# The performance of individual investors in structured financial products

**Oliver Entrop · Michael McKenzie · Marco Wilkens · Christoph Winkler**

**Abstract** This paper is the first to measure individual investors' realized risk-adjusted performance in structured financial products, which represent one of the key financial innovations in recent times. Based on a large database of trades and portfolio holdings for 10,652 retail investors in discount and bonus certificates and common stocks, we find that (1) investors typically realize negative alphas in structured financial products, even when transaction costs are ignored. (2) Their underperformance increases with product complexity, which results from the higher implicit price premiums charged by the issuing banks for the more complex products and from the investors' poor selection of products that have complex payoff specifications. (3) Investors also make poor choices when selecting the underlying assets for their structured product investments. This is merely a reflection of the poor stock selection abilities which also leads to a significant underperformance for their equity portfolios. (4) Certificate and stock investors are prone to the disposition effect. Overall, these findings suggest that retail investors may require some form of protection to avoid incurring these losses.

O. Entrop
University of Passau, Innstr. 27, 94032 Passau, Germany
e-mail: oliver.entrop@uni-passau.de

M. McKenzie
University of Liverpool Management School, Liverpool L69 7ZH, UK
e-mail: michael.mckenzie@liverpool.ac.uk

M. McKenzie
University of Sydney Business School, Sydney, Australia

M. Wilkens (✉) · C. Winkler
University of Augsburg, Universitätsstr. 16, 86159 Augsburg, Germany
e-mail: marco.wilkens@wiwi.uni-augsburg.de

C. Winkler
e-mail: christoph-winkler@gmx.de

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## 1 Introduction

*Structured financial products* represent one of the key *financial innovations* for *retail investors* during the last decade. They provide investors with an alternative path to *diversify* their portfolios by investing in assets like single stocks, indexes, baskets, commodities, currencies, or interest rates. In contrast to the more traditional forms of investment (such as stocks, bonds, or mutual funds), structured financial products offer a far greater *variety of payoff profiles* which often cannot be realized by retail investors on their own due to high *transaction costs* or *market restrictions* such as short selling constraints.[1] The *flexibility* of structured financial products has proven to be extremely *popular*, in particular in Europe which accounts for 65 % of the estimated US$2tn global market (Demos 2012). To put that in perspective, Lord (2011) reports that the total value of structured retail products under management is comparable in size to the *hedge fund industry*.

While financial innovation theoretically benefits investors, it is interesting to note that there is considerable evidence to suggest that the real world experience of investors might be somewhat different. For example, Henderson and Pearson (2011) find that SPARQS, a certain type of US structured financial products issued by Morgan Stanley, generate an expected return that is *below the risk free rate*, and most likely negative. These results, however, do not account for the investors' actual buying and selling behavior.

The aim of this paper is to close this gap by examining a unique data set consisting of *investor level trade data* and *portfolio holdings* in structured financial products for more than 10,000 self-directed retail customers of a direct bank based in Germany.[2] We investigate the following questions: do retail investors *profit* from investing in innovative financial products, and to what extent? Do retail investors suffer from product *complexity*? How do investors cope with the *complex choice* problem when making buy decisions? These questions are of particular importance as, despite their advantages, investing in structured financial products poses some very real challenges for retail investors. For example, retail investors are often unable to calculate the fair *product value* or fully understand some complex payoff profiles. Carlin (2009) considers this issue and finds that issuers could have an incentive to increase complexity to exploit the low levels of *financial literacy* among investors. In addition, the *selection* of structured financial products is far more complex compared to simple stock selection, since investors have the choice between various payoff profiles, underlying assets, maturities, issuers, and other product

[1] Financial innovation is most commonly argued to arise from the need to reduce market imperfections. The ability of investors to access alternative payoff profiles through the use of structured financial products is consistent with this view. Other explanations for financial innovation include the reduction of transaction costs or tax benefits (see, e.g., Ross 1989; Grinblatt and Longstaff 2000). Tufano (2003) provides a comprehensive overview of the literature on financial innovation.

[2] Note that Germany is the largest and most advanced market for structured retail products in the world (see Sect. 2.1).

characteristics.[3] This issue is further complicated by the fact that most structured products have a fixed life. Therefore, unlike a buy-and-hold strategy, asset selection is not a one-time proposition, as structured products that mature will need to be *replaced*. Altogether, individual investors face significant search costs when trading structured financial products.

In general, the findings of this paper suggest that retail investors have *not benefited* from this episode of financial innovation. Focusing on *discount and bonus certificates*, the two most popular types of structured retail products in Germany, we find that the investors' average risk-adjusted performance in both product types is *negative*, with economically significant net alphas of −3 and −10 % in annual terms, respectively. Ignoring direct and indirect transaction costs does not serve to alter these conclusions.

The fact that investor performance in *bonus certificates* is *worse* compared to discount certificates is interesting and implies that complexity in financial innovation is detrimental to investors' wealth. We investigate this issue and find two possible explanations. First, by considering *all* available discount and bonus certificates in the market, we find clear evidence that issuing banks price more complex products at higher premiums. This result is consistent with Carlin's (2009) hypothesis that complexity increases the issuers' market power due to retail investors' limited financial literacy. In an earlier study, Stoimenov and Wilkens (2005) show *higher* margins in *complex* products with embedded exotic options like bonus certificates in comparison to classic instruments like discount certificates.[4] Second, we find that investors make *positive* choices when they choose *discount* certificates, whereas they tend to make *bad* choices, i.e., they lose money, when selecting *bonus* certificates. Thus, our results show that the *search costs* for individual investors in the market for structured financial products are significant, an observation also made by Dorn (2012) for the less complex options market.

Further to this point, we also find that investors make *poor* choices when selecting the *underlying* asset for both types of structured product investments. This finding supports research showing that individual investors typically struggle with the task of stock selection and often make *suboptimal decisions* that result in underperforming equity portfolios (see, e.g., Odean 1999; Barber and Odean 2000, 2001; Barber et al. 2009). By examining investors' physical equity trades, our results suggest that the poor underlying selection abilities in structured products are merely a reflection of their *poor stock selection* abilities which leads to a significant underperformance for their equity portfolios, both in gross and net terms.

Finally, we find evidence that structured product investors are prone to the *disposition effect*. In particular, they sell those products that outperformed comparable products with different underlying assets sooner, while holding on to underperforming products longer. Equivalent behavior is observed in equity trades.

The results of this paper raise some interesting questions as to how retail investors, who clearly have limited information processing capacities, could be *protected* when investing in complex innovative financial products. According to Bergstresser et al. (2009) and

[3] This results in a vast number of available products in the market. For example, on the European Warrant Exchange (Euwax) alone, the leading exchange for structured retail products in Germany, more than one million different products can be traded at the same time (source: see the website of the German Derivatives Association, available at www.deutscher-derivate-verband.de).

[4] Further evidence for these findings is given by Baule and Tallau (2011) who estimate an average margin for bonus certificates on the DAX index of between 2.09 and 4.85 % whereas Stoimenov and Wilkens (2005) and Baule (2011) find that discount certificates on the DAX index are issued at an average premium to fair value of only 2.06 and 0.42 %, respectively.

Bhattacharya et al. (2012), access to financial advice is unlikely to solve this problem. Therefore other solutions might be considered, such as the requirement that investors possess some form of 'structured product trading license', or the prohibition of excessive product complexity, or the restriction on some *core payoff profiles* which are easy to understand and calculate.

The remainder of the paper is organized as follows. Section 2 briefly describes the market for retail structured products and the characteristics of the discount and bonus certificates in our sample. Section 3 introduces the data used in our empirical study and Sect. 4 evaluates investor performance in structured product and stock investments. Section 5 examines individual investors' structured product selection abilities while Sect. 6 checks the robustness of our results. Section 7 concludes and discusses policy implications.

## 2 Retail structured products

This paper analyzes German retail investors' performance in *investment certificates*, which is a major subgroup of retail structured financial products. In contrast to highly speculative leverage products, investment certificates have a longer time to maturity, which is usually between 1 and 2 years from issuance, and are held for around 20 months on average in our sample.

### 2.1 Market for retail structured products

In 2008, the average amount invested in German investment certificates was around EUR 86 billion, which is almost 99 % of all certificates. For the same period, investment certificates made up about 50 % (around EUR 36 billion) of the total retail order volume of certificates on the European Warrant Exchange (Euwax).[5] In our study, we focus exclusively on *discount and bonus certificates*. These are the most *popular* types of investment certificates, with market shares of around 30 and 25 % of total order volume.[6]

Investment certificates can be traded on *exchanges* as well as on trading *platforms* provided by the issuers. As retail investors do not have direct access to these exchanges and platforms, they buy and sell these products via their custodian accounts. In Germany, the Euwax and Scoach are the dominant exchanges with market shares of 63 and 37 % respectively as at December 2008.[7] Issuers are obliged to provide *liquidity* on the exchanges, so they act as a market maker and continuously quote binding prices for their certificates. They are usually the *counterparty* for individual investor purchase and sale transactions. In taking this role, the issuers are able to make profits by quoting bid and ask prices *above* the certificate's theoretical *fair value* as short-selling is explicitly forbidden by the exchange rules. These idiosyncrasies also imply that price arbitrage is not possible for individual investors on that market. In addition, the lack of short-selling strongly limits the potential of investment certificates as hedging instruments.

[5] The remaining 50 % of the order volume is represented by highly speculative leverage certificates which are usually held for a few days only.

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

[7] Ibid.

### 2.2 Discount and bonus certificates

To assess the effects of product complexity on individual investors' wealth and their choice behavior, it is necessary to take into account products that are *different in complexity* with respect to their payoff profile. Thus, we focus on classic *discount certificates* and classic (non-capped) *bonus certificates*. These are the two most popular types of structured financial products in Germany and the *latter* are more *complex* and harder to replicate due to an embedded barrier option. While discount and bonus certificates are issued on a wide range of stocks, most trading activity takes place in certificates that are written against stocks in the DAX index. As such, the analysis in this paper concentrates solely on *transactions and holdings* data for classic *discount* and classic *bonus certificates* on the *30 stocks* listed in the *DAX* index in the corresponding months. In addition to that, we include the investors' direct *stock holdings and trades* which allows us to examine whether their trading behavior in stocks is mirrored in the more complex setting of structured products. For reasons of consistency, we also limit our analysis of the investors' equity investments to the same set of DAX stocks.

In buying a discount certificate, the investor *participates* in the underlying's price movements. Its *upside* potential, however, is *limited* by a cap. To compensate the investor for this cap, discount certificates will trade at a *lower price* compared to the underlying. The payoffs to a discount certificate at maturity can thereby be replicated by a combination of a zero-strike call on the underlying and a short call (strike = cap) which is similar to a *covered call position* (see Fig. 1 for payoff profiles).[8]

A bonus certificate promises a fixed payment above the underlying's value at maturity (*bonus level*) if the price of the underlying does not touch or fall below a lower barrier during the lifetime of the product and if the underlying quotes below the bonus level at maturity. In all other cases, the investor receives the underlying or its cash value at maturity. The payoff profile for a bonus certificate equals a combination of a *zero-strike call* and a *down-and-out put* (strike = bonus level; barrier of the option = barrier of the certificate) on the underlying. A bonus certificate will trade close to the price of the underlying if the barrier has been breached or if the underlying price is well above the bonus level. A bonus certificate will trade above the underlying's price if there is potential for the investor to receive the bonus of a larger value than the current underlying price.

It should be noted that, in contrast to direct stock investments, investors do *not receive dividend* payments through their discount and bonus certificate positions. However, they should also profit from the underlying's dividend payments as these should be incorporated in the issuers' pricing formula in a fair price setting.

