Derivative Choices of Retail Investors: Evidence from Germany

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Abstract:

During the last few years, a strong growth of retail derivative markets has been observed in a number of financial retail markets around the world. Using a unique data set, we confront in this paper several lines of arguments that have been provided to explain the observed popularity of the instrument with data from the German secondary market. We analyze a number of determinants that are likely to affect the derivative choices of retail investors. We further analyze the performance of retail derivatives chosen by retail investors and propose a new sentiment measure to analyze the information content of the observed choices for the underlying asset.

Our results support previous studies that argue that an increase in the need for specifying the characteristics of financial products and consequently an increase in retail investors' search costs contribute to the observed popularity of retail derivatives. However, the observed pattern in derivative choices also supports other studies that argue that the retail demand for derivatives is driven by systematic deviations of retail investors from rational behaviour. Our analysis of the performance of the products chosen by retail investors further reveals that the trading behaviour that is likely to underlie the observed derivative choices results in a performance loss compared to a more diversified portfolio. We conclude that retail derivative markets emphasize the importance of situational and investor specific factors for retail investors' portfolio choices that might counteract the welfare improving potential of this instrument.

Keywords: Retail derivatives, certificates, investor behaviour, momentum, contrarian, sentiment

JEL Codes: G11, G12, D83

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1 Introduction

During the last few years, a liberal regulative environment and increases in data processing capacities have supported the growth of retail derivative markets in a number of countries around the world.[1] Being simple obligations of the issuing bank by legal terms, retail derivatives (or bank issued derivatives) allow retail investors to pursue sophisticated trading and investment strategies and the issuing banks to use their comparative advantage in structuring and hedging financial instruments. However, despite their potential for decreasing market barriers in financial retail markets, the confidence of retail investors and financial regulators in this instrument has been shaken by the recent financial crisis when a large number of retail investors incurred substantial losses from holding retail derivatives and the potential of this instrument to emphasize frictions in financial retail markets became obvious.[2] In fact, a number of studies prior to the financial crisis have pointed out that retail derivative markets are likely to benefit from a non-rational trading behaviour of retail investors and might be used to systematically exploit the valuation errors of retail investors (see e.g. Henderson and Pearson, 2009; Breuer and Perst, 2008; Hens and Rieger, 2008). However, to date only few studies have empirically analyzed actual derivative choices of retail investors. Vanini and Döbeli (2010) apply a survey design to explore the determinants of retail investors' motivation for purchasing retail derivatives, finding a positive influence of a simple verbal description of the overall investment strategy as opposed to a more technical description. Rieger (2008) analyzes the influence of probability estimates of individuals in the context of purchase decisions of retail derivatives in an experimental setup, finding evidence that a mis-estimation of probabilities is likely to explain the observed patterns in the retail demand for the instrument. Dorn (2010) analyzes warrant trades of a sample of German brokerage investors, documenting a strong influence of option characteristics that should not matter to a rational investor. Taken together, the existing studies on retail derivatives provide some initial evidence on retail investors' motivation for pursuing derivative based trading and investment strategies, but lack the support of an empirical analysis of actual derivative choices of retail investors.

[1] Note that the terms *retail derivatives*, *structured products* or *structured financial products* are used synonymously in the literature.

[2] The website http://ig-lehman-zertifikateschaden.de provides an impression of the market practices in Germany for the use of this instrument by financial product suppliers. Law (2010) provides an overview on the lessons learned for the retail derivative market in Hong Kong.

In this paper, we analyze the derivative choices of retail investors in the German secondary market. With a market volume of EUR 105.4 billion and more than 470,000 available products, the German retail derivative market represents the largest market for bank issued retail derivatives in the world.[3] Using an extensive dataset that comprises product and trading data of retail derivatives with three payoff profiles that are frequently traded and well established in the German market, we employ a panel logit model to exploit the observed heterogeneity among supplied and selected retail derivatives over time and analyze the determinants of the propensity that a product is bought in the secondary market. We study the performance of the derivative choices assuming a buy-and-hold strategy which is likely to underlie the observed trading patterns of the instrument and compare it with the performance of two benchmark portfolios that consist of alternatively available products with similar payoff profile. Furthermore, we analyze the information content of derivative choices by proposing a new payoff-specific retail investor sentiment measure that is likely to be more sensitive to changes in retail investors' sentiment than existing measures and analyze its relation between market returns by using vector autoregressive (VAR) models and Granger causality tests.

