged risk measures as independent variables. Lagged in this context means that I use the monthly averaged logarithmized delta exposure of all buy transaction per investor during the previous month of the observation as an explanatory variable.

The relevant values of this test are the t-statistic and the coefficient value. The coefficient means that, on average, one unit higher risk taking in the previous month is associated with x units higher risk taking in the current month.

The non-parametric tests for the persistence of risk taking in retail certificates are based on a contingency table approach. Originally, such analyses were used in the context of performance measurements of financial products such as mutual funds (e.g. Brown and Goetzmann, 1995; Li, 2005).

I divide the dataset for DAX exposure into two halves for each month defining the upper half as higher risk and the lower half as lower risk. Then I compare the average DAX exposure for each investor in each month with the DAX exposure of the previous month in which a trade of that investor took place. As a second measure, I also do this for the current month and for the month of lag 5. Months in which the investor did not trade are skipped. If both trades are part of the high risk half, they are defined as risk-risk combination. The same is done for no

risk-no risk, risk-no risk and no risk-risk combinations. From the number of these categories are then calculated two odds or cross-product ratios CPR_{L1} and CPR_{L5} for the first and the fifth lag,

$$CPR_i = \frac{(risk - risk) \times (no\ risk - no\ risk)}{(no\ risk - risk) \times (risk - no\ risk)}, \tag{7}$$

where i denotes $L1$ or $L5$. An odds ratio equal to unity signifies that the risk taking level in the past has no bearing on a higher level of risk taking now. Particularly, the null hypothesis, that the risk taking levels of two consecutive months are unrelated to each other, would correspond to an odds ratio equal to one. As an additional test, I again compare the risk taking of two consecutive months. The correlation coefficient is computed and used as an additional test for the risk persistence in the dataset.

All tests are computed for several investor subgroups, long and short positions and separately for warrants and leverage certificates. The results are shown in Table 6.[25] The first two columns show the results for the two cross-product ratios CPR_{L1} and CPR_{L5} for several investor subgroups. Column 3 shows the correlation coefficient *corr* and column 4 the coefficient values $coef$ of the extended regression. The number of observations is reported in the last column.

[Table 6 about here.]

I find a highly positive overall persistence of risk taking behavior in the dataset for all tests applied. Moreover, the level of persistence is very similar for warrants and leverage certificates. The odds ratio for two consecutive months is about 10 for both product groups, which corresponds to a 10 % higher chance of an investor ending up in the higher risk half if he or she also traded in a riskier way in the month before. The persistence diminishes for higher lag degrees, and at lag 5 it is still more than half as high and definitely larger than one. Also, the correlation

[25] All t-statistics of the extended regression are significant at a 1 % level. For both CPR measures used and all subgroups considered, the z-statistic is significant at a 1 % level, with one exception marked by ^{n}. Therefore I do not report the values here.

and the regression coefficient support these findings, being 0.53 (0.67) and 0.54 (0.68) for warrants and leverage certificates respectively. Clearly, investors are highly determined in their risk category for warrants and for leverage certificates and do adapt their trading and risk taking strategies over time in a similar way.

When comparing the persistence levels for traders in both product groups to those who invest only in one of the two products, I find that the former are less consistent in their risk taking behavior, adapting it more often. Very young traders are less persistent in taking risks with both products and adapt their risk-trading more often than older investors. This also holds for inexperienced investors, who are much less consistent with regard to risk when trading leverage certificates. For warrants, moderately experienced traders do adapt their degree of risk taking most, whereas inexperienced and very experienced investors do so least. Females change their risk taking behavior more often in trading warrants than do males. Wealthy and married traders are more risk persistent with regard to leverage certificates than their respective counterparts. For the rest of the investor subgroups the four indicators show ambivalent pictures.

Overall, all investors are highly persistent in their behavior regarding risk. Moreover, the risk persistence is very similar for warrants and leverage certificates and throughout investor subgroups. Additionally, traders who take more risk also tend to adapt their risk taking behavior more often, whereas older, more experienced and wealthy traders are more unchanging in their level of risk taking.

4.3 Risk Taking and Performance

My final step here is to link the investors' risk taking behavior to their performance. To measure the performance of investors, I use the gross relative return per round-trip as defined in Equation (6). Figure 5 shows the risk-performance and performance-risk relationships for warrants and

leverage certificates separately.

[Figure 5 about here.]

Similar to Section 4.1.2, I divide the average monthly risk taking into deciles for each month over all investors for the first two subfigures. Then I calculate the average gross relative return for each quarter of the observation period and decile of risk taking.[26] For the second two subfigures this is in the same way, by dividing the average monthly performances into deciles and calculating the DAX exposure respectively.

Grey dotted lines denote the year 2006, dashed lines 2007 and solid lines 2008. Moreover, the overall average is shown as a black solid line. For warrants the performance decreases according to the risk taking deciles and the overall average return results in 8.72 % for the first and -3.63 % for the last risk decile. A slightly better performance for deciles 6 to 8 is driven by the better performances during the year 2006, when the DAX increased steadily and volatility was low. Regarding leverage certificates, a clear decreasing performance is also observable for increasing deciles of risk from -1.27 % down to -22.76 %. The performance in the first risk decile is already slightly negative for leverage certificates, whereas it is positive for warrants. All in all, for both products, a larger appetite for risk leads to poorer performance.[27]

Regarding the allocation into performance quintiles for leverage certificates, the curve progression is U-shaped, but more like a skew than a smile. Hence, a higher degree of risk taking is visible in the first performance quintiles, but also in the last performance quintiles, whereas it is smaller in between. The reason is obvious: Taking high risk can either lead to large returns if the market moves advantageously or, if it does not, to a knock-out and thus, to a total loss. This holds true for leverage certificates throughout all the years covered by the observation period.

[26] Both, risk taking and performance are always assigned to the time of the first buy in the round-trip.

[27] Note, that the main reason for the decreasing performance is the mispricing of the products by the issuer, who adapts the prices differently for different moneynesses (Baller et al., 2016).

For warrants this relationship is less pronounced and, moreover, was not visible during the first years of the dataset.

To arrive at the above findings empirically, I use a logit regression approach. I define two dependent binary variables for both warrants and leverage certificates, which are one (1) for an extraordinarily positive performance in warrants and leverage certificates and (2) for a knock-out in leverage certificates or equivalently for an extraordinary loss in warrants.[28] The monthly average gross relative return is divided into quintiles for each month during the observation period and the upper performance quintile is defined as extraordinary performance. I define as "total loss" or "knock-out", all average gross relative returns equal to -0.98 or lower.[29] The probability of a knock-out or an extraordinarily high performance is then given by:

$$\begin{aligned} Pr(PERF_i) = \; & exp(\beta_{1j}\, RISK_{ij} + \beta_{2k}\, INVCHAR_{ik} + \beta_{3m}\, LOCHAR_{im} \\ & + \beta_{4n}\, CNTRLS_{in} + Constant)/ \\ & [1 + exp(\beta_{1j}\, RISK_{ij} + \beta_{2k}\, INVCHAR_{ik} + \beta_{3m}\, LOCHAR_{im} \\ & + \beta_{4n}\, CNTRLS_{in} + Constant)], \end{aligned} \tag{8}$$

where $PERF$ denotes a knock-out or an extraordinarily positive return event and $RISK$ denotes the DAX exposure quintile dummy of the observation. The various sets of investors' personal characteristics, $INVCHAR$, and investors' location-based characteristics, $LOCHAR$, are defined as in the former analysis, and $CNTRLS$ includes quarter dummies.[30] Separate regression

[28] Using an ordered logit approach does not change the qualitative results. The results become less clear though, as especially the knock-out is a special event and the number of knock-outs in the dataset is small.