## 3 Data set

This paper uses a unique account level data set for 10,653 retail customers of a large *German direct bank* which offers brokerage *without* giving financial *advice*. Individual transaction and monthly portfolio holdings information is provided for DAX stocks included in the DAX index and for discount and bonus certificates written against those same stocks. The data span the period from February 2004 through December 2008. We further have information on each certificate's name, ISIN, issue date, maturity date,

[8] Cheung and Chung (1996) and Carroll and Brask (1999) provide simple methods to replicate the payoffs of covered calls through combinations of plain vanilla options.

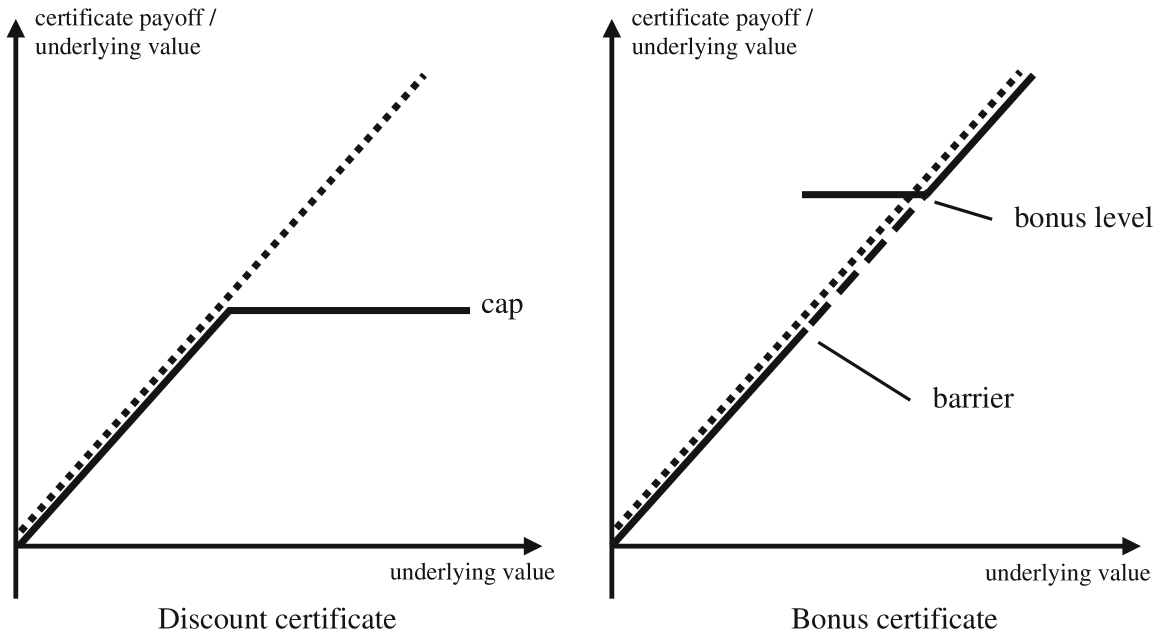


**Fig. 1** Payoff profiles of discount and bonus certificates. This figure shows payoff profiles of discount and bonus certificates dependent on the price of their underlying at the maturity date. The payoff of the certificate is indicated by the *solid line*, the value of the underlying is indicated by the *dotted line*. The *dashed line* in the *right figure* indicates the payoff of the bonus certificate at maturity if the price of the underlying has touched or fallen below the barrier level during its lifetime

underlying, issuer, cap level (for discount certificates), bonus and barrier level (for bonus certificates). This level of detail allows us to uniquely classify each certificate by its *payoff profile*.

Table 1 presents a range of summary statistics for the data set and reveals that, of the 10,653 retail investors in the data set, 3,895 (36.6 %) trade discount certificates at least once, 8,165 (76.6 %) trade bonus certificates at least once, and 1,407 investors (13.2 %) carried out at least one transaction with both discount and bonus certificates. The majority of the certificate investors also trade DAX stocks (9,815 or 92.1 %). The average *number of trades* per investor for discount certificates (8.06) is almost twice as much as it is for bonus certificates (4.32). Similarly, the average *transaction size* per trade is also higher for discount certificates (EUR 5,947) compared to bonus certificates (EUR 4,865) and both are higher when compared to the average trade size for common stocks (EUR 4,069).

The number of different securities traded in the database is very large for discount certificates (8,918) relative to bonus certificates (3,306). Recall that all of these certificates have one of the 35 stocks listed in the DAX index during our sample period as the underlying asset. The total number of trades for discount certificates (31,391) is similar to bonus certificates (35,258) as, while discount certificates have a lower number of investors, they tend to trade almost twice as often. The average relative commission for certificate transactions is low compared to stock transactions which could be the result of smaller stock trade sizes.

In addition to these individual account data, daily bid and ask closing prices for all discount and bonus certificates were sourced from the SIRCA Thomson Reuters Tick History (TRTH) database.[9] The equivalent data for all stocks in the DAX index are sourced

[9] Details of the SIRCA Thomson Reuters Tick History (TRTH) database can be found at www.sirca.org.au/products/.

**Table 1** Descriptive statistics on the investor holdings and trade data set

| | Certificates | | Stocks |
|---|---|---|---|
| | Discount | Bonus | |
| No. investors (#) | 3,895 | 8,165 | 9,815 |
| Avg. no. trades (#) | 8.06 | 4.32 | 47.25 |
| Avg. trade size (EUR) | 5,947 | 4,865 | 4,069 |
| No. securities (#) | 8,918 | 3,306 | 35 |
| No. trades (#) | 31,391 | 35,258 | 463,800 |
| Avg. commission (%) | 0.15 | 0.16 | 0.27 |
| Avg. spread (%) | 0.38 | 0.77 | 0.23 |
| Avg. roundtrip costs (%) | 0.68 | 1.09 | 0.77 |

This table reports descriptive statistics for a sample of 10,653 retail investors and their portfolios of discount and bonus certificates with DAX stocks as underlying, and of DAX stocks from a large German direct bank. The sample period is from February 2004 to December 2008. We include investors who carried out at least one transaction in either discount or bonus certificates. No. investors stands for the number of investors with at least one transaction in the particular security class. Avg. no. trades is the average number of transactions per investor during our sample period. Avg. trade size is the mean value per trade. No. securities is the number of different securities traded in our sample. No. trades is the total number of purchase and sale transactions, and maturity repayments. Avg. commission denotes the average commission paid for each trade in relation to the trade value. Avg. spread is the average bid/ask spread per roundtrip trade, as estimated in Eq. (1). Avg. roundtrip costs stands for the average loss per roundtrip trade, caused by commissions and spreads, in relation to the purchase value

from Datastream. Using these data, we compute *bid/ask spreads* for every security $j$ on each trading day $d$ during our sample period:

$$spr_{dj} = \frac{P_{dj}^{ask} - P_{dj}^{bid}}{0.5\left(P_{dj}^{ask} + P_{dj}^{bid}\right)} \tag{1}$$

where $P_{dj}^{bid}$ and $P_{dj}^{ask}$ are closing bid and closing ask prices, respectively. Spreads for certificates are known to be relatively constant during the day. Moreover, since issuers act as market makers, they are obliged to execute orders at the respective bid or ask price, which means that the use of closing prices is unlikely to have any significant impact on the estimates. The final column of Table 1 shows that the average bid/ask spread of DAX stocks is relatively low (0.23 %) in comparison to discount certificates (0.38 %) and bonus certificates (0.77 %).[10] These results imply that investors have to pay for complexity in structured products through larger spreads. Summing up the costs of commissions and spreads, an investor loses 0.68 % (1.09 %) of his invested money through direct and indirect transaction costs for each roundtrip trade in discount (bonus) certificates. *Roundtrip costs* for DAX stocks are similar at 0.67 % on average.

[10] Our spread estimates for discount certificates are comparable to Baule et al. (2008) who report bid/ask spreads of 0.35 % for discount certificates on DAX stocks in 2004. Baule and Tallau (2011) report bid/ask spreads of between 0.07 and 0.22 %, depending on the issuer, for bonus certificates on the DAX index. This suggests that bid/ask spreads are larger for certificates on single stocks than on equity indexes.

## 4 Investor performance

We measure the *performance of individuals* for their discount certificate, bonus certificate, and direct stock investments at a monthly frequency. In addition to the calculation of raw returns, we also apply a three-factor alpha model which accounts for linear and non-linear market risk exposures.

### 4.1 Performance measurement

To isolate the impact of *commissions* and *bid/ask spreads* on investor performance, three different measures of return are calculated. The first measure is a *gross* return $\left(R_{ijt}^{gr1}\right)$ which ignores any transaction fees apart from bid/ask spreads, and is calculated for the position in security $j$ held by investor $i$ as:

$$R_{ijt}^{gr1} = \frac{V_{ijt} - V_{ijt-1} - NPS_{ijt} + D_{ijt}}{IC_{ijt}} \tag{2}$$

where $V_{ijt}$ is the position value of security $j$ at the end of month $t$, $NPS_{ijt}$ denotes the net of purchases and sales/redemptions, based on actual execution prices, during month $t$. $D_{ijt}$ are dividends received during month $t$ (always zero for certificates). $IC_{ijt}$ stands for the amount of invested capital in month $t$ which is the sum of $V_{ijt-1}$ and the value of purchases made by investor $i$ in security $j$ during month $t$. Hereby, we follow Bauer et al. (2009) and assume that all securities are purchased at the beginning of the month and are sold or redeemed on the last day of the month. We acknowledge that this approach will bias both the positive and the negative returns towards zero and the results should be interpreted accordingly.

A second measure of *gross* returns $\left(R_{ijt}^{gr2}\right)$ is calculated which assumes that purchases and sales are executed at the mid price:

$$R_{ijt}^{gr2} = \frac{V_{ijt} - V_{ijt-1} - NPS_{ijt}^{mid} + D_{ijt}}{IC_{ijt}^{mid}} \tag{3}$$

i.e., half the bid/ask spread estimated in Eq. (1) is added to (subtracted from) the execution price of a sale (purchase).

The third measure is a monthly *net* return $\left(R_{ijt}^{net}\right)$ which takes into account the negative effects of both commissions $\left(TC_{ijt}\right)$ and bid/ask spreads:

$$R_{ijt}^{net} = \frac{V_{ijt} - V_{ijt-1} - NPS_{ijt} + D_{ijt} - TC_{ijt}}{IC_{ijt}} \tag{4}$$

Across these three return measures, it logically follows that $R_{ijt}^{gr2} \geq R_{ijt}^{gr1} \geq R_{ijt}^{net}$.

Following Barber and Odean (2000), the returns to a single security are aggregated to form *value-weighted* monthly portfolio returns at the investor level for each security group,

$$R_{it} = \sum_{j=1}^{m_{it}} p_{ijt} R_{ijt} \tag{5}$$

where $p_{ijt}$ is the proportion of security $j$ in the security group portfolio held by investor $i$ during month $t$, measured on the basis of the invested capital $\left(IC_{ijt}\right)$ and $m_{it}$ is the number of different securities of the same security group held by investor $i$ in month $t$.

Finally, we obtain monthly returns for the *average* investor for their security group subportfolio as

$$R_t = \frac{1}{n_t}\sum_{i=1}^{n_t} R_{it} \tag{6}$$

where $n_t$ is the number of investors who are invested in the same security group in month $t$. We weight investors equally to measure the performance of an average investor instead of a weighted portfolio of investors. Hereby we limit the effect of very large portfolios on our results.

The end result of this process is three different estimates of monthly returns $\left(R_t^{gr2}, R_t^{gr1}, R_t^{net}\right)$ for each class of asset, i.e., discount certificates, bonus certificates and stocks, respectively.