Our paper makes two major contributions to the existing literature. First, we provide extensive empirical evidence for the actual derivative choices of retail investors. To the best of our knowledge, this paper represents the first study that empirically analyses the actual derivative choices of retail investors in the German secondary market and that provides empirical evidence to several explanations that have been provided as an explanation for the observed popularity of this instrument. Our results suggest that retail investors' motivation for improving the after-tax return of their household portfolio represents a major driver of the observed derivative choices for products that provide only little equity exposure. We also document a pattern of observations that is likely to be driven by speculative purposes of retail investors rather than a motivation for hedging existing positions. Furthermore, we observe a positive impact of the cost of investing on the observed derivative choices. This is likely to be related with the documented mispricing in the secondary market (see e.g. Stoimenov and Wilkens, 2005; Baule, 2009; Nicolaus, 2010) but also suggests that individual investors fail to identify the best deal in the market as they are subject to *search costs* (see e.g. Dorn, 2010). This line of arguments is further supported by other observations such as a low sensitivity to issuers credit risk or a strong influence of product characteristics that should not matter to a rational investor. However, our results also support the idea that retail investors differ in the

[3] Source: German Derivatives Association (DDV), June 2010.

extend to which they are subject to *systematic biases* in their financial decision making. For example, we observe momentum trading tendencies among investment product investors whereas we observe contrarian trading tendencies among leverage product investors which is in line with previous studies that study the trading behaviour of individual investors. For example, Goetzmann and Massa (2002) find that more frequent index-fund traders act as contrarian investors, while infrequent traders typically act as momentum investors. Goetzmann and Kumar (2008) find that momentum investors exhibit greater under-diversification in their portfolio. Bailey et al. (2010) document that trend-chasing behaviour is positively related with investors being subject to behavioural biases. Blackburn et al. (2009) find that mutual fund growth investors tend to be momentum buyers, whereas mutual fund value investors tend to act as contrarian buyers. Our study adds to this strand of the literature in that we document the trading behaviour of retail derivative investors is likely to be payoff-specific. Our results further document that the performance of derivative choices on average underperforms a benchmark portfolio that consists of similar products that are available to retail investors. This further supports that the market timing abilities of retail investors tend to be weak as has been documented by several previous studies (see e.g. Odean, 1999; Frazini and Lamont, 2008; Bauer et al., 2008; Dorn, 2010) and can be related to the observed contrarian and momentum tendencies.

Second, we propose a new retail investor sentiment measure that is based on the payoff-specific derivative choices of retail investors. Using the heterogeneity among purchased retail derivatives with equal payoff profile, we construct a new sentiment measure which is likely to be more sensitive to changes in retail investors' sentiment as it avoids a methodological drawback of previous measures that neglect the differences in (equity) exposure. Our analysis reveals that our measure is well in line with alternative measures of retail investor sentiment. We further document that our derivative-choice based sentiment measure contains no fundamental information for subsequent returns of the underlying index. This further supports that the information content of derivative choices is likely to be high with respect to the trading behaviour of retail investors whereas the role of derivative choices appears to be limited for the underlying index.

Our study provides a new perspective on the role of retail derivatives as instrument for financial retail markets. The relevance of retail investors' search costs documented by our results emphasizes the importance for an adequate disclosure of conflicts of interests in financial retail markets. Furthermore, our results provide new insights on the role of behavioral factors in retail investors' trading and investment behaviour. Given the potential

role of these factors, our results suggest that the sensitivity of retail investors to bear financial risks might be emphasized by a disclosure of these factors.

The paper is organized as follows: In section 2 we describe potential motivations for pursuing derivative based investment and trading strategies and provide an overview of the related literature. Section 3 presents our data set and summary statistics for retail derivative trades that can be observed in the secondary market. Section 4 examines the determinants of the observed retail derivative purchases in the secondary market and their performance. In section 5 we present a new retail investor sentiment measure and analyze its information content for subsequent index returns. Section 6 concludes.

2 Why do retail investors buy retail derivatives?

The observed growth of retail derivative markets has raised the attention of financial researchers and regulators on the motivation of retail investors for pursuing derivative based strategies. According to standard-financial theory, the derivative choices of retail investors should be related with investors' motivation to exploit arbitrage opportunities (see e.g. Sharpe, 1964). However, due to the fact that individual investors face short selling restrictions and lack access to alternative derivative markets which restricts them from taking advantage of possible arbitrage opportunities, alternative explanations appear to be feasible for the increasing use of retail derivatives by retail investors.[4] A first explanation for the popularity of the instrument is that retail derivatives reveal divergent beliefs among retail investors about the future price level of the underlying.[5] As an example, the payoff profile of warrants can be used to express a divergent belief with regard to the future price level or changes in the volatility of the underlying (e.g. via a straddle or strangle).[6] Other payoff profiles of popular retail derivatives are more complex in the sense that their payoff consists of several single positions that allow a more detailed 'mapping' of retail investors' belief about the future price level of the underlying. For example, discount and bonus certificates which both are among the most popular payoff profiles in European derivative markets combine a long position in the underlying with one option that partially hedges the downside risk of the long position.

[4] See also Bartram and Fehle (2007) and Ter Horst and Veld (2008).
[5] Note that divergent beliefs could be information driven (see e.g. Black, 1975) or arise from differential interpretations of public information (see e.g. Kandel and Pearson, 1995). Note that this line of arguments has been used extensively in the literature that analyzes (plain-vanilla) option trading.
[6] Figure 1 depicts the payoff profiles that are discussed in the following. Note that warrants also can be used for hedging existing positions (protective put) but which has been documented to be of minor importance for retail investors (see Schmitz et al., 2009; Bauer et al., 2008; Dorn, 2010).