[29] As the products investigated contain asymmetric pay-off profiles, a total loss is a special and extreme event, especially when trading leverage certificates. I therefore do not use the lowest quintile for the extraordinary loss definition, which would be analogous to the extraordinary gain. However, doing a robustness check led to similar, though less clear, results.

[30] I did not use volatility and return measures as they are per definition highly correlated with the performance.

results for warrants and leverage certificates can be found in Table 7.

[Table 7 about here.]

The marginal effects for an average investor are reported, i.e. continuous variables are fixed at their means, whereas factor covariates are evaluated as though there were an equal number of observations in each level.[31] I do not report the constant and abstain from interpreting it, as a zero value for all predictor variables in the examined model provides little evidence.

Whereas the probability of ending up with a knock-out (extraordinarily positive performance) is smaller (larger) for the first quintiles than for the rest of the observations, it increases (decreases) for higher DAX exposure quintiles. Especially the highest risk taking quintile leads to a higher (lower) probability of a knock-out (extraordinarily positive return). Overall, the probability of obtaining a knock-out increases and the probability of obtaining an extraordinarily positive performance decreases with increasing exposure quintiles. This effect is much more pronounced for the knock-out regression however.[32] These findings are consistent with the results from Figure 5.[33]

The influence on performance of investor characteristics is not as clear as that of risk taking. The reason is that risk taking involves an active decision by investors which is in turn influenced by the investor's personal characteristics. The return depends not only on the investor's appetite for risk taking (or lack of it), but first and foremost on the market conditions. Therefore I focus here on only the more important results regarding the influence of investors characteristics:

[31] For factor variables, the discrete first-difference from the base category is shown and not the derivative, as for continuous variables.

[32] Regressions were also calculated using the odds ratios: Over all quintiles, the increase is disproportionate and more pronounced for knock-outs, i.e. for the fifth quintile of risk taking the probability of a knock-out for leverage certificates is four times as high as when less risk is taken. For warrants it is even 4.76 as high. Compared to this, the odds of achieving an extraordinarily high performance are only about 0.64 and 0.76 times as high respectively for highly risky investments in leverage certificates and warrants than for other investments.

[33] When regressing the influence of risk taking on performance using a similar approach to that in Section 4.1.3, findings are also consistent with the U-shaped relation already reported in Figure 5.

The trades of older investors are significantly less likely to result in a knock-out, complete loss or to generate an extraordinary positive return. Whereas experience does not have an influence on the poor performance regressions, the probability of ending up with an extraordinarily positive return is significantly higher for more experienced investors in both product groups. This holds also for retired traders, who are much more likely to end up in the group with extraordinarily positive returns when investing in warrants. Investors who invest in both products have a smaller probability than other investors in obtaining a knock-out for both products, but they are also significantly less likely to receive an extraordinarily positive return when investing in warrants. The probability of a knock-out in leverage certificates is larger for male investors than for females. Finally, traders with a large income have a smaller likelihood of a knock-out in leverage certificates, whereas a knock-out in both products is more likely for traders with a low income. Again, using the odds ratio underlines the findings.

Overall, the regression results strengthen the findings from the graphical analysis. Investors' performance and risk taking are negatively correlated. Moreover, investor subgroups that take more risk tend to perform poorer.

5 Conclusion

This is the first paper to analyze the influence of investors' socio-economic characteristics on their risk taking in the market of speculative exchange-traded retail certificates. By using a large trade dataset of warrants and leverage certificates from the German market, this paper examines the influence of investors' personal characteristics, their location-based demographic factors and the market conditions on investors' risk taking behavior. I find clear evidence that all three sets of factors have a large influence on the risk taking decisions of private investors in the market of short-term retail products:

Speculative gamblers on the German exchange-traded certificates market have characteristics similar to the speculative traders on the US stock market. I indeed find evidence that the traders most willing to take risks are inexperienced young males with little secure status in their lives. Moreover, several investor groups show differences in their risk taking behavior regarding warrants and leverage certificates. They seem to see warrants as a less risky alternative to leverage certificates and therefore take more risk when trading the former. This holds especially for females and people who trade in both product groups.

Traders in speculative exchange-traded retail products generally take more risks if they live in less advantaged areas, i.e. in regions with higher unemployment, less advanced education levels or less wealth. The characteristics of the trading environment, such as the size and content of the investor's portfolio as well as the market situation also have significant influence on the risk taking behavior of traders. Traders take more risk in a less risky trading environment and if the possible losses are smaller or are (potentially) limited.

Additionally, traders are highly persistent in their risk taking behavior. Their behavior with regard to risk is very consistent for both warrants and leverage certificates and throughout the investor subgroups. Traders who take more risks also tend to adapt their risk taking behavior more often, whereas older, more experienced and wealthier traders are more consistent in their behavior in this regard.

Finally, I find a clearly negative correlation between investors' performance and risk taking. Investors who take more risks also perform more poorly. This holds also for all investor subgroups. On the other hand, it is only possible to obtain an extraordinarily positive return by taking high risks, which produces a U-shaped form of performance-risk relationship.

References

Baller, S., Entrop, O., Schober, A., Wilkens, M., 2016. What drives performance in the speculative market of short-term exchange-traded retail products? Working Paper (May), University of Passau and University of Augsburg.

Barber, B. M., Odean, T., 2000. Trading is hazardous to your wealth: The common stock investment performance of individual investors. Journal of Finance 55 (2), 773–806.

Barber, B. M., Odean, T., 2001. Boys will be boys: Gender, overconfidence, and common stock investment. Quarterly Journal of Economics 116 (1), 261–292.

Barberis, N., Huang, M., 2008. Stocks as lotteries: The implications of probability weighting for security prices. American Economic Review 98 (5), 2066–2100.

Bauer, R., Cosemans, M., Eichholtz, P., 2009. Option trading and individual investor performance. Journal of Banking and Finance 33 (4), 731–746.

Baule, R., 2011. The order flow of structured financial products and issuer pricing behavior. Journal of Banking and Finance 35 (11), 3120–3133.

Black, F., Scholes, M., 1973. The pricing of options and corporate liabilities. Journal of Political Economy 81 (3), 637–654.

Brown, C., Dark, J., Davis, K., 2010. Exchange traded contracts for difference: Design, pricing, and effects. Journal of Futures Markets 30 (12), 1108–1149.

Brown, S. J., Goetzmann, W. N., 1995. Performance persistence. Journal of Finance 50 (2), 679–698.

Cox, J. C., Ross, S. A., Rubinstein, M., 1979. Option pricing: A simplified approach. Journal of Financial Economics 7 (3), 229–263.

Dorn, D., 2012. Investors with too many options? Working Paper (October), LeBow College of Business, Drexel University.

Dorn, D., Sengmueller, P., 2009. Trading as entertainment. Management Science 55 (4), 591–603.

Entrop, O., Scholz, H., Wilkens, M., 2009. The price-setting behavior of banks: An analysis of open-end leverage certificates on the German market. Journal of Banking and Finance 33 (5), 874–882.