In addition to the three measures of returns to investors' certificate and common stock portfolios, performance can also be assessed using a measure of *risk-adjusted* performance. To this end, we specify the following multifactor model which can be individually estimated for discount certificate, bonus certificate, and stock portfolios:

$$R_t - R_{ft} = \alpha + \beta_{DAX} R_{DAXt} + \beta_{ATMC} ATMC_t + \beta_{ATMP} ATMP_t + \varepsilon_t \tag{7}$$

where $\beta_{DAX}$, $\beta_{ATMC}$, and $\beta_{ATMP}$ are coefficients to be estimated and $\varepsilon_t$ is the error term. The intercept ($\alpha$) in this equation provides an estimate of the risk-adjusted performance of the average investor's security group subportfolio.

$R_{ft}$ is the month $t$ risk-free rate which is proxied by the one-month money market rate reported by the Deutsche Bundesbank (series SU0104). $R_{DAXt}$ is the monthly DAX performance index excess return which is the proxy for the market factor. The use of the DAX index is a logical outcome of our choice to only consider stocks included in the index or certificates written against those stocks.

$ATMC_t$ and $ATMP_t$ denote the monthly excess returns to a *call* and *put* trading strategy, respectively. To understand the role of these two factors, recall that the payoffs to a discount certificate can be replicated using a zero-strike call (which is equal to an underlying position without dividend payments until maturity of the certificate) and a short call position, while the payoffs to a bonus certificate are represented as the sum of a zero-strike call and a down-and-out put. This means that a portfolio containing discount or bonus certificates is subject to some form of *nonlinear risk*. The market factor is unable to fully account for this nonlinearity and so, additional variables must be employed to perform in this role. Following Glosten and Jagannathan (1994), Agarwal and Naik (2004) and Bauer et al. (2009), we include the variables $ATMC_t$ and $ATMP_t$ which measure the excess returns of *at-the-money* (ATM) calls and puts on the DAX performance index, respectively. These call and put factors are constructed as follows: at the end of each month, ATM call and put options on the DAX expiring on the third Friday of the month following the next month are purchased. At the end of the next month these options are sold and again ATM calls and puts with a maturity of then almost 2 months are purchased. Thus, we obtain a time series of monthly excess returns for the call factor and for the put factor. As these options are ATM, we are careful to only select those options whose strike price is closest to the current index value. Further, to avoid multicollinearity, we *orthogonalize* the

call and the put factor by the market factor. All option prices were sourced from Datastream.

Note that Fama and French's (1993) SMB and HML factors and Carhart's (1997) WML factor are not included in this multifactor regression model specification. Recall that the focus of our model is on explaining the returns of only 30 blue chip stocks and their derivatives. Fama and French's (1993) size and value factors and Carhart's (1997) momentum factor are typically employed to explain a much larger investment universe and the construction of SMB, HML, and WML factors for a sample of only 30 stocks is neither sensible nor feasible.

### 4.2 Main results

Each of the different measures of raw $\left(R_t^{gr2}, R_t^{gr1}, R_t^{net}\right)$ and risk-adjusted returns ($\alpha$) are separately estimated for discount certificates, bonus certificates, and stocks. The results for the *full sample period* are presented in Panel A of Table 2. Before the deduction of direct and indirect transaction costs $\left(R_t^{gr2}\right)$, investors win on average 0.01 % per month with their discount certificate investments, *lose* 0.18 % on their bonus certificate investments and earn 0.17 % per month on their DAX stock investments. After the deduction of direct and indirect transaction costs $\left(R_t^{net}\right)$, however, investors *lose* on their investments in discount and bonus certificates (−0.07 and −0.23 %, respectively). Their investments in stocks in the *DAX index*, however, earn a net *positive* return of 0.11 % per month. It is interesting to note that these raw returns to DAX stock holdings are consistently less than the average monthly DAX performance index returns (0.40 %).

Comparing across the two different measures of gross returns $\left(R_t^{gr2} \text{ and } R_t^{gr1}\right)$, bid/ask spreads reduce certificate returns by about 0.02 percentage points for discount certificates and 0.03 percentage points for bonus certificates per month. The effects of bid/ask spreads on DAX stock returns are close to zero (0.01 percentage points). The differences between the net and gross return after spreads (i.e., $R_t^{gr1}$ and $R_t^{net}$) show that investors lose an average of 0.06 % per month for discount certificates, 0.02 % for bonus certificates, and 0.05 % for stocks through trade commissions. These numbers are low when compared to Barber and Odean's (2000) results, which show that stock investors lose 0.13 % on average per month in return terms through direct and indirect trading costs. Bauer et al. (2009) calculate an even larger negative monthly return impact of almost 1 %, caused by direct transaction costs for stock portfolios. The *lower costs* in this study could be a reflection of the longer holding periods and lower transaction costs in our sample. This is not to suggest, however, that our cost estimates are irrelevant. In annual terms, the direct and indirect trading costs add up to economically significant 0.93 % (0.67 %) for discount (bonus) certificate portfolios and 0.70 % for stock portfolios, respectively.

Panel A of Table 2 also presents the estimated $\alpha$ coefficient from Eq. (7). This is a measure of risk-adjusted return which accounts for linear and non-linear market risk exposures. Even when trading costs are ignored $\left(R_t^{gr2}\right)$, monthly *alphas* are *negative* for *discount* certificates at −0.17 % which is equivalent to −2.02 % per year. The risk-adjusted performance of *bonus* certificate investments is even *worse*, with a significant and negative alpha equal to −0.80 % which is equivalent to −9.19 % per year.

Our sample of investors performs *poorly* with their *direct investments* as well, the estimate of alpha for stocks is −0.18 % (or −2.14 % per year). Recall that for the purposes

**Table 2** Performance of individual investors' certificate and stock portfolios

| | $R_t^{net}$ | | | $R_t^{gr1}$ | | | $R_t^{gr2}$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | Discount | Bonus | Stocks | Discount | Bonus | Stocks | Discount | Bonus | Stocks |
| Panel A: Performance full period: 2004/02–2008/12 | | | | | | | | | |
| Raw return | −0.07 % | −0.23 % | 0.11 % | −0.01 % | −0.21 % | 0.16 % | 0.01 % | −0.18 % | 0.17 % |
| Alpha | −0.25 % | −0.85 %** | −0.24 %** | −0.20 % | −0.83 %** | −0.19 % | −0.17 % | −0.80 %* | −0.18 % |
| | (0.277) | (0.039) | (0.047) | (0.391) | (0.046) | (0.115) | (0.450) | (0.053) | (0.131) |
| Panel B: Performance subperiod 1: 2004/02–2006/07 | | | | | | | | | |
| Raw return | 0.50 % | 0.11 % | 0.72 % | 0.56 % | 0.14 % | 0.77 % | 0.58 % | 0.19 % | 0.78 % |
| Alpha | −0.27 % | −1.09 % | −0.40 %** | −0.21 % | −1.06 % | −0.36 %** | −0.19 % | −1.00 % | −0.35 %** |
| | (0.263) | (0.102) | (0.016) | (0.377) | (0.114) | (0.034) | (0.423) | (0.114) | (0.034) |
| Panel C: Performance subperiod 2: 2006/08–2008/12 | | | | | | | | | |
| Raw return | −0.65 % | −0.59 % | −0.53 % | −0.61 % | −0.58 % | −0.48 % | −0.58 % | −0.56 % | −0.47 % |
| Alpha | −0.22 % | −0.55 % | −0.07 % | −0.18 % | −0.53 % | −0.02 % | −0.15 % | −0.51 % | −0.01 % |
| | (0.515) | (0.356) | (0.650) | (0.601) | (0.372) | (0.894) | (0.654) | (0.372) | (0.894) |
| | Full period: 2004/02–2008/12 | | | Subperiod 1: 2004/02–2006/07 | | | Subperiod 2: 2006/08–2008/12 | | |
| | Discount | Bonus | Stocks | Discount | Bonus | Stocks | Discount | Bonus | Stocks |
| Panel D: Factor loadings | | | | | | | | | |
| $R_{DAX}$ | 0.6653*** | 0.9765*** | 0.9750*** | 0.6123*** | 1.2448*** | 0.9877*** | 0.6009*** | 1.0624*** | 0.9515*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) | (0.000) |
| *ATMC* | −0.0260*** | 0.0217** | −0.0026 | −0.0130** | −0.0163 | 0.0001 | −0.0389*** | 0.0399** | −0.0082 |
| | (0.000) | (0.043) | (0.423) | (0.040) | (0.680) | (0.983) | (0.000) | (0.019) | (0.118) |
| *ATMP* | 0.0116* | −0.0149 | 0.0035 | 0.0041 | 0.0179 | 0.0025 | 0.0137 | −0.0197** | 0.0043 |
| | (0.099) | (0.163) | (0.432) | (0.550) | (0.593) | (0.575) | (0.128) | (0.017) | (0.404) |

**Table 2** continued

| | Full period: 2004/02–2008/12 | | | Subperiod 1: 2004/02–2006/07 | | | Subperiod 2: 2006/08–2008/12 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Discount | Bonus | Stocks | Discount | Bonus | Stocks | Discount | Bonus | Stocks |
| Adj. $R^2$ (%) | 78.43 | 65.27 | 93.65 | 80.62 | 61.70 | 92.76 | 77.70 | 67.49 | 93.64 |

This table reports monthly average raw returns and three-factor alphas of discount, bonus, and equity portfolios in $R_t^{net}$, $R_t^{gr1}$, and $R_t^{gr2}$ terms. Panel A presents the performance for the full sample period, February 2004 to December 2008, Panel B for the first subperiod from February 2004 to July 2006, and Panel C for the second subperiod from August 2006 to December 2008. Panel D presents estimated coefficients for the full period and the two subperiods and for all three security group subportfolios, using $R_t^{gr2}$ excess returns as dependent variables. *p* values based on Newey–West heteroskedasticity and autocorrelation robust standard errors are in parenthesis. ***, **, * denote significance at the 1, 5, and 10 percent levels, respectively

of these calculations, dividend payments are incorporated into the stock return calculations. Thus, this latter result implies that the investors systematically *overweight poor* performing DAX *stocks* compared to the DAX performance index composition. This finding is consistent with Barber and Odean (2000) who also show poor risk-adjusted stock performance before the deduction of costs for US equity traders. Gross alphas estimated by Bauer et al. (2009) for Dutch equity traders, however, are close to zero. Taking trading costs into account $\left(R_t^{net}\right)$ worsens alphas even more, resulting in highly negative net alphas of −0.25 % for discount certificates, −0.85 % for bonus certificates, and −0.24 % for direct stock investments per month.

To test the *robustness* of these results to the choice of sample period, we re-estimated the raw and risk-adjusted measures of return in *two sample periods*. The first subperiod runs from February 2004 to July 2006 and includes the bull market period (the average monthly return of the DAX performance index is 1.18 %). The second subperiod runs from August 2006 to December 2008 and so captures the end of the bull market run and the subsequent collapse due to the subprime crisis (the average monthly DAX return is −0.40 %). The investment performance for both subperiods is presented in Panels B and C of Table 2, respectively.

The magnitude of the different cost components in the subperiods is similar to that previously discussed for the full sample. The main difference to the full sample results is that returns are typically *positive* across all asset classes in the *first subperiod*, while returns are *negative* across the board in the *second subperiod*. This is to be expected given the first subperiod captures the bull market, while the second subperiod includes the *crisis* in which markets dropped dramatically. In terms of risk-adjusted performance, the subperiod alphas are again negative, although less so for the second subperiod. As such, the subperiod results confirm the validity of the full period alphas. Their low level of statistical significance, particularly for discount certificates, is therefore likely to result from the small sample size.