While discount certificates include a plain vanilla short call position, bonus certificates include a down-and-out put option that partially hedges the downside risk of the long position. For discount certificates to be profitable, the investor must be able to predict better than the market that the price level of the underlying asset at maturity will not move out of a certain bandwidth (see e.g. Rendleman, 2001). For bonus certificates, the investor must be able to predict better than the market that the price level of the underlying asset will not move out of a certain bandwidth during the lifetime of the contract (path dependent). However, given the fact that some of the most successful products in the retail derivative market represent sophisticated payoff profiles that basically reflect a particular deviation from market expectation, divergent beliefs about the future price level of the underlying do not appear to be a plausible explanation for the entire growth of the retail derivative market.[7]

A second line of arguments that has been provided by recent studies for explaining the observed patterns in the demand for retail derivatives involves recent findings about *systematic biases* in the financial decision making of individual investors.[8] One of the earliest study which considers the impact of bounded rationality (see Simon, 1959) on financial product demand was Shefrin and Statman (1993) who use a combination of prospect theory preferences (Tversky and Kahnemann, 1979) and hedonic framing (Thaler, 1985). More recently, Breuer and Perst (2008) analyze the pattern in the retail demand for reverse convertibles and discount certificates by combining cumulative prospect theory preferences (Tversky and Kahnemann, 1992) with standard option pricing theory (Black and Scholes, 1973), concluding that discount certificates are less attractive for a bounded rational investor than for a rational investor and that hedonic framing helps to explain the retail demand for reverse convertibles. Hens and Rieger (2008) show the restricted explanatory power of normative models for the observed patterns in derivative choices of retail investors and argue that behavioral biases such as framing, loss aversion and probability mis-estimation are likely to determine the derivative choices of retail investors.[9] A major drawback of this line of arguments is the lack of empirical evidence for actual derivative choices by retail investors. Among the few empirical studies is Rieger (2008) who uses an experimental setup to analyze the influence of probability estimates of individual investors' purchase decisions for retail derivatives and documents a positive relation between probability mis-estimation

[7] Note that this line of arguments has been used extensively in prior research that analyzes option trading. See e.g. Easley et al. (1998), Cao et al. (2005), Choy and Wei (2010).
[8] Barberis et al. (1998), Hirshleifer and Subrahmanyam (1998) or Hong and Stein (1999) present behavioural models where some of the known behavioural biases from the psychological literature are taken into account.
[9] Similar arguments are used by Henderson and Pearson (2009), Bernard and Boyle (2008), Roger (2008) and Branger and Breuer (2008).

and the perceived attractiveness of bonus certificates. Vanini and Döbeli (2010) use a questionnaire to explore the determinants of derivative choices of retail investors and find that these are positively influenced by a simple verbal description of the overall investment strategy rather than a more technical description of the product. Dorn (2010) analyzes the call warrant trades of retail investors from a German brokerage and finds a strong influence of derivative characteristics that should be irrelevant to a rational investor. Summarizing this strand of the literature, some of the observed patterns in the retail derivative market are likely to be explained by systematic biases in the financial decision making of retail investors, but due to the existing gap in the empirical literature of retail derivatives, the scope of this line of arguments to date is unclear.

A third line of arguments that has been used for explaining the observed popularity of retail derivatives is associated with *search costs* retail investors face when trading and investing in financial products (see e.g. Dorn, 2010). In fact, the high flexibility of retail derivatives and comparatively low issuance costs allow financial product suppliers to increase retail investors search costs by increasing the number of available products or adding complexity to the payoff profile of retail derivatives.[10] An implication of investors being subject to search costs is price dispersion and an emphasis of strategies and heuristics used by retail investors to cope with a complex (financial) decision situation (see e.g. Hortascu and Syverson, 2004; Tapia and Yermo, 2007; Choi et al., 2009). An increase in search costs therefore is also likely to emphasize the role of intermediaries' incentives that act as information providers in financial retail markets and consequently the disclosure of conflicts of interest (see Inderst and Ottaviani, 2009).[11] Empirical evidence for an adverse effect of intermediaries acting as information agent for retail investors has been provided by Hackethal et al. (2008) who document that the advised accounts on average offer lower returns due to more frequent trading of the retail investor. Furthermore, Hackethal et al. (2010) document that a higher fraction of financial products with high sales incentive for financial advisors end up in the portfolio of retail investors who rely on financial advice. Hence to summarize this line of arguments, given the potential role of search costs on the portfolio decisions of retail investors, the flexibility of retail derivatives and low issuance costs are likely to emphasize the existing frictions in financial retail markets such as an increase of strategies and heuristics

[10] Carlin (2009) provides an economic analysis of the strategic use of complexity in financial retail markets.

[11] As an example, some issuers allow financial advisors to *lock in* an additional margin in the secondary market pricing of the retail derivative, and provide tools that aim to tailor the product characteristics to the *demand of financial advisors* (see e.g. Börsenzeitung 23rd April 2010). Furthermore, according to industry sources the product design of promoted retail derivatives is the result of an iterative process between issuer and financial advisors that aims to increase the attractiveness of financial products to most customers.

used by retail investors to cope with complex decision situations or an inadequate disclosure of conflicts of interest in financial retail markets.