Frankfurter Wertpapierbörse, 2013, Section 104. Exchange rules of the Frankfurter Wertpapierbörse (FWB) (16 December 2013).

Goetzmann, W. N., Kumar, A., 2008. Equity portfolio diversification. Review of Finance 12 (3), 433–463.

Grinblatt, M., Keloharju, M., 2009. Sensation seeking, overconfidence, and trading activity. Journal of Finance 64 (2), 549–578.

Han, B., Kumar, A., 2013. Speculative retail trading and asset prices. Journal of Financial and Quantitative Analysis 48 (2), 377–404.

Heckman, J. J., 1979. Sample selection bias as a specification error. Econometrica 47 (1), 153–161.

Hentschel, L., 2003. Errors in implied volatility estimation. Journal of Financial and Quantitative Analysis 38 (4), 779–810.

Korniotis, G. M., Kumar, A., 2011. Do older investors make better investment decisions? Review of Economics and Statistics 93 (1), 244–265.

Kumar, A., 2009. Who gambles in the stock market? Journal of Finance 64 (4), 1889–1993.

Kumar, A., Page, J. K., Spalt, O. G., 2011. Religious beliefs, gambling attitudes, and financial market outcomes. Journal of Financial Economics 102 (3), 671–708.

Lakonishok, J., Lee, I., Pearson, N. D., Poteshman, A. M., 2007. Option market activity. Review of Financial Studies 20 (3), 813–857.

Li, X., 2005. The persistence of relative performance in stock recommendations of sell-side financial analysts. Journal of Accounting and Economics 40 (1–3), 129–152.

Rossetto, S., van Bommel, J., 2009. Endless leverage certificates. Journal of Banking and Finance 33 (8), 1543–1553.

Rubinstein, M., Reiner, E., 1992. Exotic options. Working Paper (May), Berkeley University.

Schmitz, P., Weber, M., 2012. Buying and selling behavior of individual investors in option-like securities. Die Betriebswirtschaft 72 (5), 409–426.

Seru, A., Shumway, T., Stoffman, N., 2010. Learning by trading. Review of Financial Studies 23 (2), 705–739.

Shefrin, H., Statman, M., 2000. Behavioral portfolio theory. Journal of Financial and Quantitative Analysis 35 (2), 127–151.

Stuttgart Stock Exchange, 2014, Section 53. Exchange rules of the Stuttgart stock exchange (1 January 2014).

White, H., 1980. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. Econometrica 48 (4), 817–838.

Figures

Figure 1: Sensitivities of Warrants and Leverage Certificates

The figure reports the different sensitivities for call warrants and long leverage certificates with a remaining time to maturity T of 10 days. Sensitivities are shown with regard to changes in the underlying price and therefore the moneyness. The moneyness is defined as $S/Strike$. The values of the products (given in €) 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 $\sigma = 0.3$.

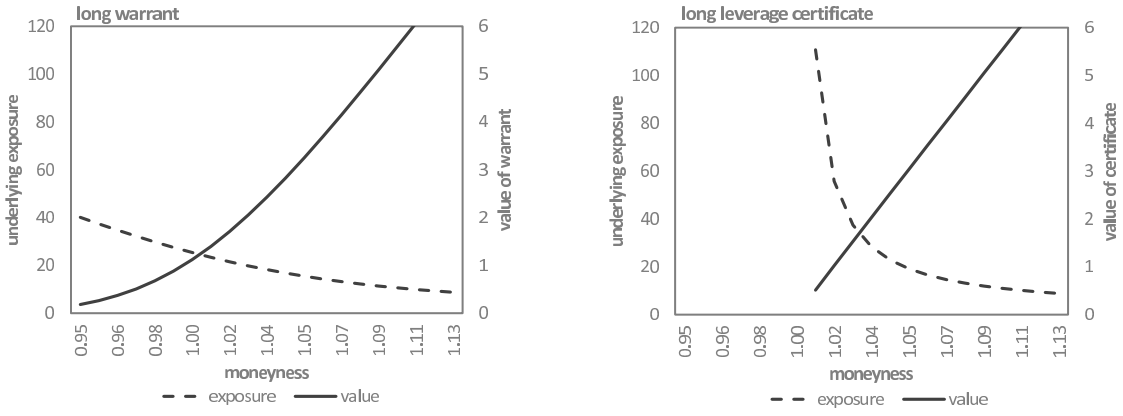


Figure 2: Development of the DAX

The figure reports the development of the DAX during the observation period from January 2006 to December 2008. The DAX is a performance index on the German Stock Market and the underlying of the examined products in this analysis. The DAX is reported in index points.

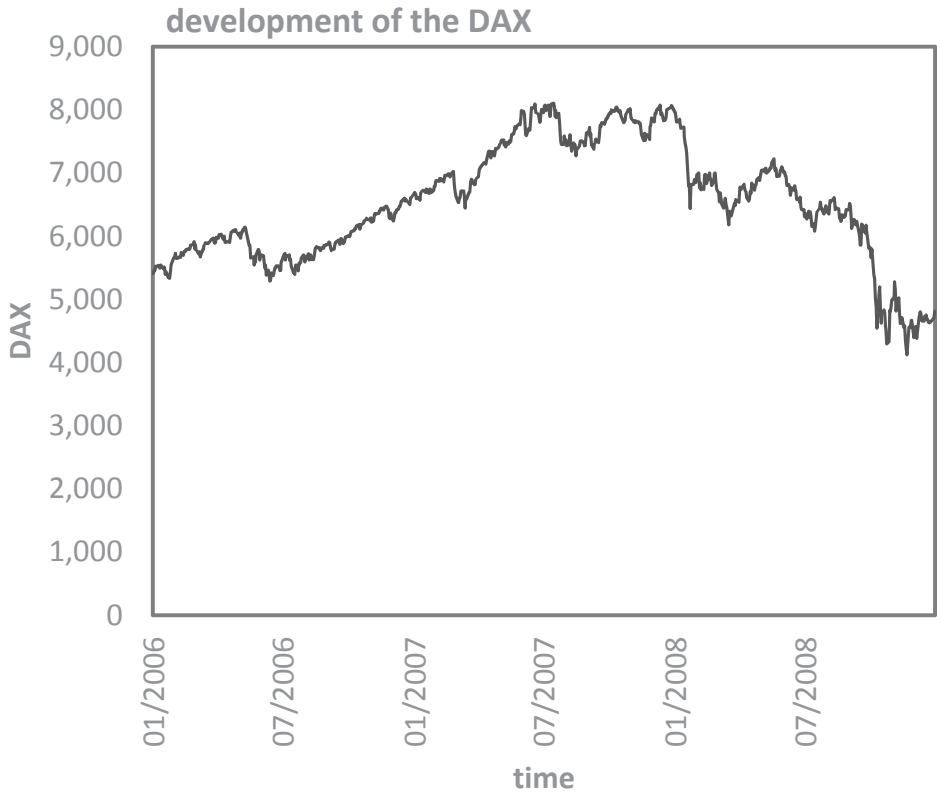


Figure 3: Risk Taking in Warrants

The figure reports the average value or share of investors' key personal characteristics for different risk taking deciles for warrants. The risk taking deciles are calculated for each month during the observation period separately using the monthly averaged DAX exposure per investor. The average age, experience and portfolio holdings as well as the share of total investors who are male, married, retired traders, traders with a doctorate or professorship, who are employed in a finance related field and who invest in both product groups are calculated for each year and each risk taking decile respectively. Grey dotted lines denote the year 2006, dashed lines 2007 and solid lines 2008. Black solid lines denote the overall average.