Details of the individual coefficient estimates for the multifactor regression equation, in which returns are measured exclusive of the spread and commissions (i.e., $R_t^{gr2}$), are presented in Panel D of Table 2.[11] The *market betas* for *discount* certificates are considerably *lower than one* and their *call* factor loadings are *negative* and significant. This is to be expected given that discount certificates can be duplicated by a combination of a long zero-strike call and a short call position. For rising markets in particular, when the latter option is more likely to be in the money, this capped payoff structure results in reduced sensitivity to price movements of the underlying. By way of comparison, classic *bonus* certificates are more prone to underlying price changes since they are not capped. Therefore, their *market beta* is closer to *one* and we find that their option factor loadings change over time. As expected, individual investors' portfolios of DAX *stocks* have a *market beta* of almost *one* and no evidence can be found of significant nonlinear risk factors. The $R^2$ value for all estimated equations is large which suggests that the factor *model* specified explains discount certificate, bonus certificate, and stock returns *very well* and is *robust* over time.

So far, we have provided evidence of two important findings that warrant further investigation. First, the *risk-adjusted performance* of both structured product types is consistently *negative*. Second, the considerably low alphas of bonus certificates compared

[11] The estimation results are qualitatively similar, where $R_t^{gr1}$ or $R_t^{net}$ are specified as the dependent variable. These results are not presented to conserve space and are available on request.

to those of discount certificates. This latter result suggests that investors *suffer* severely from product *complexity* in some way. In the discussion that follows, we will provide further evidence on the various *causes* of this *poor performance*. Our analyses will also give further insights on the issue of how and why the complexity of financial innovation is harmful for individual investors. To begin, we note that *transaction costs*, like bid/ask spreads and commissions, only contribute to a small proportion of the net losses (0.08 % for discount, 0.05 % for bonus certificates in monthly alpha terms) and do *not explain the performance gap* between bonus and discount certificates at all.

One potential explanation for the negative alphas is the *overpricing* of certificates by the issuing banks. For example, Wilkens et al. (2003), Stoimenov and Wilkens (2005), and Baule (2011) find that discount certificates on the DAX index are issued at an average premium to fair value of 4.2, 2.06, and 0.42 %, respectively. Further, the *overpricing* of *discount certificates on stocks* is *larger* than for (performance) index certificates, as Stoimenov and Wilkens (2005) and Baule et al. (2008) estimate margins for discount certificates on DAX stocks of 3.63 % and between 0.39 and 1.97 %, respectively.[12] Marsden and Poskitt (2004), however, find average premiums of only 0.04 and 1.21 % for New Zealand instalment receipts which are less complex than discount certificates as they can be replicated without option components. Stoimenov and Wilkens (2005) find that, in comparison to classic instruments like discount certificates, *complex products* with embedded exotic options like bonus certificates are priced with a *higher margin*. Baule and Tallau (2011) provide further support for this finding and estimate an average margin for bonus certificates on the DAX index of between 2.09 and 4.85 %. For both discount and bonus certificates, issuers tend to reduce the markups as the time to maturity falls. Wilkens et al. (2003), Stoimenov and Wilkens (2005), Baule (2011), and Baule and Tallau (2011) provide evidence on this *lifecycle hypothesis*. This price setting behavior is expected to have a negative effect on both raw returns and alphas in the case of a buy-and-hold strategy, which is supported by Henderson and Pearson (2011) who find *negative expected returns* for SPARQS, a type of US retail structured equity product.

If discount and bonus certificates are overpriced and these margins decrease during their lifetime, the multifactor model value for alpha should be negative. To test this proposition, we estimate the alphas of portfolios consisting of *all* available certificates in the corresponding months. To this end, *price data for all discount and bonus certificates* on DAX stocks that were traded at Euwax during our sample period are gathered over the sample period.[13] For each certificate, monthly excess buy-and-hold returns from issuance to maturity on the basis of mid prices are calculated.[14] These monthly returns are averaged across all certificates in each group to get the final series which is specified as the dependent variable in the three-factor model specified in Eq. (7). To test the possibility that alphas are driven by over- and under-weighting certain underlying stocks, we also average certificate excess returns of the same underlying stock and then average across all underlying stocks.

The results of this analysis for the full sample period are presented in Panel A of Table 3. *Negative monthly alphas* of −0.22 % are estimated for discount certificates

[12] It is probable that issuers often do not embed dividend payments in their pricing formula. Hence, stock certificate investors lose alpha compared to a benchmark including positive dividend effects (e.g., the DAX performance index used in our factor model). Hernández et al. (2013) shed light on this issue and find that banks tend to issue outperformance certificates written on issues with relatively high dividend yields in order to enhance their own profits.

[13] These data are sourced from the SIRCA TRTH database.

[14] Intramonth returns in the months of issuance and maturity are treated as if they refer to the full month. This ensures comparability to the above calculated realized returns.

**Table 3** Performance of certificate benchmark portfolios

| | Equally weighted at the certificate level | | Equally weighted at the underlying level | |
|---|---|---|---|---|
| | Discount | Bonus | Discount | Bonus |
| Panel A: Performance full period: 2004/02–2008/12 | | | | |
| Raw return | 0.00 % | 0.14 % | 0.01 % | 0.06 % |
| Alpha | −0.22 % | −0.39 %* | −0.22 % | −0.44 %* |
| | (0.275) | (0.072) | (0.280) | (0.071) |
| Panel B: Performance subperiod 1: 2004/02–2006/07 | | | | |
| Raw return | 0.71 % | 1.07 % | 0.76 % | 1.10 % |
| Alpha | −0.31 % | −0.70 %*** | −0.21 % | −0.68 %*** |
| | (0.182) | (0.004) | (0.314) | (0.006) |
| Panel C: Performance subperiod 2: 2006/08–2008/12 | | | | |
| Raw return | −0.68 % | −0.74 % | −0.71 % | −0.93 % |
| Alpha | −0.19 % | −0.17 % | −0.25 % | −0.36 % |
| | (0.501) | (0.499) | (0.350) | (0.199) |
| Panel D: Factor loadings (full period) | | | | |
| $R_{DAX}$ | 0.7017*** | 1.1192*** | 0.6769*** | 1.0832*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| *ATMC* | −0.0270*** | −0.0079 | −0.0261*** | −0.0102* |
| | (0.001) | (0.292) | (0.000) | (0.072) |
| *ATMP* | 0.0129* | −0.0011 | 0.0118* | 0.0007 |
| | (0.075) | (0.873) | (0.090) | (0.923) |
| Adj. $R^2$ (%) | 80.16 | 88.94 | 81.11 | 89.43 |

This table reports monthly average raw returns and three-factor alphas of portfolios consisting of all discount and bonus certificates on DAX stocks which were tradable in the corresponding months. For each certificate, monthly buy-and-hold returns from issuance to maturity are calculated on the basis of mid prices. Intra-month returns in the months of issuance and maturity are treated as if they refer to the full month. These results can therefore be compared to realized $R_t^{gr2}$ terms. Monthly returns are aggregated in two ways: (1) equally weighted across all certificates and (2) equally weighted across all certificates of the same underlying and then across all underlyings. Panel A presents the performance for the full sample period, February 2004 to December 2008, Panel B for the first subperiod from February 2004 to July 2006, and Panel C for the second subperiod from August 2006 to December 2008. Panel D presents estimated coefficients for the full period. *p* values based on Newey–West heteroskedasticity and autocorrelation robust standard errors are in parenthesis. ***, **, * denote significance at the 1, 5, and 10 percent levels, respectively

and −0.39 % for bonus certificates. Results for equally weighted returns on the underlying are similar and they are robust to testing within subperiods. Thus, consistent with the prior literature, these results suggest that discount and bonus certificates are priced above their fair value at the beginning of their lifetime and that the markups reduce as maturity approaches, resulting in *negative risk-adjusted returns*. More importantly, *overpricing for complex products*, such as bonus certificates, is *larger* than for discount certificates. This latter result is also in line with the observations of the past literature. In particular, it supports Carlin's (2009) finding that complexity increases the issuers' market power enabling them to set larger price premiums as some retail investors could be unable to determine the fair prices of complex products.

Comparing the alpha estimates of Table 3 to the equivalent values in Table 2, which are based on the investors' actual portfolio holdings of certificates, two observations are

immediately apparent. The realized alpha of bonus certificates is more negative (−0.80 % for the full period results for the mid price returns, $R_t^{gr2}$) compared to the alpha of a benchmark portfolio including all available bonus certificates (−0.39 %) which suggests that *overpricing explains only part* of investors' *underperformance* in bonus certificates. Realized alphas of discount certificate portfolios, however, are less negative (−0.17 %) than benchmark portfolio alphas of all discount certificates (−0.22 %), i.e., the investors partially compensate losses from overpricing by their trading behavior/decisions. Further, our results indicate that the issuers' pricing policy contributes only partially to the investors' actual complexity losses, since the performance gap between discount and bonus certificates is much larger for realized alphas than for benchmark portfolio alphas.

Overall, the results of this section show that the investors' risk-adjusted *performance* is *negative* for certificates and stocks, both *before and after transaction costs*, and that the *complexity* of structured products is *detrimental* to individual investors' wealth. Further, while the overpricing of certificates can explain some of these outcomes, other factors are clearly at play. One factor we can rule out is the influence of investors' abilities (or inabilities) to time the market.[15] As we only consider the average realized returns of the investors' actual monthly portfolio positions, and we do not take their overall portfolios (including their cash holdings) into account, the effects of unrealized returns from before the purchase or after the sale date are neglected.

Hence, the differences between the investors' realized alphas and the benchmark portfolio alphas as well as the large extent of realized complexity losses could rather be explained by the investors' ability to choose certificates from a large range of (overpriced) products. We analyze individual investors' *selection abilities* concerning various *certificate characteristics* in the following section. The above results indicate that investors are poor in selecting complex bonus certificates, while their discount certificate selection abilities are rather good.

## 5 Structured product selection

The literature suggests that individual investors (see Barber and Odean 2013 for an overview) and even institutions (see, e.g., Malkiel 1995; Gruber 1996) have *poor stock selection* abilities. *Structured product selection* is far *more complex* than simple stock selection, however, as investors are exposed to a large *variety of payoff profiles* from which they have to choose the most appropriate product type for their investment strategy. Further, they have the choice between various *maturity dates*, numerous *underlying assets*, and several *issuers*. Dorn (2012) addresses the issue of derivative selection complexity by analyzing how well individual investors choose options among similar alternatives. He finds that traders choose options that lose 1.2 % per one-week roundtrip trade compared to a benchmark portfolio comprised of ex ante superior options. He also finds that traders would have been better off by an average of 0.4 % per one-week roundtrip trade if they had chosen options randomly. Our paper is unique in that it is the first to extensively *investigate individual investor choice* of products representing more complex payoff profiles than plain vanilla options.

[15] However, as our data are monthly, we cannot rule out intra-month timing as a factor.

## 5.1 Methodology

To analyze individual investors' structured product selection abilities, we obtain detailed information on the *characteristics* of *all discount and bonus certificates* on DAX stocks which were tradable at Euwax during our sample period. This detailed information allows us to identify selection abilities with regard to issuer, moneyness (discount certificates), and distance to barrier/bonus level (bonus certificates), respectively. Moreover, since the products used in our study have stocks as the underlying asset, rather than an index, we are also able to examine investors' selection abilities with regard to the underlying asset.

To assess investors' structured product selection ability, we use the *Return Difference* (*RD*) between investors' realized returns and benchmark portfolio returns, i.e.:

$$RD^{y}_{t,t+T} = R^{y}_{t,t+T} - \frac{1}{S}\sum_{z \in S} R^{z}_{t,t+T} \tag{8}$$

where $R^{y}_{t,t+T}$ is the roundtrip return of certificate $y$ purchased on trading day $t$ and sold/redeemed on trading day $t + T$. The subtrahend denotes the roundtrip return of an equally-weighted benchmark portfolio. This benchmark portfolio consists of $S$ certificates which are available to the investor at the time of the purchase, including the actually purchased certificate.