A fourth line of arguments that has been used for retail investors' motivation for pursuing derivative based strategies is related with the taxation of this instrument. Until June 2008, German retail investors were able to improve the tax-efficiency of their household portfolio by using retail derivatives for investment purposes as gains from holding retail derivatives where tax-exempted whenever the holding period exceeded one year.[12] In fact, Scholz and Walther (2009) document significant after-tax utility improvements from retail derivatives with popular payoff profile when compared to a direct investment in the underlying asset. Furthermore, Baule (2009) and Nicolaus (2010) document the taxation of discount and bonus certificates being reflected in investor order flows and their pricing in the secondary market. However, there exists also evidence that less sophisticated and experienced investors fail to anticipate the tax consequences of their derivative choices (see Horn et al., 2009). Hence the tax treatment of retail derivatives is likely to explain only a fraction of the observed growth of retail derivative markets.

3 Data and summary statistics

Having outlined several explanations that have been provided for explaining the observed popularity of retail derivatives and patterns observed in this market, we now confront the four lines of arguments with data from the secondary market. Since the large majority of retail derivatives are purchased in the secondary market rather than in the primary market, secondary market data provides a compelling case for the analysis of derivative choices of retail investors. The data was gathered from *Börse Stuttgart* which runs a specialized market segment for retail derivatives (*EUWAX*) that is dedicated to retail investors and represents the largest organized exchange for retail derivatives in Europe.[13] Our data set is the result of a filtering procedure that was applied to obtain product and trading data of a substantial fraction of all available retail derivatives with payoff profiles that are well established in the German market. For this purpose, we identified retail derivatives that have been available at *Börse Stuttgart* between July 2003 and June 2009 with DAX 30 (henceforth DAX) and DowJones

[12] Note that after January 1st 2009, the gains from investment products are taxed with a tax rate of 25 percent like any other investment product. A regulatory reform of the German tax code in May 2007 restricted this tax advantage to products that were purchased before June 30th 2008.

[13] Note that institutional and professional investors are able to avoid trading on EUWAX and are able to trade on organized derivative markets such as EUREX. See also Bartram and Fehle (2007).

EUROSTOXX 50 (henceforth ESX) as underlying asset and collected the product data from various sources.[14] We focused on these indexes as underlying asset as these are the most commonly traded underlying assets in the German retail derivative market (see e.g. Burghardt and Riordan, 2009). The DAX is a capital-weighted performance index where dividends are reinvested and comprises the 30 largest and most actively traded German companies that are listed at the Frankfurt Stock Exchange. The ESX is a price index that comprises the 50 largest and most actively traded companies from the Eurozone. To cope with the observed heterogeneity among the identified products, we restrict our analysis to those retail derivatives with payoff profiles that are well established in the German market. For investment products, we focus our analysis on *discount* and *(capped) bonus certificates.*[15] For leverage products, we focus on *warrants*. Within each of these payoff categories, we dropped those products that include additional product features (e.g. time-dependent barrier options) which increases the comparability of the products in our sample. For leverage products, we only consider warrants from two issuers (*Deutsche Bank* and *Commerzbank)* with DAX as underlying index due to the fact that these issuers strongly dominate the market for leverage products and the DAX is the by far most traded asset for this payoff category.[16] As a result of our filtering procedure, we end up with 17,158 products with three different payoff profiles with DAX and ESX as underlying index.

Table 1 provides an overview of our sample products which includes 9,837 discount certificates, 1,795 (capped) bonus certificates and 5,500 warrants. Our sample includes more (capped) bonus certificates with ESX than with DAX as underlying index which can be attributed to the fact that withheld dividends for products on ESX price index are used by issuers to finance the embedded barrier option.[17] Panel C of table 1 shows summary statistics for the number of available products in our sample conditional on the time to maturity and provides an impression of the decision space retail investors face within each payoff category. As an example, retail investors can choose on each trading day on average between 66 DAX discount certificates that differ only with respect to the issuing bank and the strike level of the embedded option. For warrants, this number appears to be lower, but considering the fact that

[14] ariva.de and onvista.de. In some cases, product data was gathered from issuance prospectus which are available from the website of the issuer.
[15] Note that the payoff profile of capped bonus certificates includes an additional short call position in addition to the embedded barrier option.
[16] Note that *Commerzbank* and *Deutsche Bank* together have a market share of more than 60 percent in leverage product market (June 2009). Source: German Derivatives Association.
[17] See also Manley and Mueller-Glissmann (2008) who provide an overview on the market for dividends and its relation to retail derivative markets.

our sample only includes warrants from two issuers, the observed frictions for retail investors from a non-continuous product supply appears to be lowest for leverage products.[18]