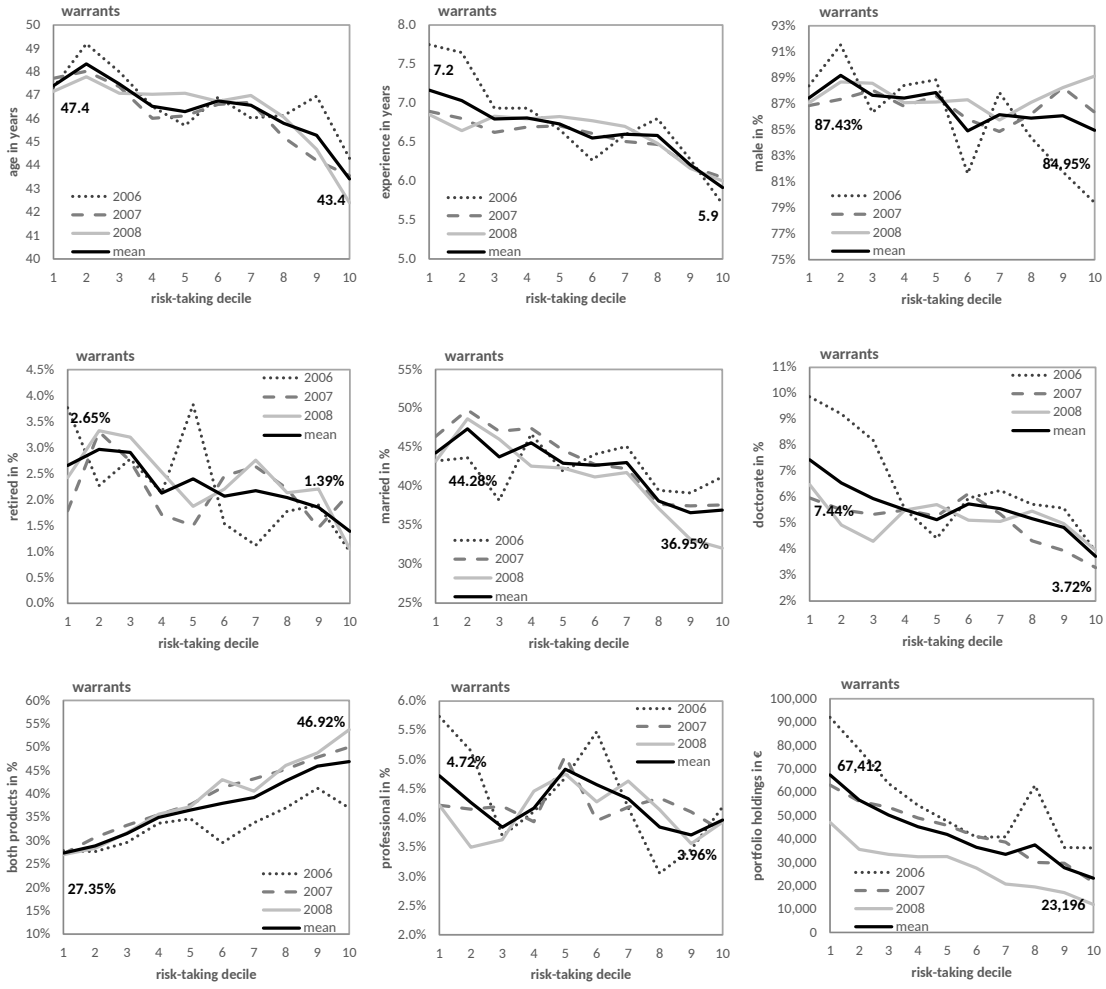


Figure 4: Risk Taking in Leverage Certificates

The figure reports the average value or share of key investors' characteristics for different risk taking deciles for leverage certificates. The risk taking deciles are calculated for each month during the observation period separately using the monthly averaged DAX exposure per investor. The average age, experience and portfolio holdings as well as the share of total investors who are male, married, retired traders, traders with a doctorate or professorship, who are employed in a finance related field and who invest in both product groups are calculated for each year and each risk taking decile respectively. Grey dotted lines denote the year 2006, dashed lines 2007 and solid lines 2008. Black solid lines denote the overall average.

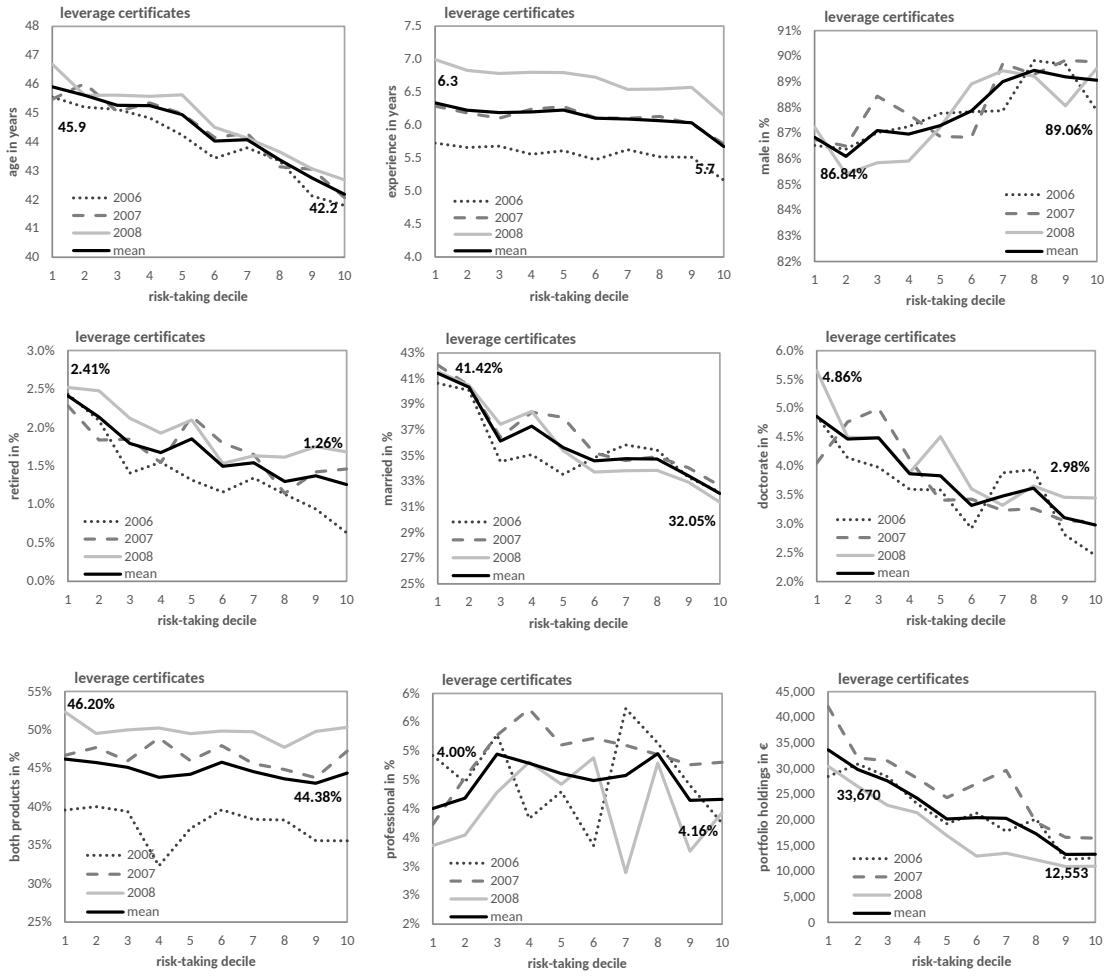
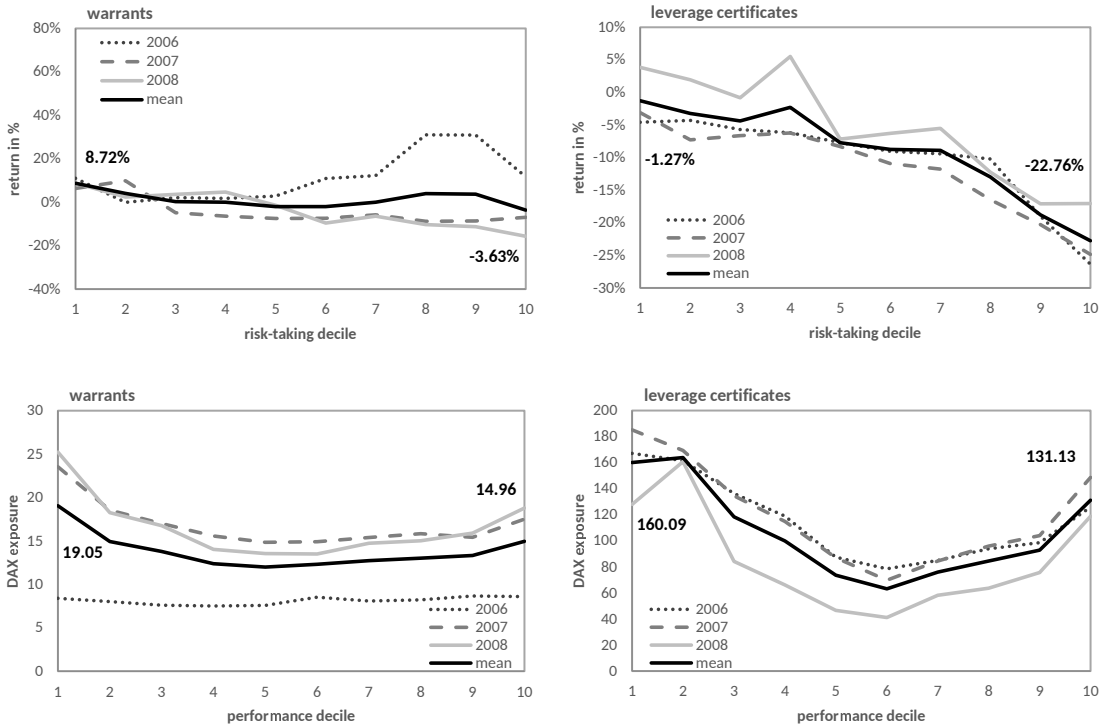