A *roundtrip trade* is considered complete if a previously established position is entirely closed out, either through selling or through redemption at maturity. Moreover, the certificate's underlying has to be included in the DAX at the purchase and sale/redemption date and the position has to be closed by December 31, 2008 at the latest. Returns are calculated under the assumption that certificates are purchased at the Euwax closing ask price of the purchase day and sold at the closing bid price on the sale/redemption day. As such, the analysis does not account for intraday return effects. We also calculate $RD^{y}_{t,t+T}$ for incomplete roundtrips assuming that all open positions at the end of the sample period are sold at the Euwax closing bid on December 31, 2008.

For each roundtrip trade, *RD* is calculated relative to one of *four different benchmark portfolios*. Benchmark portfolio one (BP1) reflects a very broad benchmark containing *all certificates* of the same product group with *similar* remaining *time to maturity* (±5 trading days) as the purchased certificate which could have been purchased at the Euwax on that day. Benchmark portfolio two (BP2) is a restricted version of BP1, in which only those certificates with the *same underlying* as the purchased certificate are included. Benchmark portfolio three (BP3) has a further restriction that only certificates with a *similar* level of *moneyness* (±5 %) for discount certificates or a similar *distance to barrier and distance to bonus level* (±5 %) for bonus certificates, compared to the purchased certificate, are included.[16] Finally, benchmark portfolio four (BP4) excludes certificates from BP3 that are not issued by the same *financial institution* as the purchased certificate. Thus, BP1 to BP4 are benchmark portfolios consisting of certificates that are matched by an increasingly strict set of criteria. The *number of certificates* included in the benchmark portfolios therefore *reduces* from BP1 until BP4. *RD*s are only calculated if the particular benchmark portfolio consists of at least three certificates.

[16] Moneyness is calculated as the ratio of the underlying's closing price at the purchase date to the certificate's cap level. Distance to barrier is the ratio of the underlying's closing price at the purchase date to the certificate's barrier. Distance to bonus level is the ratio of the certificate's bonus level to the underlying's closing price at the purchase date.

**Table 4** Return differences of certificate roundtrips

| Subset filters (Benchmark certificates must have matched criteria to the purchased certificate.) | BP1 | BP2 | BP3 | BP4 | BP1 | BP2 | BP3 | BP4 | BP1 | BP2 | BP3 | BP4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time to maturity (±5 trading days) | Same | Same | Same | Same | Same | Same | Same | Same | Same | Same | Same | Same |
| Underlying | | Same | Same | Same | | Same | Same | Same | | Same | Same | Same |
| Moneyness (±5 %) | | | Same | Same | | | Same | Same | | | Same | Same |
| Issuer | | | | Same | | | | Same | | | | Same |
| | Full period: 2004/02–2008/12 | | | | Subperiod 1: 2004/02–2006/07 | | | | Subperiod 2: 2006/08–2008/12 | | | |
| Panel A: Discount certificates—all roundtrips (not annualized) | | | | | | | | | | | | |
| Mean *RD* | 0.60 %*** | 0.59 %*** | 0.15 %*** | 0.02 %** | 0.64 %*** | −0.01 % | 0.20 %*** | 0.01 % | 0.49 %*** | 1.10 %*** | 0.12 %*** | 0.02 %** |
| *p* value | (0.000) | (0.000) | (0.000) | (0.032) | (0.000) | (0.902) | (0.000) | (0.388) | (0.001) | (0.000) | (0.000) | (0.049) |
| SD of *RD* | 10.10 % | 5.78 % | 0.87 % | 0.25 % | 6.20 % | 4.78 % | 0.57 % | 0.22 % | 12.71 % | 6.51 % | 1.11 % | 0.26 % |
| # of observations | 14,598 | 14,414 | 9,971 | 1,194 | 6,667 | 6,513 | 4,326 | 238 | 7,931 | 7,901 | 5,645 | 956 |
| Panel B: Discount certificates—roundtrips completed in <100 days (not annualized) | | | | | | | | | | | | |
| Mean *RD* | 0.69 %*** | 0.40 %*** | 0.11 %*** | 0.01 % | 0.54 %*** | 0.18 %*** | 0.13 %*** | 0.05 %* | 0.77 %*** | 0.54 %*** | 0.09 %*** | 0.00 % |
| *p* value | (0.000) | (0.000) | (0.000) | (0.338) | (0.000) | (0.000) | (0.000) | (0.055) | (0.000) | (0.000) | (0.000) | (0.683) |
| SD of *RD* | 4.88 % | 3.25 % | 0.67 % | 0.19 % | 3.02 % | 1.80 % | 0.40 % | 0.19 % | 5.84 % | 4.02 % | 0.82 % | 0.20 % |
| # of observations | 4,660 | 4,625 | 3,176 | 419 | 1,693 | 1,665 | 1,117 | 55 | 2,967 | 2,960 | 2,059 | 364 |
| Panel C: Discount certificates—roundtrips completed in ≥100 days (not annualized) | | | | | | | | | | | | |
| Mean *RD* | −0.02 % | 0.40 %*** | 0.16 %*** | 0.01 % | 0.63 %*** | −0.07 % | 0.23 %*** | 0.00 % | −1.02 %*** | 1.04 %*** | 0.09 %*** | 0.02 % |
| *p* value | (0.867) | (0.000) | (0.000) | (0.430) | (0.000) | (0.393) | (0.000) | (0.986) | (0.000) | (0.000) | (0.000) | (0.390) |
| SD of *RD* | 10.81 % | 6.21 % | 0.97 % | 0.34 % | 7.00 % | 5.51 % | 0.62 % | 0.24 % | 14.79 % | 7.06 % | 1.35 % | 0.39 % |
| # of observations | 8,585 | 8,447 | 5,910 | 586 | 4,945 | 4,828 | 3,208 | 183 | 3,640 | 3,619 | 2,702 | 403 |
| Panel D: Discount certificates—roundtrips completed in ≥100 days (annualized) | | | | | | | | | | | | |
| Mean *RD* | 0.35 %** | 0.98 %*** | 0.21 %*** | 0.00 % | 0.97 %*** | 0.14 %* | 0.27 %*** | −0.01 % | −0.40 % | 2.19 %*** | 0.14 %*** | 0.00 % |
| *p* value | (0.013) | (0.000) | (0.000) | (0.817) | (0.000) | (0.085) | (0.000) | (0.608) | (0.207) | (0.000) | (0.000) | (0.926) |
| SD of *RD* | 13.19 % | 7.56 % | 1.14 % | 0.46 % | 7.85 % | 5.62 % | 0.73 % | 0.25 % | 19.18 % | 9.89 % | 1.61 % | 0.53 % |

**Table 4** continued

| | Full period: 2004/02–2008/12 | | | | Subperiod 1: 2004/02–2006/07 | | | | Subperiod 2: 2006/08–2008/12 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # of observations | 8,585 | 8,447 | 5,910 | 586 | 4,945 | 4,828 | 3,208 | 183 | 3,640 | 3,619 | 2,702 | 403 |
| Panel E: Discount certificates—incomplete roundtrips (not annualized) | | | | | | | | | | | | |
| Mean *RD* | 4.12 %*** | 2.40 %*** | 0.25 %*** | 0.05 %** | 8.13 %** | 0.84 % | | | 4.03 %*** | 2.42 %*** | 0.25 %*** | 0.05 %** |
| *p* value | (0.000) | (0.000) | (0.000) | (0.010) | (0.013) | (0.194) | | | (0.000) | (0.000) | (0.000) | (0.010) |
| SD of *RD* | 16.46 % | 8.75 % | 0.90 % | 0.25 % | 16.59 % | 2.81 % | | | 16.45 % | 8.81 % | 0.90 % | 0.25 % |
| # of observations | 1,353 | 1,342 | 885 | 189 | 29 | 20 | | | 1,324 | 1,322 | 884 | 189 |
| Subset filters (Benchmark certificates must have matched criteria to the purchased certificate.) | BP1 | BP2 | BP3 | BP4 | BP1 | BP2 | BP3 | BP4 | BP1 | BP2 | BP3 | BP4 |
| Time to maturity (±5 trading days) | Same | Same | Same | Same | Same | Same | Same | Same | Same | Same | Same | Same |
| Underlying | | Same | Same | Same | | Same | Same | Same | | Same | Same | Same |
| Distance to barrier (±5 %) and bonus level (±5 %) | | | Same | Same | | | Same | Same | | | Same | Same |
| Issuer | | | | Same | | | | Same | | | | Same |
| | Full period: 2004/02–2008/12 | | | | Subperiod 1: 2004/02–2006/07 | | | | Subperiod 2: 2006/08–2008/12 | | | |
| Panel F: Bonus certificates—all roundtrips (not annualized) | | | | | | | | | | | | |
| Mean *RD* | −4.81 %*** | −1.24 %*** | 0.03 % | −0.33 %*** | −6.43 %*** | −0.73 %*** | 0.23 %* | −0.47 %** | −3.28 %*** | −1.51 %*** | 0.00 % | −0.31 %*** |
| *p* value | (0.000) | (0.000) | (0.534) | (0.000) | (0.000) | (0.000) | (0.063) | (0.013) | (0.000) | (0.000) | (0.932) | (0.001) |
| SD of *RD* | 18.03 % | 5.65 % | 2.05 % | 1.46 % | 20.31 % | 4.82 % | 1.95 % | 1.29 % | 15.82 % | 6.02 % | 2.07 % | 1.58 % |
| # of observations | 11,008 | 8,095 | 1,751 | 326 | 5,341 | 2,823 | 248 | 51 | 5,667 | 5,272 | 1,503 | 275 |
| Panel G: Bonus certificates—roundtrips completed in <100 days (not annualized) | | | | | | | | | | | | |
| Mean *RD* | −0.38 %*** | −0.48 %*** | 0.04 % | −0.36 %*** | −0.26 % | −0.38 %*** | 0.03 % | −0.84 %*** | −0.47 %** | −0.53 %*** | 0.04 % | −0.26 %* |
| *p* value | (0.006) | (0.000) | (0.527) | (0.008) | (0.200) | (0.000) | (0.876) | (0.006) | (0.012) | (0.000) | (0.537) | (0.084) |
| SD of *RD* | 8.91 % | 4.04 % | 1.82 % | 1.65 % | 7.95 % | 2.47 % | 1.88 % | 1.41 % | 9.51 % | 4.47 % | 1.86 % | 1.69 % |
| # of observations | 4,196 | 3,245 | 751 | 155 | 1,572 | 809 | 82 | 26 | 2,624 | 2,436 | 669 | 129 |

**Table 4** continued

| | Full period: 2004/02–2008/12 | | | | Subperiod 1: 2004/02–2006/07 | | | | Subperiod 2: 2006/08–2008/12 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel H: Bonus certificates—roundtrips completed in ≥100 days (not annualized) | | | | | | | | | | | | |
| Mean *RD* | −8.15 %*** | −1.67 %*** | 0.01 % | −0.33 %*** | −9.21 %*** | −0.87 %*** | 0.34 %** | −0.08 % | −6.63 %*** | −2.35 %*** | −0.07 % | −0.38 %*** |
| *p* value | (0.000) | (0.000) | (0.928) | (0.004) | (0.000) | (0.000) | (0.040) | (0.705) | (0.000) | (0.000) | (0.445) | (0.003) |
| SD of *RD* | 21.65 % | 6.68 % | 2.33 % | 1.39 % | 23.27 % | 5.57 % | 2.12 % | 1.05 % | 19.23 % | 7.44 % | 2.43 % | 1.45 % |
| # of observations | 6,207 | 4,328 | 840 | 155 | 3,707 | 1,972 | 163 | 25 | 2,500 | 2,356 | 677 | 130 |
| Panel I: Bonus certificates—roundtrips completed in ≥100 days (annualized) | | | | | | | | | | | | |
| Mean *RD* | −8.06 %*** | −2.49 %*** | −0.01 % | −0.44 %* | −7.84 %*** | −1.01 %*** | 0.32 %* | −0.32 % | −8.31 %*** | −3.74 %*** | −0.09 % | −0.46 %* |
| *p* value | (0.000) | (0.000) | (0.943) | (0.053) | (0.000) | (0.000) | (0.070) | (0.579) | (0.000) | (0.000) | (0.556) | (0.063) |
| SD of *RD* | 26.57 % | 9.02 % | 3.64 % | 2.80 % | 24.93 % | 5.95 % | 2.25 % | 2.86 % | 29.04 % | 11.08 % | 3.98 % | 2.80 % |
| # of observations | 6,207 | 4,328 | 840 | 155 | 3,707 | 1,972 | 163 | 25 | 2,500 | 2,356 | 677 | 130 |
| Panel J: Bonus certificates—incomplete roundtrips (not annualized) | | | | | | | | | | | | |
| Mean *RD* | −1.33 % | −2.10 %*** | 0.07 % | −0.08 % | 1.44 % | −0.66 % | 0.68 % | | −1.68 %** | −2.23 %*** | 0.06 % | −0.08 % |
| *p* value | (0.108) | (0.000) | (0.528) | (0.701) | (0.664) | (0.500) | (0.449) | | (0.047) | (0.000) | (0.599) | (0.701) |
| SD of *RD* | 20.42 % | 5.22 % | 1.49 % | 0.83 % | 25.94 % | 6.30 % | 1.26 % | | 19.72 % | 5.12 % | 1.49 % | 0.83 % |
| # of observations | 605 | 522 | 160 | 16 | 62 | 42 | 3 | | 543 | 480 | 157 | 16 |