Beside product data, we gathered daily trading data from *Börse Stuttgart* and matched these with issuer quotes.[19] Due to the specific market characteristic of the German derivative market where issuers act as market makers and continuously submit binding quotes to organized exchanges, each observed (and time stamped) trade in the secondary market can be classified as (retail) investor purchase or sale without relying on additional classification algorithms (e.g. Lee and Ready, 1991).[20] After matching the observed trades with issuer quotes, we end up with 323,689 trades that could be identified unambiguously.[21] Figure 2 depicts the number of weekly trades in our sample for each payoff profile. As can be seen, the number of trades strongly increased after 2003 which can be explained to some extend by the increasing number of derivatives in our sample. Figure 2 also shows three grey shaded areas in each graph. The first area (from left to right) depicts the time period from July 30th to August 17th 2007, the second the time period between January 1st to 20th January 2008 and the third the time period between September 7th and October 10th, 2008.[22] The figure already provides an a priori indication on derivative choices of retail investors. During the first period, one can observe relatively little fluctuation in the sample that could directly be related to the events within that period. For the second period, one can observe an increase in purchases of investment products, most notably for discount certificates, and an increase in retail investors' sales for (capped) bonus certificates. At the same time, we observe a strong increase of call warrant purchases and, more modestly, of put warrant purchases. This suggests that call warrant investors tend to speculate on an increase of the underlying index whereas investment product investors were likely to expect a further decrease or only minor recovery of the market. For the third period, one can observe strong increases in investor sales for investment products while at the same time, albeit lower than for the second period, call warrant purchases increased. As for the second period, this suggests that call warrant investors were betting on a recovery of the market whereas investment product investors were likely to expect a further decrease or minor recovery of the market.

[18] This is also confirmed by data from the German derivative association (DDV).
[19] The data can be obtained from the website of *Börse Stuttgart*.
[20] At EUWAX, issuer quotes are binding up to EUR 3,000 for leverage products and EUR 10,000 for investment products or alternatively 10,000 units. See Baden-Württembergische Wertpapierbörse (2010b), pp. 25-26.
[21] Note that not all sample trades could be identified unambiguously as we gave priority to an exact matching between transaction price and issuer quotes. See also Nicolaus (2010)
[22] During the fist period, IKB collapsed and major central banks intervened in money markets (10th of August) and the Federal Reserve decreased the discount rate by 50 basis points (17th August). In the second period, the DAX fell by 16 percent. During third period, Fannie Mae and Freddie Mac were nationalized and major US-American investment banks were acquired (Bear Stearns, Merril Lynch) or collapsed (Lehman Brothers).

Table 3 shows additional summary statistics for the classified trades in our sample. As can be seen from the last row in each panel, our sample does not include any trade for about one third of the derivatives in our sample which is in line with industry sources. The (median) sell volume for discount certificates with DAX as underlying of EUR 16.8 thousand (EUR 18.3 thousand for ESX) is higher than the (median) purchase volume of EUR 14.9 thousand (EUR 16.5 thousand for ESX). Furthermore, our sample trades of discount certificates comprise considerable more retail investor purchases than investor sales. This is in line with industry sources that discount certificates are commonly held until maturity and therefore less likely to be sold by retail investors in the secondary market. For (capped) bonus certificates, the (median) buy volume is significantly lower with EUR 10 thousand for both underlying indexes. In contrast to discount certificates, one can observe more investor sales than purchases for bonus certificates in our sample. A possible explanation for this observation is that the issuance of (capped) bonus certificates is accompanied to a higher extend by promotional activities of the issuer or financial product supplier than for discount certificates. For leverage products, we observe a lower trading volume than for investment products. The (median) buy volume for call warrants is EUR 2.1 thousand and EUR 1.85 thousand for put warrants. Again, (median) investor sales are higher with EUR 2.62 thousand for call warrants and EUR 2.16 thousand for put warrants.

Table 4 shows additional summary statistics for our sample trades. Panel A shows summary statistics for the time since issuance and panel B for the time to maturity. As one major difference for investment products, we can observe the time since issuance for (capped) bonus certificates being significantly lower than for discount certificates. This further supports our previous explanation that a larger number of (capped) bonus certificates are purchased soon after their issuance when promotional activities of issuers or financial product suppliers are highest. For the time to maturity, we observe the (median) time to maturity being higher for bonus certificates (1.3 / 1.7 years) than for discount certificates (1.2 years). For warrants, the time to maturity is significantly lower than for investment products with a median of 0.32 years for call warrants and 0.25 years for put warrants. Furthermore, the difference between the time to maturities of investor purchases and investor sales are considerably lower for leverage products (e.g. median difference of 0.03 years for call warrants vs. 0.56 years for DAX discount certificates) which suggests a considerable lower mean holding period for leverage products and confirms the results of previous studies that analyze individual investors' trading of plain vanilla options (see Bauer et al., 2008; Schmitz et al., 2009; Dorn, 2010).

Table 5 shows summary statistics for the disaggregated purchase volume of our sample trades for different time to maturities and moneyness levels of the embedded option. For discount (bonus) certificates, the moneyness level denotes the relation between the cap level (barrier level) and the closing price of the underlying index on trading day *t* of the observed purchase. For warrants, the moneyness level indicates the relation between strike and closing price of the underlying index. For discount certificates, we observe the highest buy volumes for products with time to maturity below 0.8 years. For discount certificates with time to maturity above 0.8 years, the purchase volume is highest for products with low cap level of the embedded call option, indicating a negative relation between equity exposure and purchase volume. For bonus certificates, we observe the purchase volume to decrease with the time to maturity of the product. Similar to the previous observation, we also observe a much higher number of purchases of (capped) bonus certificates with ESX as underlying than with DAX as underlying index.[23] For warrants, we observe more purchases and higher purchase volumes for call warrants than for put warrants which might be driven by a preference of retail investors for call warrants.[24] For both warrant types, we observe a negative relation between the leverage of the product and the purchase volume.