Figure 5: Risk Taking and Performance

The figure reports the average value of the gross relative return (GRR) (DAX exposure) for different risk taking (performance) deciles. The risk taking and performance deciles are calculated for each month during the observation period from the average monthly investor performance and risk taking separately. Then the average GRR is calculated for each year and each risk decile and the DAX exposure for each year and each performance decile respectively. Grey dotted lines denote the year 2006, dashed lines 2007 an solid lines 2008. Black solid lines denote the overall average. Values are reported for warrants and leverage certificates separately.



Tables

Table 1: Warrant and Leverage Certificate Round-Trips

	Warrants							Leverage certificates						
	Moneyness		**δ-Exposure**		**Buy-volume in €**			**Moneyness**		**δ-Exposure**		**Buy-volume in €**		
	Mean	Median	Mean	Median	Mean	Median	N	Mean	Median	Mean	Median	Mean	Median	N
Q1-2006	0.930	0.941	7.42	6.31	5,828	2,443	181	1.015	1.012	121.19	82.71	2,766	924	16,389
Q2-2006	0.916	0.925	7.67	6.84	8,537	1,920	625	1.018	1.014	107.24	69.56	3,331	1,063	23,374
Q3-2006	0.908	0.929	8.32	7.62	6,960	1,927	852	1.016	1.013	117.58	78.11	2,331	970	21,000
Q4-2006	0.949	0.947	10.00	9.74	6,195	1,747	1,742	1.014	1.011	136.69	91.20	2,547	1,020	21,991
Q1-2007	0.946	0.964	11.50	10.39	6,168	1,817	3,996	1.017	1.013	127.17	79.76	2,815	1,100	24,845
Q2-2007	0.960	0.974	24.96	18.66	9,467	2,100	20,652	1.018	1.013	114.76	75.87	3,874	1,200	43,809
Q3-2007	0.963	0.981	23.95	18.52	9,184	2,570	22,529	1.019	1.014	116.88	71.06	3,515	1,230	44,593
Q4-2007	0.967	0.985	25.66	19.64	6,314	2,270	12,582	1.016	1.012	139.90	87.39	3,361	1,120	28,498
Q1-2008	0.947	0.962	20.47	15.38	5,062	1,555	14,622	1.026	1.018	101.77	56.47	3,389	1,094	33,280
Q2-2008	0.971	0.984	24.13	18.62	5,760	1,950	9,991	1.025	1.016	102.50	62.05	4,040	1,276	30,694
Q3-2008	0.962	0.975	25.00	17.88	6,038	1,870	13,143	1.030	1.020	89.11	50.22	4,763	1,237	32,154
Q4-2008	0.901	0.913	14.08	10.02	4,740	1,640	17,096	1.062	1.043	52.65	23.80	4,793	1,284	36,419
Total	0.951	0.972	21.73	15.85	6,962	1,992	118,011	1.024	1.015	108.30	66.15	3,598	1,140	357,046
	GRR		**Buys**	**Sells**	**Limit^B**	**Limit^S**	**Long**	**GRR**		**Buys**	**Sells**	**Limit^B**	**Limit^S**	**Long**
	Mean %	Median %	Mean	Mean	%	%	%	Mean %	Median %	Mean	Mean	%	%	%
Q1-2006	6.84	3.92	1.33	1.23	20.42	25.11	71.82	-6.46	1.56	1.13	1.06	6.28	13.26	52.46
Q2-2006	16.64	3.48	1.48	1.26	16.31	19.54	64.32	-6.21	1.72	1.18	1.09	5.52	12.57	61.57
Q3-2006	3.33	2.08	1.47	1.24	11.16	13.30	57.86	-3.28	2.44	1.18	1.08	5.85	13.15	48.96
Q4-2006	5.84	2.58	1.47	1.27	13.71	15.17	59.30	-4.48	2.56	1.19	1.09	5.42	12.68	51.25
Q1-2007	6.15	2.75	1.40	1.21	12.68	14.84	43.57	-4.86	1.95	1.22	1.11	5.32	12.72	48.82
Q2-2007	1.58	1.83	1.50	1.26	5.27	8.67	57.58	-4.97	1.33	1.27	1.15	3.50	11.46	52.24
Q3-2007	-4.21	0.68	1.56	1.24	5.06	7.24	49.24	-4.06	2.19	1.20	1.10	3.92	11.52	51.28
Q4-2007	-5.72	0.52	1.44	1.21	6.05	7.91	54.74	-3.53	2.06	1.21	1.12	3.27	12.37	52.68
Q1-2008	-4.41	1.54	1.35	1.16	8.11	9.98	49.32	-2.09	2.54	1.24	1.13	3.95	11.53	50.37
Q2-2008	-2.06	1.16	1.45	1.23	5.07	8.74	47.20	-2.14	2.37	1.28	1.15	3.28	10.31	46.22
Q3-2008	4.81	2.78	1.44	1.25	6.10	9.97	44.75	-1.09	2.67	1.24	1.12	3.55	10.21	45.03
Q4-2008	2.28	2.49	1.50	1.24	6.88	10.05	50.23	2.76	1.98	1.21	1.11	2.83	8.74	45.30
Total	-0.57	1.45	1.47	1.23	6.43	9.24	50.90	-3.10	2.08	1.22	1.11	4.11	11.46	50.23