This table reports average roundtrip return differences (*RD*) between purchased certificates and four benchmark portfolios including available certificates of a certain grade of similarity compared to the actually purchased certificate (including the actually purchased certificate). BP1 includes all available certificates with similar time to maturity (±5 trading days) as the purchased certificate. BP2 includes all certificates of BP1 with the same underlying as the purchased certificate, respectively. BP3 contains all certificates of BP2 with similar moneyness (±5 %) or similar distance to barrier and bonus level (±5 %), BP4 includes all certificates of BP3 issued by the same financial institution as the purchased certificate. Panels A–E report results for discount certificates, Panels F–J for bonus certificates. Panels A and F summarize *RD*s across all observations, Panels B and G for roundtrips completed in less than 100 days, Panels C and H for roundtrips completed in at least 100 days (not annualized), Panels D and I for roundtrips completed in at least 100 days (annualized). Panels E and J report *RD*s for incomplete roundtrips (not annualized), assuming that they are closed on December 31, 2008. ***, **, * denote that *RD* is significantly different from zero at the 1, 5, and 10 percent levels, respectively, under the assumption that observations are independent. All results have been winsorized at the 1 percent level

This process results in a maximum of four *RD*s for each roundtrip trade. Since BP1, BP2, and BP3 contain every benchmark certificate, which is also included in the BP of the next lower similarity level, the comparison of *RD*s between the BPs indicates, how good investors are at selecting underlyings, cap levels, barrier/bonus levels, and issuers when they buy certificates.

### 5.2 Do investors choose the wrong products?

Each *RD* is calculated for the *actual holding period* of the purchased certificate and summarized by averaging these estimates across the whole sample. One possible concern is that this process involves averaging *RD*s measured across (possibly very) different roundtrip lengths. To address this issue, we also estimate summary statistics for the average *RD* distinguishing between roundtrip lengths of less than 100 days (not annualized) and roundtrip lengths of at least 100 days (annualized and not annualized).

The estimation results are presented in Table 4, distinguishing between the *different benchmark portfolios* (BP1 to BP4), *discount and bonus certificates*, and across *different time periods*. We begin our analysis by considering the set of results benchmarked against the most restrictive portfolio for the whole sample period and the results reveal that the *RD*s of BP4 are on average close to zero for discount certificates. Thus, investors do *not* appear to make significant *mistakes* when selecting a certificate from among a group of certificates with a similar time to maturity, similar moneyness, the same underlying, and the same issuer. We do note however, that compared to the other BPs, the number of observations in BP4 is relatively low.

The next set of results we consider is for investors in discount certificates when faced with the choice between certificates with a similar time to maturity, the same underlying, and similar moneyness, but from different issuers, i.e., the benchmark portfolio BP3. The *RD*s of BP3 are higher than the previously discussed *RD*s of BP4 which suggests that individual investors are able to *choose favorable issuers* (i.e., those with a relatively low level of overpricing) from among those who offer *discount* certificates with similar characteristics.

In contrast to BP3, BP2 contains discount certificates with different levels of moneyness. Return differences between these portfolios indicate gains or losses caused by selecting discount certificates with beneficial or detrimental caps. The results presented in Panels A to E show that the *RD*s of BP2 are significantly positive and much larger than the *RD*s of BP3. Hence, investors profit from their ability to *choose discount* certificates with *superior caps*, compared to other discount certificates with the same underlying and similar time to maturity.

The final comparison for discount certificates is with respect to the *RD*s of BP1 relative to BP2. Across all roundtrips, the results show a slight increase in the *RD* (0.60 vs. 0.59 % previously), indicating a slightly positive underlying selection. This observation, however, appears to be driven by short term and incomplete roundtrips, as can be seen by comparing Panels B and E of Table 4 (BP1's *RD*s of 0.69 and 4.12 %[17] versus BP2's *RD*s of 0.40 and 2.40 %). For roundtrips of longer durations, the outcomes are reversed (BP1's *RD* of 0.35 % vs. BP2's *RD* of 0.98 % in annualized terms). Hence, investors' ability to *choose* the appropriate *underlying* for their discount certificates seems to be *good for shorter* and incomplete *roundtrips*, but very *poor* for *long term roundtrips*. Taken together, the results

[17] Large *RD* numbers for incomplete roundtrips might result from market distortions during the financial crisis by end of 2008.

for BP1 across Panels A to E of Table 4 suggest that discount certificates chosen by investors do significantly outperform those discount certificates of similar time to maturity which were also available at the purchase date.

To test the veracity of these results to the choice of sample period, Table 4 also presents the equivalent set of results across the *two subperiods*. The results for BP4 and BP3 in both subperiods serve to *confirm* our findings regarding the investors' ability to find preferable issuers for their demanded certificate characteristics for both subperiods. The selection of certificates by moneyness is positive for all roundtrips of the second subperiod and for short roundtrips of the first subperiod. The individual investors' ability to select favorable discount certificates with respect to their underlying can be rated positive for all roundtrips of the first subperiod and for short term and incomplete roundtrips of the second subperiod. Regarding roundtrips with longer durations, however, the underlying asset selection has a tremendous negative impact on *RD*s in the second subperiod and more than offsets the positive effects of the selection by the moneyness criteria.

Return differences for *bonus* certificates are presented in Panels F to J of Table 4. In contrast to discount certificates, *RD*s of bonus certificates benchmarked against BP4 are significantly negative at −0.33 % across all roundtrips in the full sample period (although we note the relatively low number of observations). The fact that the purchased bonus certificate has a similar time to maturity, a similar distance to barrier/bonus level, the same underlying, and the same issuer as those included in BP4, implies that investors *choose* the most *detrimental maturities* and *barrier/bonus levels* from a small sample of very similar alternatives. These losses are compensated by *advantageous issuer selection*, as can be seen from the estimated BP3 *RD*s which are close to zero.

Comparing across BP2 and BP3 in Panels F to J of Table 4, it is obvious that investors make *poor decisions* when choosing the appropriate *barrier and bonus level* when they purchase a bonus certificate. The choices made by investors produce a negative return impact of −1.27 % per roundtrip trade on average. Recall that investors did well in selecting beneficial cap levels for their discount certificates. By way of contrast, the evidence for bonus certificates suggests the opposite is true and investors seem to have great difficulty in selecting from among the various complex payoff structures of bonus certificates.

The situation gets even worse when we take into account individual investors' *poor underlying selection* choices as the *RD* for BP1 is −4.81 % which is nearly four times as large as the average loss of −1.24 % benchmarked against BP2. Panels G to J of Table 4 show that these losses are associated with longer roundtrips with an extremely negative *RD* of −8.06 % against BP1 compared to a *RD* of −2.49 % against BP2, expressed in annualized terms. By way of contrast, we find that the average *RD*s improve from BP2 to BP1 for shorter and incomplete roundtrips.

To summarize the results for *bonus* certificates, we find that investors suffer *large losses* of −4.81 % per roundtrip trade (with an average duration of 234 calendar days) compared to all available bonus certificates of similar maturity. To some extent, these largely negative BP1 *RD*s, compared to the positive BP1 *RD*s of discount certificates, are the result of investors challenged with the selection of complex payoff profiles. The major part of these *RD* differences can either be explained by poor underlying selection or by a worse underlying selection per se in complex settings. Thus, it is not so much the sheer variety of available products that reduces investors' wealth, but rather their complexity. The *RD*s estimated for the subperiods serve to reinforce these whole sample period results as can be seen in columns 5 to 12 of Panels F to J of Table 4.

### 5.3 Structured product investors and the disposition effect

One could be tempted to interpret the results of the previous section as suggesting that investors choose favorable certificates with respect to the underlying asset when trading short term, however, they fail to identify promising opportunities for long term buy and hold strategies. While possible, this interpretation could be misleading since individual investors often do not determine their investment horizon ex ante. Instead, they could be prone to the *disposition effect*, i.e., they tend to sell winning investments soon and hold losing investments longer. This effect was first documented by Shefrin and Statman (1985) and later confirmed for many countries and various kinds of securities, except for financial innovations such as structured products.[18] If the disposition effect is present in our sample of investors, better (i.e., more positive or less negative) *RD*s of BP1 compared to BP2 for short term roundtrips, could be explained by investors' selling behavior rather than by their short term underlying selection ability.

To test for the presence of the disposition effect, we calculate *RD*s based on the *hypothetical* assumption that the purchased certificates are *sold* either 30, 90, 180, 270, or 360 days after their purchase date. We use the *same roundtrip durations* for the certificates in the respective benchmark portfolios. The results are presented in Panels A–E of Table 5 for discount certificates and Panels F–J for bonus certificates.

The results reveal that BP1 displays slightly more positive *RD*s compared to BP2 only in the very short term (30 days) and only for discount certificates. In all other cases (i.e., across both discount and bonus certificates), the *RD*s for BP1 are worse than the *RD*s for BP2. These results imply that the choice of the underlying asset does not lead to superior short term certificate returns compared to a benchmark including certificates with other underlying assets. Rather, the results suggest that the superior *RD*s of BP1 compared to BP2 for short term roundtrips (Panels B and G of Table 4) are the result of the investors' tendency to *sell winner* discount and bonus certificates *sooner*. Further to this point, the positive short term and negative long term BP1 *RD*s of discount certificates for the various hypothetical roundtrip lengths (see Panels A to E in Table 5) show that investors' performance gets worse (relative to the broad benchmark of available certificates) the longer they hold their purchased certificates. The same can be observed for bonus certificates, resulting in a remarkably negative BP1 *RD* of −8.50 % for a hypothetical holding period of one year (see Panels F to J in Table 5). This can be taken as evidence of investors holding on to losing trades longer, which is further *evidence* in support of the *disposition effect*.

### 5.4 Poor underlying selection, poor stock selection?

The results of the previous sections clearly highlight the problems individual investors have in choosing the underlying stock for their discount and bonus certificate investments. This raises the question as to whether this weakness is merely a reflection of their well-known *poor stock selection abilities* for their equity portfolios (see, in particular, Odean 1999). The negative alphas estimated in Sect. 4 for $R_t^{gr2}$ support this idea, at least compared to the DAX index composition. In this section, we test how well investors' actual DAX stock purchases perform compared to an equally weighted portfolio of all DAX stocks. We therefore measure the difference between the return of the purchased DAX

[18] Barber and Odean (2013) give a thorough overview on the evidence of the disposition effect.