Taken together, we expect the representativeness of our data set as being excellent. The observed patterns in product characteristics and (classified) sample trades are well in line with industry sources and confirm the results of previous studies. However, in the following analysis, we restrict our sample period until June 30th 2008. This is motivated by the fact that a regulatory reform of the German tax code as well as the increasing tensions in the financial system after July 2008 are likely to have resulted in derivative transactions of retail investors that deviate strongly from the rest of our sample period.[25]

4 Retail derivative choices in the secondary market

In this section, we empirically analyze the observed derivative choices of retail investors in the German secondary market. In a second step, we analyze the performance of the observed derivative choices vis-à-vis a benchmark portfolio that resembles the characteristics of the purchased derivatives in the secondary market.

[23] See footnote 16. Note also that barrier options are commonly perceived by market participants to be "cheaper" than plain vanilla options (see e.g. Taleb, 1997, p. 317).
[24] See also Lakonishok et al. (2007) for a similar pattern.
[25] Note that the analysis of the observed transactions between July 2008 and June 2009 is subject of a separate study.

4.1 Determinants

The German retail derivative market is characterized from issuers' perspective by a liberal regulative environment, low issuance costs and large economies of scale.[26] This allows issuers to provide retail derivatives irrespective of any particular retail demand at issuance but instead to issue whole series of derivatives that might gain in attractiveness over the course of their life cycle. Retail investors therefore are able to choose from a very large number of available products which has increased retail investors' need for specifying the derivative characteristics in great detail.[27] Since our data set includes a substantial fraction of retail derivatives with particular payoff profile that have been available to retail investors during our sample period, we can exploit the observed heterogeneity among supplied and purchased retail derivatives and infer the trading behaviour of retail investors that is likely to contribute to the observed demand patterns in the secondary market. For this purpose, we employ a panel logit model which is frequently used for analyzing consumer or investor choices (see e.g. Grinblatt and Keloharju, 2001). A drawback of such a modelling strategy is that it is restricted to observed investor purchases as investor sales are conditional on the prior choices of investors. As dependent variable for the panel logit model, we use a binary variable which is equal to one whenever we observe a retail derivative being purchased in the secondary market on a particular trading day and zero otherwise. We estimate the model

$$P(RD\ bought = 1) = \Lambda(\beta_1 X_1 + \beta_2 X_2) \qquad (1)$$

where X_1 denotes a vector of derivative characteristics, X_2 a vector of market characteristics at the time of the observed purchase and Λ denotes the logistic cumulative distribution function. For the vector X_1, we include seven security-specific variables that are likely to affect the derivative choices of retail investors. First, we include the time to maturity and a dummy variable that is equal to one in case the remaining time to maturity is below one year. The latter variable accounts for the tax treatment of capital gains from holding investment products for more than one year during our sample period. Second, we include the credit

[26] As an example, the listing fee on EUWAX is capped at EUR 25,000 per calendar year (see Baden-Württembergische Wertpapierbörse (2010a)). Furthermore, issuers' benefit from netting the single positions of retail derivatives in the trading book increases with the order flow from the retail derivative market.

[27] As of end of September 2010, retail investors were able to choose between 219,604 investment and 253,799 leverage products. Source: German Derivatives Association (DDV).

spread of the issuer to account for issuers' credit risk.[28] Third, we include the security specific omega ('effective leverage') defined as

$$\Omega_{i,t} = \frac{\partial V}{\partial S}\frac{S}{V} \qquad (2)$$

for investment products where V denotes the (theoretical) value of the product and S the respective value of the underlying index on trading day *t* to control for the security-specific (equity) exposure.[29] For leverage products (warrants), we use the moneyness level to control for the security-specific exposure.[30] Fourth, we include two dummy variables that separate our sample products on each trading day with equal payoff profile and time to maturity in three groups that differ with respect to their omega (moneyness for warrants). The first group ($D_{low} = 1, D_{high} = 0$) is the group of products with omega (moneyness) below the first tercile of the omega (moneyness) of all available products on trading day *t* with equal payoff profile and time to maturity. Similarly, the middle group ($D_{low} = 0, D_{high} = 0$) and third group ($D_{low} = 0, D_{high} = 1$) is defined. This separation allows analyzing the differences in observed derivative choices between products within a payoff category that differ with respect to the equity exposure. Fifth, we control for the costs of investing in retail derivatives and include the relative price deviation between the observed midquote at EUREX closing time on trading day *t* and the theoretical value of a duplication strategy as explanatory variable. We believe this to be a more accurate measure for investors' cost of investing in retail derivatives than other measures such as the bid-ask spread since the latter is subject to issuers' price setting behaviour which has been reported to deviate from a "fair" price setting in the secondary market (see e.g. Wilkens et al., 2003; Stoimenov and Wilkens, 2005; Muck, 2006; Baule, 2009; Nicolaus; 2010).[31] Sixth, we include the time since issuance as explanatory variable which accounts for the fact that some retail derivatives are strongly promoted at the beginning of their life cycle. This is likely to affect the derivative choices of retail investors that face substantial *search costs* and rely on financial advice (see e.g. Hortascu and Syverson, 2004; Choi et al., 2009, Hackethal et al., 2010). Seventh and restricted to (capped) bonus certificates, we include a dummy variable which is equal to one whenever each

[28] We use the spread of credit default swap on 3 year senior debt of the issuer available from Datastream. We use the lagged value of the credit spread to ensure that the credit risk was observable for the investor at the time of the purchase decision.