This table exhibits information on the trade dataset aggregated into round-trips during the observation period from January 2006 to December 2008. The moneyness 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 δ-exposure measures the sensitivity of the product's fair value with respect to the underlying. For both measures, the mean and the median are reported for the first initiated buy transactions of each round-trip. The buy-volume reports the average accumulated volume of all buys per round-trip in €. N denotes the overall number of round-trips in each quarter. By using the gross relative return (GRR) all transaction fees and bid/ask spreads are included in the purchase and sales price and thus the calculation of the return. Moreover, the average number of buys and sells per round-trip are shown, as well as the fraction of limit order sells (buys) of total sells (buys) in % and the long ratio of the products in %. Results are shown for warrants and leverage certificates separately.

Table 2: Summary Statistics on Investor Base

	Warrants					Leverage certificates				
	%	*N*	Ø Number of trades	Ø Volume in €	Ø Purchase share in %	%	*N*	Ø Number of trades	Ø Volume in €	Ø Purchase share in %
Age										
0 to 25 year	6.52	657	17	1,196	18.53	8.51	741	48	1,068	29.22
26 to 40 years	37.95	3,823	32	2,181	16.69	40.05	3,488	84	1,771	27.68
41 to 55 years	38.62	3,891	31	2,454	14.04	37.03	3,225	114	2,275	24.59
56 to 100 years	16.91	1,704	39	3,410	11.64	14.41	1,255	109	2,661	20.48
Experience										
0 to 1 year	14.05	1,416	24	1,939	25.02	15.81	1,377	65	1,666	34.68
1 to 5 years	19.15	1,929	34	2,298	12.38	21.52	1,874	97	1,966	24.25
5 to 10 years	49.69	5,006	33	2,412	14.14	51.13	4,453	100	1,987	24.55
More than 10 years	17.11	1,724	32	3,035	11.79	11.54	1,005	117	2,804	20.55
Gender										
Male	87.37	8,803	30	2,395	14.78	87.67	7,635	94	2,002	25.61
Female	12.09	1,218	45	2,519	16.00	11.78	1,026	100	1,999	25.75
n/a	0.54	54	62	6,100	14.91	0.55	48	200	6,386	26.27
Retirement status										
Retired	1.89	190	37	2,258	12.65	1.61	140	112	2,883	22.67
Not retired	98.11	9,885	32	2,433	14.97	98.39	8,569	95	2,012	25.67
Marital status										
Married	40.45	4,075	30	2,386	13.13	36.11	3,145	93	2,100	22.67
Not married	59.55	6,000	33	2,460	16.15	63.89	5,564	97	1,984	27.30
Doctoral degree										
Doctorate	5.01	505	27	3,331	10.10	3.78	329	103	3,214	19.21
No doctorate	94.99	9,570	32	2,383	15.19	96.22	8,380	95	1,979	25.88
Trader										
Leverage certificate						60.31	5,252	79	2,003	30.14
Warrant	65.69	6,618	26	2,484	17.79					
Both	34.31	3,457	43	2,327	9.46	39.69	3,457	121	2,061	18.77
Professional										
Professional	3.99	402	35	3,341	11.91	4.13	360	121	2,771	24.87
Not professional	96.01	9,673	32	2,392	15.06	95.87	8,349	95	1,994	25.66
Portfolio holdings										
<12,000 €	26.79	2,699	30	1,070	26.39	38.51	3,354	95	1,163	41.20
12,000 € to 27,000 €	47.54	4,790	33	2,130	13.02	44.03	3,835	96	1,927	18.59
>27,000 €	25.67	2,586	31	4,405	6.51	17.45	1,520	96	4,180	9.02
Income										
<25,000 €	13.11	1,321	27	2,014	15.56	16.71	1,455	70	1,477	27.58
25,000 € to 75,000 €	33.09	3,334	31	2,236	14.20	33.92	2,954	98	1,878	25.65
>75,000 €	5.33	537	38	3,775	12.26	4.36	380	161	3,552	26.14
n/a	48.47	4,883	33	2,527	15.55	45.01	3,920	97	2,193	24.83
Total	100.00	10,075	32	2,430	14.93	100.00	8,709	96	2,026	25.63

This table exhibits information on the personal characteristics of all 15,327 individual investors in the dataset, 3,457 of whom hold both warrants and leverage certificates. Investors are sorted according to their age group, experience, gender, retirement status and marital status, whether they hold a doctorate or professorship, trade both products, work in the financial industry, and according to their wealth in the form of portfolio holdings and income. Age is given as that at the beginning of the observation period. The average experience per investor is calculated as the average of the time between each trade and the opening date of the brokerage account. Portfolio holdings are end-of-month holdings per investor. The average number of trades refers to the trades per investor in warrants or leverage certificates during the observation period, average volume in € is the average buy volume per trade and the purchase share is the average volume of the purchases in warrants or leverage certificates in relation to all purchases carried out per investor during the observation period. Results are shown for warrants and leverage certificates separately.

Table 3: Definitions and Sources of Main Variables

Abbreviation	Variable description	Data source
Investors' personal characteristics		
Age	Age in years of the investor at the beginning of the observation period	Investors dataset
Experience	Experience in years of the investor beginning with the opening of the broker account until the time of the specific transaction	Investors dataset
Male dummy	Set to one if investor is male[1]	Investors dataset
Retired dummy	Set to one if investor is retired[1]	Investors dataset
Married dummy	Set to one if investor is married[1]	Investors dataset
Doctorate dummy	Set to one if investor has at least a doctorate degree[1]	Investors dataset
Both products dummy	Set to one if investor trades in both leverage certificates and warrants during the observation period	Investors dataset
Professional dummy	Set to one if investor belongs to a job category related to finance[1]	Investors dataset
Portfolio holdings	Month-end portfolio holdings in ten thousand € per investor	Investors dataset
Income < 25 dummy	Set to one if income of the investor is smaller than 25,000 €[1]	Investors dataset
Income > 75 dummy	Set to one if income of the investor is larger than 75,000 €[1]	Investors dataset
Foreign dummy	Set to one if investor is foreign-born	Investors dataset
Investors' location-based characteristics		
Persons/sqkm	Population density, i.e. persons per square kilometer, of investor's administrative district or city	GENESIS
Catholic dummy	Set to one if the share of Catholics is larger than the share of Protestants in investor's administrative district or city	EU Census 2011
Wealth level	Logarithm of GDP per person employed of investor's administrative district or city	GENESIS
A-levels rate	Share of school-leavers with A-levels in investor's administrative district or city	GENESIS
No graduation rate	Share of school-leavers without a basic secondary school certificate in investor's administrative district or city	GENESIS
Unemployment rate	Unemployment rate in terms of the entire civilian working population in investor's administrative district or city	GENESIS
Foreign born rate	Foreign citizens as percentage of total population of investor's administrative district or city	GENESIS
Lottery tax dummy	Set to one if the lottery tax payments per person of investors' state are larger than the overall average in Germany	GENESIS
Trading environment for each round-trip		
Long dummy	Set to one if the position is a long leverage certificate or long warrant	Trade dataset
Exchange dummy	Set to one if the trade took place on an exchange	Trade dataset
Limit dummy	Set to one if a limit order was used during the round-trip	Trade dataset
Log volume	Logarithm of the trade's purchase volume	Trade dataset
Risky pf share	Share of volume bought in knock-out products in all bought volumes over the observation period	Trade dataset
Trade number	Number of round-trips per investor	Trade dataset
Return (2m) dummy	Set to one if the DAX return over the last two months was positive	Sirca
Return (1d)	Lagged one day DAX return	Sirca
Volatility dummy	Set to one if the value belongs to the highest volatility quintile of the 30-day mean VDAXNEW return	Sirca
Other variables		
DAX exposure	Sensitivity of product value with respect to the underlying	Trade dataset
Controls		
Quarter dummy	Dummy for each quarter of the observation period	Trade dataset