**Table 5** Return differences of certificate roundtrips for fixed roundtrip lengths

| Subset filters (Benchmark certificates must have matched criteria to the purchased certificate.) | BP1 | BP2 | BP3 | BP4 |
|---|---|---|---|---|
| Time to maturity (±5 trading days) | Same | Same | Same | Same |
| Underlying | | Same | Same | Same |
| Moneyness (±5 %) | | | Same | Same |
| Issuer | | | | Same |
| | Full period: 2004/02–2008/12 | | | |
| Panel A: Discount certificates—roundtrip duration = 30 days | | | | |
| Mean *RD* | 0.24 %*** | 0.21 %*** | 0.08 %*** | 0.00 % |
| *p* value | (0.000) | (0.000) | (0.000) | (0.708) |
| SD of *RD* | 3.38 % | 2.13 % | 0.36 % | 0.14 % |
| # of observations | 13,317 | 13,151 | 9,237 | 997 |
| Panel B: Discount certificates—roundtrip duration = 90 days | | | | |
| Mean *RD* | 0.26 %*** | 0.30 %*** | 0.12 %*** | 0.01 %* |
| *p* value | (0.000) | (0.000) | (0.000) | (0.065) |
| SD of *RD* | 5.19 % | 2.90 % | 0.40 % | 0.21 % |
| # of observations | 12,017 | 11,854 | 8,351 | 865 |
| Panel C: Discount certificates—roundtrip duration = 180 days | | | | |
| Mean *RD* | 0.39 %*** | 0.50 %*** | 0.15 %*** | 0.02 %** |
| *p* value | (0.000) | (0.000) | (0.000) | (0.010) |
| SD of *RD* | 6.86 % | 3.96 % | 0.45 % | 0.21 % |
| # of observations | 10,845 | 10,687 | 7,503 | 734 |
| Panel D: Discount certificates—roundtrip duration = 270 days | | | | |
| Mean *RD* | −0.25 %*** | 0.47 %*** | 0.17 %*** | 0.03 %** |
| *p* value | (0.007) | (0.000) | (0.000) | (0.012) |
| SD of *RD* | 9.22 % | 5.04 % | 0.53 % | 0.27 % |

**Table 5** continued

| | Full period: 2004/02–2008/12 | | | |
|---|---|---|---|---|
| # of observations | 9,891 | 9,748 | 6,774 | 553 |
| Panel E: Discount certificates—roundtrip duration = 360 days | | | | |
| Mean *RD* | −0.25 %** | 0.16 %** | 0.18 %*** | 0.06 %*** |
| *p* value | (0.021) | (0.011) | (0.000) | (0.004) |
| SD of *RD* | 10.20 % | 5.83 % | 0.59 % | 0.38 % |
| # of observations | 8,600 | 8,460 | 5,791 | 409 |
| Subset filters (Benchmark certificates must have matched criteria to the purchased certificate.) | BP1 | BP2 | BP3 | BP4 |
| Time to maturity (±5 trading days) | Same | Same | Same | Same |
| Underlying | | Same | Same | Same |
| Distance to barrier (±5 %) and bonus level (±5%) | | | Same | Same |
| Issuer | | | | Same |
| | Full period: 2004/02–2008/12 | | | |
| Panel F: Bonus certificates—roundtrip duration = 30 days | | | | |
| Mean *RD* | −0.46 %*** | −0.12 %*** | 0.00 % | −0.12 %*** |
| *p* value | (0.000) | (0.000) | (0.972) | (0.006) |
| SD of *RD* | 6.43 % | 2.68 % | 1.41 % | 1.29 % |
| # of observations | 10,840 | 7,717 | 2,797 | 916 |
| Panel G: Bonus certificates—roundtrip duration = 90 days | | | | |
| Mean *RD* | −1.70 %*** | −0.29 %*** | −0.14 %*** | −0.40 %*** |
| *p* value | (0.000) | (0.000) | (0.001) | (0.000) |
| SD of *RD* | 10.84 % | 3.94 % | 2.23 % | 2.16 % |
| # of observations | 10,281 | 7,350 | 2,617 | 855 |

**Table 5** continued

| | Full period: 2004/02–2008/12 | | | |
|---|---|---|---|---|
| Panel H: Bonus certificates—roundtrip duration = 180 days | | | | |
| Mean *RD* | −3.77 %*** | −0.60 %*** | 0.05 % | −0.65 %*** |
| *p* value | (0.000) | (0.000) | (0.456) | (0.000) |
| SD of *RD* | 14.22 % | 4.87 % | 3.23 % | 2.15 % |
| # of observations | 9,615 | 6,830 | 2,369 | 747 |
| Panel I: Bonus certificates—roundtrip duration = 270 days | | | | |
| Mean *RD* | −6.37 %*** | −1.25 %*** | −0.28 %*** | −0.60 %*** |
| *p* value | (0.000) | (0.000) | (0.000) | (0.000) |
| SD of *RD* | 17.80 % | 5.20 % | 2.73 % | 2.07 % |
| # of observations | 8,969 | 6,326 | 2,069 | 613 |
| Panel J: Bonus certificates—roundtrip duration = 360 days | | | | |
| Mean *RD* | −8.50 %*** | −1.27 %*** | −0.39 %*** | −0.82 %*** |
| *p* value | (0.000) | (0.000) | (0.000) | (0.000) |
| SD of *RD* | 21.15 % | 5.63 % | 2.70 % | 2.17 % |
| # of observations | 8,308 | 5,770 | 1,742 | 521 |

This table reports average roundtrip return differences (*RD*) between purchased certificates and four benchmark portfolios including available certificates of a certain grade of similarity compared to the actually purchased certificate (including the actually purchased certificate). Roundtrip returns are based on the hypothetical assumption that the actually purchased certificates are sold either 30, 90, 180, 270, or 360 days after their purchase date. We use the same roundtrip durations for the certificates in the respective benchmark portfolios. BP1 includes all available certificates with similar time to maturity (±5 trading days) as the purchased certificate. BP2 includes all certificates of BP1 with the same underlying as the purchased certificate, respectively. BP3 contains all certificates of BP2 with similar moneyness (±5 %) or similar distance to barrier and bonus level (±5 %), BP4 includes all certificates of BP3 issued by the same financial institution as the purchased certificate. Panels A–E report results for discount certificates, Panels F–J for bonus certificates. ***, **, * denote that *RD* is significantly different from zero at the 1, 5, and 10 percent levels, respectively, under the assumption that observations are independent. All results have been winsorized at the 1 percent level

stock and the average return of all DAX stocks (including the purchased stock) for each roundtrip trade during our sample period (we refer to these stock purchase return differences as *RD*).

Table 6 reports average *RD*s, divided up into roundtrips completed in less than 100 days, roundtrips completed in at least 100 days (annualized and not annualized), and incomplete roundtrips which are again assumed to be closed on December 31, 2008. We find that the *RD*s are *negative across all observations*, as well as for long term roundtrips and incomplete roundtrips. Returns of roundtrips completed in less than 100 days, however, beat the benchmark.

As previously discussed, positive short term *RD*s might result from the disposition effect. Hence, we calculate *RD*s for hypothetical roundtrip durations of 30, 90, 180, 270, and 360 days. The results are presented in Table 7 and the results provide evidence of highly significant negative *RD*s for all roundtrip durations. This result suggests that investors are very poor in selecting stocks from a rather small investment universe of only 30 alternatives. Further, it seems that individual investors tend to *sell their winning stocks soon* and are therefore prone to the disposition effect.

## 6 Robustness checks

In Sect. 4, monthly raw returns and monthly alphas were obtained by weighting every single investor portfolio return equally (see Eq. (6)). To test the robustness of these results, we *weight* each investor portfolio *by its invested capital* in the corresponding month $t$, $IC_{it}$. The unreported results (available from the authors on request) are broadly consistent with our reported findings of individual investors' underperformance in discount certificate, bonus certificate, and stock investments.

With regard to the conclusions drawn from Sect. 5, one could suggest alternative ways to compare return differences across benchmark portfolios of different sample sizes, as the number of observations is gradually increasing from BP4 to BP1. To address this issue, we modify our method by equalizing our sample size based on the number of trades in BP3. Hence, BP1 and BP2 include only those roundtrip trades which are contained in BP3.[19] Return differences resulting from this adjustment are presented in Table 8. The results reveal that, compared to results presented in Table 4, while marginal changes in the reported statistics for BP1 and BP2 are observed across both discount and bonus certificates, the basic tenor of our conclusions remains intact.

## 7 Conclusion

Despite the large degree of innovation in financial markets, little is understood of the benefits of this innovation and the subject "remains one in which our intellectual maps show vast uncharted—and potentially interesting—lands to be explored" (Tufano 2003, p. 331). In this paper, we venture into this 'uncharted land' in an attempt to discover whether individual investors profit from financial innovation by investigating their actual risk-adjusted performance in structured financial products. The results of this paper suggest that they do not, as in net risk-adjusted terms, investors underperform by 0.25 % in discount certificates and 0.85 % in bonus certificates per month which is almost 3 and

[19] The sample size of BP4 is too small, especially for bonus certificates.

**Table 6** Return differences of stock roundtrips

| | Full period: 2004/02–2008/12 | Subperiod 1: 2004/02–2006/07 | Subperiod 2: 2006/08–2008/12 |
|---|---|---|---|
| Panel A: Stocks—all roundtrips (not annualized) | | | |
| Mean *RD* | −0.47 %*** | −2.24 %*** | 0.85 %*** |
| *p* value | (0.000) | (0.000) | (0.000) |
| SD of *RD* | 14.24 % | 16.71 % | 12.67 % |
| # of observations | 33,322 | 14,124 | 19,198 |
| Panel B: Stocks—roundtrips completed in <100 days (not annualized) | | | |
| Mean *RD* | 0.83 %*** | 0.32 %*** | 1.12 %*** |
| *p* value | (0.000) | (0.000) | (0.000) |
| SD of *RD* | 6.83 % | 5.07 % | 7.94 % |
| # of observations | 17,410 | 6,516 | 10,894 |
| Panel C: Stocks—roundtrips completed in ≥100 days (not annualized) | | | |
| Mean *RD* | −3.90 %*** | −4.67 %*** | −2.53 %*** |
| *p* value | (0.000) | (0.000) | (0.000) |
| SD of *RD* | 20.55 % | 21.89 % | 17.66 % |
| # of observations | 10,510 | 7,046 | 3,464 |
| Panel D: Stocks—roundtrips completed in ≥100 days (annualized) | | | |
| Mean *RD* | −3.15 %*** | −3.88 %*** | −1.69 %*** |
| *p* value | (0.000) | (0.000) | (0.001) |
| SD of *RD* | 25.10 % | 21.98 % | 31.02 % |
| # of observations | 10,510 | 7,046 | 3,464 |
| Panel E: Stocks—incomplete roundtrips (not annualized) | | | |
| Mean *RD* | 2.01 %*** | −2.11 % | 2.60 %*** |
| *p* value | (0.000) | (0.143) | (0.000) |
| SD of *RD* | 18.31 % | 34.06 % | 16.64 % |

**Table 6** continued

| | Full period: 2004/02–2008/12 | Subperiod 1: 2004/02–2006/07 | Subperiod 2: 2006/08–2008/12 |
|---|---|---|---|
| # of observations | 5,402 | 562 | 4,840 |

This table reports average roundtrip return differences (*RD*) between purchased DAX stocks and a benchmark portfolio containing all DAX stocks (including the purchased stock). Panel A summarizes *RD*s across all observations, Panel B for roundtrips completed in less than 100 days, Panel C for roundtrips completed in at least 100 days (not annualized), Panel D for roundtrips completed in at least 100 days (annualized). Panel E report *RD*s for incomplete roundtrips (not annualized), assuming that they are closed on December 31, 2008. ***, **, * denote that *RD* is significantly different from zero at the 1, 5, and 10 percent levels, respectively, under the assumption that observations are independent. All results have been winsorized at the 1 percent level