[29] For brevity, we refer to Nicolaus (2010) for the calculation of the theoretical value of each derivative.

[30] Note that the use of the moneyness instead of the omega for warrants is motivated by the fact that the calculation of a duplication strategy for put warrants would require the use of numerical techniques (American style options) which is beyond the scope of this paper.

[31] Note that this introduces a small bias due to a time difference between the observed trade and the closing price which we expect to be negligible. For put warrants, we refrain from including a proxy for investors' transaction costs (see previous footnote).

certificate does *not* refer to a fraction of 1 percent of the underlying index. The inclusion of such an indicator variable is motivated by the observation that such (capped) bonus certificates elude a direct comparison to the majority of available products which increases the complexity level for retail investors to assess the value of the product.[32]

As second set of explanatory variables (X_2), we use variables that characterize the market at the time of the observed purchase. The inclusion of these variables is inspired by Lakonishok et al. (2007) who analyze the determinants for option market activity at NYSE. First, we include the past returns of the underlying index. For bonus and discount certificates, we include four non-overlapping return trading-day horizons (R_{Week}, R_{Month}, $R_{Quarter}$, R_{Year}). For warrants, we include six trading day horizons (R_{Day1}, R_{Day2}, R_{Day3}, R_{Day4}, R_{Week2}, R_{Month}) which is motivated by the considerably higher trading frequency that is observed for warrants (see Schmitz et al., 2009; Dorn, 2010). Second, we include the (option-implied) volatility of an at-the-money call option that is traded at EUREX with one year time to expiration to analyze the impact of changes in the (expected) volatility on derivative choices in the secondary market.[33] Third, we include interaction terms between D_{low}, D_{high} and the past market returns and the implied volatility. Lastly, we include the inverse of the number of available products with equal payoff and time to maturity on trading day *t* which addresses potential correlations across securities and over time.[34]

4.1.1 Investment products

Columns (1) to (6) of table 5 present the results of our panel logit model for investment products. The results document five statistically significant relations: First, we can observe that the purchase propensities reflect the particular tax treatment of retail derivatives during our sample period: holding all other variables at their mean, the purchase propensity for discount certificates drops by a statistically significant 100 percent (about 80 percent for (capped) bonus certificates) when the time to maturity falls below one year. Furthermore, we observe a negative effect of the time to maturity and products' omega on the purchase propensities in the secondary market. This pattern of observations suggests that the derivative choices are driven to a considerable extend by retail investors motivation for using tax-

[32] See footnote 8.
[33] The volatility was derived from EUREX options using the well established Black and Scholes (1973) framework and a two-dimensional interpolation framework (see e.g. Baule, 2009). We use one year to expiration since the expected holding period for the majority of our products is likely to be one year.
[34] This is similar to including the unconditional probability of a purchase on trading day t. See also Dorn (2010).

advantaged instruments which applies in particular to discount certificates, where the preferred products provide relatively little equity exposure.[35]

Second, we can observe a positive relation between our proxy for retail investors' cost of investing in retail derivatives and the purchase propensity in the secondary market. For discount certificates with DAX as underlying, an increase of the relative price deviation between the market and its theoretical value by one standard deviation *increases* the propensity of a purchase by 7 percent. For bonus certificates, the estimates are higher with 28 and 90 percent for ESX and DAX as underlying. This observation can be attributed to some extend to the fact that issuers adjust their price setting in the secondary market to investor order flow which implies a positive relation between the price deviation in the secondary market and the observed purchase propensities (see e.g. Wilkens et al., 2003; Baule, 2009; Nicolaus, 2010). However, this observation is also in line with the notion that retail investors fail to identify the 'best deal' in the market due to existing *search costs* (see e.g. Hortascu and Syverson, 2004; Choi et al., 2009). The higher estimates for bonus certificates compared to discount certificates then would imply that bonus certificate investors differ from discount certificate investors in that they are subject to higher search costs.

Third, we observe differing coefficients for the other security specific variables which are difficult to explain with the assumption of a single marginal investor. For example, the estimates that control for issuers credit risk are significantly negative for discount certificates (minus 24 and 13 percent for DAX and ESX respectively for a one standard deviation increase) but insignificant for (capped) bonus certificates. Similarly, an increase by one month in the time since issuance for discount certificates *increases* the purchase propensity by 3 percent (both DAX and ESX) while for (capped) bonus certificates the coefficients suggest a *decrease* by 3 to 9 percent. Again, differences in search costs between discount and bonus certificate investors might explain this pattern of observation: a higher fraction of (capped) bonus certificates are purchased at the beginning of their lifecycle when the promotional activities of issuers and financial product supplier are highest. This explanation further is supported by the estimate for the indicator variable D_{ratio} which suggests that whenever a (capped) bonus certificate does *not* refer to a fraction of 1 percent of the underlying index, its purchase propensity increases by roughly 200 percent.[36] An alternative line of argument that could explain the differing estimates is that retail investors differ with respect to the extend to which they are subject to systematic biases in their financial decision making which has been

[35] See panel C of table 3.
[36] See also Grabbe (2009).

used by previous studies that analyze theoretically the observed demand patterns in retail derivative markets (see e.g. Breuer and Perst, 2008; Hens and Rieger, 2008). However, this line of argument cannot explain the observed differences between products with equal payoff profile.