1 The status refers to the date of data collection, i.e. after the observation period.

This table exhibits an overview of all variables used during the empirical analysis. It includes the abbreviations used, a description of the variables and the data source. Variables are grouped according to key investors' personal characteristics, investors' location-based demographic characteristics, characteristics of trading environmental, and other variables and control variables used. Data sources are as follows: (i) Trade dataset and investors dataset: Dataset provided by a large German online broker with a very large base of retail customers, (ii) GENESIS: Regional Database Germany (GENESIS) of the Federal Statistical Office and the Statistical Offices of the *Länder*, (iii) EU census 2011: EU population and housing census 2011, (iv) Sirca: Securities Industry Research Centre of Asia-Pacific (SIRCA) on behalf of Thomson Reuters.

Table 4: Risk Taking and Investors' Socio-Economic Characteristics

	Warrants			**Leverage certificates**		
	(1)	(2)	(3)	(1)	(2)	(3)
Investor's personal characteristics						
Age	-0.005 ***	-0.005 ***	-0.003 ***	-0.006 ***	-0.007 ***	-0.006 ***
Experience	-0.008 ***	-0.010 ***	-0.009 ***	-0.008 ***	-0.012 ***	-0.007 ***
Male dummy	-0.002	-0.006	-0.022	0.067 ***	0.070 ***	0.069 ***
Retired dummy	0.016	0.007	-0.017	-0.018	-0.082	-0.027
Married dummy	-0.066 ***	-0.052 ***	-0.029 *	-0.059 ***	-0.069 ***	-0.054 ***
Doctorate dummy	-0.021	-0.073 ***	-0.025	-0.071 ***	-0.139 ***	-0.066 ***
Both products dummy	0.200 ***	0.223 ***	0.153 ***	-0.002	-0.041 **	-0.006
Professional dummy	0.000	-0.019	0.007	0.035 *	-0.009	0.043 **
Portfolio holdings	-0.004 ***	-0.001 *	0.000 ***	-0.004 ***	-0.001	0.000 ***
Income < 25 dummy	0.028 **	0.022	-0.011	-0.019	-0.009	-0.011
Income > 75 dummy	0.021	-0.028	0.024	-0.031 *	0.024	-0.024 *
Foreign dummy	0.110 ***	0.090 **	0.040	0.017	0.098 **	0.016
Population density (persons/sqkm)						
300 to 1,500	0.026 **	0.015	-0.015	-0.039 ***	-0.010	-0.040 **
>1,500	0.024	0.014	-0.001	-0.135 ***	-0.062	-0.134 ***
Other investors' location-based characteristics						
Catholic dummy	0.014	-0.006	0.035 ***	0.036 ***	0.035	0.036 ***
Wealth level	0.023	-0.006	-0.082 *	-0.033	0.026	-0.036
A-levels rate	0.085	0.065	0.224 **	0.052	-0.081	0.091
No graduation rate	0.095	0.138	-0.502	0.545 *	-0.131	0.600 **
Unemployment rate	0.396 *	0.093	0.519 **	0.494 **	1.289 ***	0.440 ***
Foreign born rate	-0.019	0.039	0.244 *	1.176 ***	0.287	1.212 ***
Lottery tax dummy	0.004	0.010	0.015	-0.081 ***	-0.044 *	-0.079 ***
Controls	Yes	Yes	No	Yes	Yes	No
Intercept	2.208 ***	2.846 ***	3.355 ***	4.791 ***	4.447 ***	4.620 ***
R^2	13.49	12.05	13.93	15.52	15.00	3.54
N	35,377	35,377	35,377	48,200	48,200	48,200

This table exhibits the results of (1) pooled, (2) random effects and (3) Fama-McBeth risk taking regressions. The dependent variable is the monthly average of the DAX exposure per investor as defined in Equation (5) for all reported regressions. The independent variables are grouped into three categories: Investors' personal characteristics, location-based demographic measures and control variables. Moreover, as controls I use quarter dummies and for regressions (1) and (2) additionally the inverse Mills ratio, which is extracted using a two-stage procedure to account for self-selection in the trading decision (Heckman, 1979). Further definitions and data sources of the variables used are given in Table 3. Results are shown for warrants and leverage certificates separately. N denotes the number of observations. t-statistics are estimated using heteroskedasticity robust standard errors (White, 1980). Significance at the 10 % level is indicated with *, at the 5 % level with ** and at the 1 % level with ***.

Table 5: Risk Taking and Trading Environment

	Warrants	**Leverage certificates**
Long dummy	0.207 ***	0.117 ***
Exchange dummy	-0.640 ***	-0.518 ***
Limit dummy	0.402 ***	0.396 ***
Log volume	-0.116 ***	-0.266 ***
Risky pf share	0.012 ***	0.045 ***
Trade number	0.016 ***	0.018 ***
Return (2m) dummy	0.013	0.061 ***
Volatility dummy	-0.035 ***	-0.043 ***
Return (1d) x short	1.832 ***	4.420 ***
Return (1d) x long	0.105	-1.523 ***
Controls	Yes	Yes
Intercept	2.667 ***	5.956 ***
R^2	19.11	28.55
N	118,011	357,046

This table exhibits the results of the trading environment and risk taking regressions. The dependent variable is the DAX exposure as defined in Equation (5) and the independent variables are transaction, portfolio and market environmental characteristics and control variables. Quarter dummies are used as controls. Further definitions and data sources of the variables used are given in Table 3. Results are shown for warrants and leverage certificates separately. N denotes the number of observations. t-statistics are estimated using heteroskedasticity robust standard errors (White, 1980). Significance at the 10 % level is indicated with *, at the 5 % level with ** and at the 1 % level with ***.