**Table 7** Return differences of stock roundtrips for fixed roundtrip lengths

| Full period: 2004/02–2008/12 | |
|---|---|
| Panel A: Stocks—roundtrip duration = 30 days | |
| Mean *RD* | −0.20 %*** |
| *p* value | (0.001) |
| SD of *RD* | 7.33 % |
| # of observations | 16,117 |
| Panel B: Stocks—roundtrip duration = 90 days | |
| Mean *RD* | −1.01 %*** |
| *p* value | (0.000) |
| SD of *RD* | 9.70 % |
| # of observations | 19,127 |
| Panel C: Stocks—roundtrip duration = 180 days | |
| Mean *RD* | −1.72 %*** |
| *p* value | (0.000) |
| SD of *RD* | 13.59 % |
| # of observations | 13,984 |
| Panel D: Stocks—roundtrip duration = 270 days | |
| Mean *RD* | −3.28 %*** |
| *p* value | (0.000) |
| SD of *RD* | 17.36 % |
| # of observations | 14,242 |
| Panel E: Stocks—roundtrip duration = 360 days | |
| Mean *RD* | −3.28 %*** |
| *p* value | (0.000) |
| SD of *RD* | 21.22 % |
| # of observations | 12,446 |

This table reports average roundtrip return differences (*RD*) between purchased DAX stocks and a benchmark portfolio containing all DAX stocks (including the purchased stock). Roundtrip returns are based on the hypothetical assumption that the actually purchased stocks are sold either 30, 90, 180, 270, or 360 days after their purchase date. We use the same roundtrip durations for the stocks in the respective benchmark portfolios. ***, **, * denote that *RD* is significantly different from zero at the 1, 5, and 10 percent levels, respectively, under the assumption that observations are independent. All results have been winsorized at the 1 percent level

10 % per year, respectively.

While *transaction costs* are found to contribute to this underperformance, it is only to a small extent. Rather, the results of this paper suggest that *product complexity* has a substantial and negative impact on the returns to investors who trade in structured products. We find evidence for larger premiums in complex products (bonus certificates) resulting in economically large negative risk-adjusted buy-and-hold returns of −0.39 % per month for bonus certificates (more than −4.5 % annually) compared to −0.22 % per month for discount certificates (about −2.6 % per year). However, the issuers are not solely to blame for this underperformance. Our analysis of structured product selection provides evidence that investors have great *difficulty* in *selecting* appropriate barrier and bonus levels for their bonus certificates, whereas they are well equipped to find appropriate cap levels for their discount certificates. Further, individual investors suffer large losses by systematically *selecting inferior underlying* assets for both product types in our data set. The investors' poor underlying selection reduces their performance to a much larger extent when they trade complex products. These poor selection skills are also evident when it comes to investors picking stocks for their physical equity portfolios. Therefore, investors' equity portfolio gross performance is negative with a monthly alpha of −0.18 % (−2.14 % per year).

**Table 8** Return differences with equalized samples

| Subset filters (Benchmark certificates must have matched criteria to the purchased certificate.) | BP1 | BP2 | BP3 | BP4 |
|---|---|---|---|---|
| Time to maturity (±5 trading days) | Same | Same | Same | Same |
| Underlying | | Same | Same | Same |
| Moneyness (±5 %) | | | Same | Same |
| Issuer | | | | Same |
| | Full period: 2004/02–2008/12 | | | |
| Panel A: Discount certificates—all roundtrips (not annualized) | | | | |
| Mean *RD* | 0.51 %*** | 0.62 %*** | 0.15 %*** | 0.02 %** |
| *p* value | (0.000) | (0.000) | (0.000) | (0.032) |
| SD of *RD* | 9.61 % | 5.02 % | 0.87 % | 0.25 % |
| # of observations | 9,971 | 9,971 | 9,971 | 1,194 |
| Panel B: Discount certificates—roundtrips completed in <100 days (not annualized) | | | | |
| Mean *RD* | 0.66 %*** | 0.33 %*** | 0.11 %*** | 0.01 % |
| *p* value | (0.000) | (0.000) | (0.000) | (0.338) |
| SD of *RD* | 4.67 % | 2.48 % | 0.67 % | 0.19 % |
| # of observations | 3,176 | 3,176 | 3,176 | 419 |
| Panel C: Discount certificates—roundtrips completed in ≥100 days (not annualized) | | | | |
| Mean *RD* | −0.16 % | 0.43 %*** | 0.16 %*** | 0.01 % |
| *p* value | (0.235) | (0.000) | (0.000) | (0.430) |
| SD of *RD* | 10.30 % | 5.47 % | 0.97 % | 0.34 % |
| # of observations | 5,910 | 5,910 | 5,910 | 586 |
| Panel D: Discount certificates—roundtrips completed in ≥100 days (annualized) | | | | |
| Mean *RD* | 0.16 % | 0.98 %*** | 0.21 %*** | 0.00 % |
| *p* value | (0.340) | (0.000) | (0.000) | (0.817) |
| SD of *RD* | 12.85 % | 6.96 % | 1.14 % | 0.46 % |

**Table 8** continued

| | Full period: 2004/02–2008/12 | | | |
|---|---|---|---|---|
| # of observations | 5,910 | 5,910 | 5,910 | 586 |
| Panel E: Discount certificates—incomplete roundtrips (not annualized) | | | | |
| Mean *RD* | 4.05 %*** | 2.81 %*** | 0.25 %*** | 0.05 %** |
| *p* value | (0.000) | (0.000) | (0.000) | (0.010) |
| SD of *RD* | 15.97 % | 7.66 % | 0.90 % | 0.25 % |
| # of observations | 885 | 885 | 885 | 189 |
| Subset filters (Benchmark certificates must have matched criteria to the purchased certificate.) | BP1 | BP2 | BP3 | BP4 |
| Time to maturity (±5 trading days) | Same | Same | Same | Same |
| Underlying | | Same | Same | Same |
| Distance to barrier (±5 %) and bonus level (±5 %) | | | Same | Same |
| Issuer | | | | Same |
| | Full period: 2004/02–2008/12 | | | |
| Panel F: Bonus certificates—all roundtrips (not annualized) | | | | |
| Mean *RD* | −3.81 %*** | −1.40 %*** | 0.03 % | −0.33 %*** |
| *p* value | (0.000) | (0.000) | (0.534) | (0.000) |
| SD of *RD* | 15.64 % | 5.70 % | 2.05 % | 1.46 % |
| # of observations | 1,751 | 1,751 | 1,751 | 326 |
| Panel G: Bonus certificates—roundtrips completed in <100 days (not annualized) | | | | |
| Mean *RD* | −1.20 %*** | −0.58 %*** | 0.04 % | −0.36 %*** |
| *p* value | (0.001) | (0.000) | (0.527) | (0.008) |
| SD of *RD* | 9.47 % | 4.08 % | 1.82 % | 1.65 % |
| # of observations | 751 | 751 | 751 | 155 |

**Table 8** continued

| | Full period: 2004/02–2008/12 | | | |
|---|---|---|---|---|
| Panel H: Bonus certificates—roundtrips completed in ≥100 days (not annualized) | | | | |
| Mean *RD* | −6.59 %*** | −1.95 %*** | 0.01 % | −0.33 %*** |
| *p* value | (0.000) | (0.000) | (0.928) | (0.004) |
| SD of *RD* | 18.58 % | 7.16 % | 2.33 % | 1.39 % |
| # of observations | 840 | 840 | 840 | 155 |
| Panel I: Bonus certificates—roundtrips completed in ≥100 days (annualized) | | | | |
| Mean *RD* | −6.89 %*** | −3.02 %*** | −0.01 % | −0.44 %* |
| *p* value | (0.000) | (0.000) | (0.943) | (0.053) |
| SD of *RD* | 27.79 % | 9.93 % | 3.64 % | 2.80 % |
| # of observations | 840 | 840 | 840 | 155 |
| Panel J: Bonus certificates—incomplete roundtrips (not annualized) | | | | |
| Mean *RD* | −2.20 % | −2.04 %*** | 0.07 % | −0.08 % |
| *p* value | (0.178) | (0.000) | (0.528) | (0.701) |
| SD of *RD* | 20.60 % | 3.82 % | 1.49 % | 0.83 % |
| # of observations | 160 | 160 | 160 | 16 |

This table reports average roundtrip return differences (*RD*) between purchased certificates and four benchmark portfolios including available certificates of a certain grade of similarity compared to the actually purchased certificate (including the actually purchased certificate). BP1 includes all available certificates with similar time to maturity (±5 trading days) as the purchased certificate. BP2 includes all certificates of BP1 with the same underlying as the purchased certificate, respectively. BP3 contains all certificates of BP2 with similar moneyness (±5 %) or similar distance to barrier and bonus level (±5 %), BP4 includes all certificates of BP3 issued by the same financial institution as the purchased certificate. In this table, the sample size is equalized on the level of BP3. Hence BP1 and BP2 include only those roundtrip trades which are contained in BP3. Panels A–E report results for discount certificates, Panels F–J for bonus certificates. Panels A and F summarize *RD*s across all observations, Panels B and G for roundtrips completed in less than 100 days, Panels C and H for roundtrips completed in at least 100 days (not annualized), Panels D and I for roundtrips completed in at least 100 days (annualized). Panels E and J report *RD*s for incomplete roundtrips (not annualized), assuming that they are closed on December 31, 2008. ***, **, * denote that *RD* is significantly different from zero at the 1, 5, and 10 percent levels, respectively, under the assumption that observations are independent. All results have been winsorized at the 1 percent level

In addition, we also find that structured product investors are prone to some kind of *disposition effect*, i.e., they tend to sell outperforming certificates (compared to certificates with a different underlying asset) while holding on to underperforming positions. This irrational selling behavior is also found in the trading data for stocks.

All in all, our results suggest that investing in *innovative financial products* does not pay off for individual investors. Rather, the issuing banks are apparently able to exploit the investors' inability to calculate fair prices for complex payoff profiles by selling products at high premiums. Moreover, retail investors seem to find the task of selecting complex products for their portfolios difficult. One possible explanation for these results is that investors *lack* the necessary *skills*, knowledge, and time to understand this complex market, which is characterized by a wide variety of products and high search costs.

Our results raise the question as to how retail investors could be *protected* when investing in complex innovative financial products. As our sample of investors is self-directed, one potential solution might be the help from financial *advisors*. However, Bergstresser et al. (2009) find no tangible benefits to the use of financial intermediaries in the mutual fund industry. Bhattacharya et al. (2012) find that investors tend not to obtain financial advice or, where they do, typically choose not to follow the given recommendations. As such, access to financial advice is unlikely to improve the situation. In the absence of advice, investors have to rely on their own skills. The literature provides evidence that the performance of individual investors in stocks improves with their IQ (see Grinblatt et al. 2012) as well as with their trading experience (see Seru et al. 2010). Therefore, it is possible that a higher level of *financial literacy* in the market for structured retail products may reduce investor losses. This could involve a requirement of some form of training or qualification such as a 'structured product trading license'. For example, trading at some major derivative exchanges which are targeted at professional investors (e.g., Eurex) requires practical trading experience and passing an examination. Carlin and Manso (2011) reject this idea and show that investor education motivates issuers to further increase wasteful obfuscation.

Perhaps the most viable solution comes from Campbell et al. (2011) and Carroll et al. (2009), who suggest that consumers can be protected from complexity in financial products by promoting a certain group of standard products. The Belgian Financial Services and Markets Authority (FSMA) put this idea into practice and introduced a voluntary moratorium on the distribution of 'particularly complex' structured products to retail investors arguing that it would *reduce search costs*, make it easier to evaluate the products' true value and, therefore, lower welfare losses for retail investors (see Financial Services and Markets Authority 2011).

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