Table 6: Risk Taking Persistence

	Warrants					Leverage certificates				
	CPR_{L1}	CPR_{L5}	$corr$	$coef$	N	CPR_{L1}	CPR_{L5}	$corr$	$coef$	N
Total	10.353	6.207	0.526	0.669	35,377	10.955	7.898	0.536	0.677	48,200
Long	9.559	5.789	0.507	0.686	17,439	10.138	7.293	0.521	0.690	23,197
Short	11.080	6.952	0.533	0.674	17,938	11.810	8.513	0.549	0.750	25,003
Age										
0 to 25 year	5.737	2.555	0.401	0.569	1,718	8.511	8.171	0.486	0.589	2,697
26 to 40 years	10.724	6.607	0.530	0.700	12,079	10.319	6.845	0.523	0.715	17,916
41 to 55 years	10.422	6.589	0.527	0.684	14,576	11.364	8.189	0.542	0.742	19,860
56 to 100 years	10.352	5.361	0.525	0.676	7,004	11.140	8.610	0.533	0.712	7,727
Experience										
0 to 1 year	16.382	11.888	0.603	0.712	4,002	8.802	7.310	0.495	0.689	4,895
1 to 5 years	9.516	5.427	0.509	0.648	6,823	11.225	7.851	0.540	0.721	10,663
5 to 10 years	9.306	5.630	0.506	0.683	18,122	11.326	7.959	0.542	0.715	26,232
More than 10 years	11.803	7.317	0.548	0.716	6,430	10.348	7.635	0.524	0.732	6,410
Gender										
Male	10.543	6.372	0.529	0.691	30,816	10.869	7.922	0.534	0.723	42,375
Female	9.307	5.451	0.506	0.654	4,344	11.297	7.152	0.540	0.739	5,514
n/a	6.640	2.057^{n}	0.438	0.378	217	13.060	20.938	0.566	0.500	311
Retirement status										
Retired	13.237	7.339	0.568	0.584	794	11.810	9.500	0.547	0.660	813
Not retired	10.292	6.178	0.525	0.688	34,583	10.936	7.879	0.535	0.726	47,387
Marital status										
Married	10.125	6.117	0.521	0.700	14,851	11.819	9.069	0.549	0.731	17,381
Not married	10.299	6.116	0.523	0.677	20,526	10.433	7.280	0.527	0.721	30,819
Doctoral degree										
Doctorate	10.515	4.395	0.528	0.530	1,822	12.031	10.520	0.551	0.688	1,835
No doctorate	10.341	6.342	0.525	0.695	33,555	10.908	7.806	0.535	0.727	46,365
Trader										
Leverage certificate						11.245	8.301	0.540	0.727	26,611
Warrant	11.122	6.805	0.537	0.696	21,656					
Both	8.640	5.183	0.487	0.675	13,721	10.619	7.491	0.530	0.725	21,589
Professional										
Professional	11.488	5.613	0.544	0.578	1,482	10.944	6.428	0.536	0.689	2,170
Not professional	10.306	6.241	0.525	0.693	33,895	10.955	7.983	0.536	0.727	46,030
Portfolio holdings										
<12,000 €	11.805	8.143	0.518	0.650	9,323	10.961	7.555	0.529	0.722	21,760
12,000 € to 27,000 €	8.995	4.826	0.499	0.667	16,829	10.135	7.400	0.521	0.715	18,803
>27,000 €	7.697	4.705	0.458	0.675	9,225	9.286	7.366	0.494	0.711	7,637
Income										
<25,000 €	10.953	4.977	0.534	0.686	4,536	10.053	5.863	0.520	0.689	7,367
25,000 € to 75,000 €	9.714	5.916	0.514	0.693	12,349	11.371	8.255	0.542	0.717	17,618
>75,000 €	11.266	5.765	0.541	0.580	1,998	16.932	12.043	0.609	0.708	2,707
n/a	10.545	6.817	0.529	0.690	16,494	10.307	7.837	0.525	0.738	20,508

The table exhibits information on the risk taking persistence of all 15,327 individual investors in the dataset. CPR is the cross product or odds ratio for consecutive risk persistence. To calculate CPR_{L1} I use the monthly averaged DAX exposures of two consecutive observations per investor and for CPR_{L5} the monthly averaged DAX exposures of two observations lagged by degree 5 respectively. *corr* denotes the correlation of the average DAX exposure of two consecutive observations for each investor. Moreover, as a parametric test for risk persistence, I extend regression (1) in Table 4 by the lagged monthly DAX exposure and report the respective coefficient, $coef$. The values are calculated for different investors' personal characteristics and long and short products. Results are shown for warrants and leverage certificates separately. All coefficient values and odds ratios (with one exception marked with ^{n}) are highly significant at a 1 % level.

Table 7: Risk Taking and Performance

	Warrants		Leverage certificates	
	(1)	(2)	(1)	(2)
DAX exposure				
2nd quintile	-0.013 *	0.020 ***	-0.019 ***	0.021 ***
3rd quintile	-0.003	0.030 ***	-0.050 ***	0.025 ***
4th quintile	-0.021 ***	0.057 ***	-0.073 ***	0.036 ***
5th quintile	-0.043 ***	0.085 ***	-0.070 ***	0.093 ***
Investors' personal characteristics				
Age	-0.001 ***	0.000 *	-0.001 ***	-0.001 ***
Experience	0.003 ***	0.000 **	0.001 ***	0.000
Male dummy	0.009	-0.002	0.008	0.009 ***
Retired dummy	0.042 **	-0.001	0.007	-0.001
Married dummy	0.004	0.002	0.002	0.002
Doctorate dummy	0.001	0.005	0.003	-0.002
Both products dummy	-0.020 ***	-0.028 ***	-0.001	-0.009 ***
Professional dummy	-0.005	-0.003	0.008	-0.006
Portfolio holdings	0.000 ***	0.000 **	0.001 ***	0.000
Income < 25 dummy	0.008	0.007 **	0.002	0.011 ***
Income > 75 dummy	0.001	0.001	-0.012	-0.014 ***
Foreign dummy	-0.008	-0.005	-0.017 *	0.007
Population density (persons/sqkm)				
300 to 1,500	-0.009	0.003	-0.005	-0.002
>1,500	-0.024 **	-0.010 *	0.002	-0.008
Other investors' location-based characteristics				
Catholic dummy	0.000	-0.002	0.001	0.003
Wealth level	0.011	0.006	0.016	0.003
A-levels rate	0.015	-0.031	-0.026	-0.025
No graduation rate	-0.282	0.017	-0.205	0.116
Unemployment rate	-0.011	0.138 **	0.245 ***	0.074
Foreign born rate	0.110	0.051	0.039	0.057
Lottery tax dummy	0.011 *	-0.002	-0.009 *	0.000
Controls	Yes	Yes	Yes	Yes
Pseudo-R^2	0.48	5.72	0.68	3.52
N	35,377	35,377	48,200	48,200

This table exhibits the results of two pooled logit regressions on individual investors' performance and risk taking. The dependent variable is one, (1) for the upper quintile of average monthly gross relative returns (GRR), as defined in Equation (6) and (2) for a knock-out (leverage certificates) or a total loss (warrants), defined as an average monthly GRR of -0.98 or lower. The independent variables are grouped into four categories: Quintiles of the risk variable, investors' personal characteristics, investors' location-based characteristics and control variables, which include quarter dummies. Further definitions and data sources of the variables used are given in Table 3. Results are shown for warrants and leverage certificates separately. N denotes the number of observations. Pseudo-R^2 is the percentage improvement in the log-likelihood achieved by the model compared to a constant-only model. t-statistics are estimated using heteroskedasticity robust standard errors (White, 1980). Significance at the 10 % level is indicated with *, at the 5 % level with ** and at the 1 % level with ***.

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