Fourth, the coefficients for past market returns suggest an *increase* in the purchase propensity of investment products after price *decreases* of the underlying index. The estimates for past returns of the underlying index are negative and statistically significant in four cases. This tendency appears to be most pronounced for products with low equity exposure ($D_{low} = 1$). This pattern is consistent with a momentum trading tendency among investment product investors.[37] Stated differently, the observed increase in purchase propensities of investment products where a (large) fraction of the downside risk is hedged after price decreases of the underlying can be explained with a negative (or moderate) expectation of the future price level of retail investors after price decreases of the underlying index.[38] The observation of momentum tendencies among investment product investors is in line with other studies that analyze the trading behaviour of individual investors. For example, Goetzmann and Massa (2002) document that less active index fund investors tend to be momentum investors. Goetzmann and Kumar (2008) document that trend-following behaviour is higher among individual investors which have more under-diversified portfolios, are less-sophisticated and where financial decisions are behaviourally more biased. Similarly, Bailey et al. (2010) document for mutual fund choices in a sample of US discount brokerage investors that trend-chasing appears to be related to behavioural biases. Blackburn et al. (2009) find that mutual fund growth investors tend to be momentum buyers and mutual fund value investors tend to act as contrarian buyers. Our finding of momentum tendencies among investment product investors adds to this strand of the literature as it suggests that the trading strategies individual investors adopt for retail derivatives is payoff specific.

Fifth, we observe that the (expected) volatility of the underlying tends to negatively affect the purchase propensity of investment products in the secondary market. For discount certificates, we further observe a strong negative (positive) influence for products with low (high) relative equity exposure ($D_{Low}=1$) which supports the idea that at least some discount

[37] See also section 3.

[38] Note that due to the partial hedge retail investors also benefit from holding discount or (capped) bonus certificates when the underlying trades sideways. Further note that several robustness tests with returns of the retail derivative that are not shown here for brevity confirm our observation of momentum tendencies among investment product investors.

certificate investors use the instrument to benefit from a decreasing volatility.[39] For (capped) bonus certificates, the influence appears to be less clear cut but indicates that volatility is unlikely to be a major motivation for retail investors' purchase of this payoff profile.

4.1.2 Leverage products

For leverage products, we observe several differences in the determinants of purchase propensities compared to investment products. First, we observe a preference for out-of-the-money put warrants which further confirms that warrants are used in particular for speculative purposes rather than for hedging purposes (see also Schmitz et al., 2009; Dorn, 2010; Nicolaus, 2010). Second, we observe that warrant investors tend to trade on negative feedback, i.e. act as contrarian investors. While put warrants are purchased after price *increases* of the previous two trading days, call warrants are purchased after price *decreases* of the previous day. For example, a one standard deviation increase in the past return of the previous trading day is associated with a decrease of the purchase propensity by 46 percent for call warrants (increase by 18 percent for put warrants). For call warrants, our results also show the contrarian tendency being highest for products with high (relative equity) exposure. This pattern of observations confirms the results of previous studies which find that retail investors using vanilla options tend to trade on negative feedback (see Schmitz et al., 2009; Burghardt and Riordan, 2009). Our finding of contrarian tendencies among leverage product investors and momentum tendencies among investment product investors also confirm Goetzmann and Massa (2002) who find that more active individual investors tend to act as contrarian investors. Furthermore, the different trading behaviour among investment and leverage investors further supports our previous notion of a payoff-specific trading behaviour of retail investors.

Third, our results confirm Lakonishok et al. (2007) that option trading activity is positively related with market volatility (see also e.g. Lemmon and Ni, 2008; Choy and Wei, 2010). This result appears to be most pronounced for put warrants where our estimates suggest an increase of the purchase propensity by 27 percent for a one percent increase of the (implied) volatility from its sample mean. Again, our results show that the positive effect of implied volatility is most pronounced for call warrants that provide the highest (relative)

[39] Note that the vega of discount certificates is negative, i.e. retail investors earn a positive premium for volatility risk.

leverage which further supports the speculative purpose of retail investors for using this payoff profile.

4.2 Performance

An implication of derivative choices being subject to *search costs* or suffering from *systematic biases* in the financial decision making of retail investors is that the selected securities in the secondary market should underperform a benchmark portfolio that is closer to the efficient frontier (see e.g. Markowitz, 1952). To analyze this notion, we study the performance of a buy-and-hold strategy of the products chosen by retail investors in the secondary market and compare it with the performance of a portfolio of products with similar characteristics that have been available to retail investors at the time of the observed purchase (including the purchased product). This methodology is close to Dorn (2010) but differs from his study in that we cluster our data on individual security instead of individual investors. This requires an additional assumption for the holding period of the trading strategy retail investors are likely to adopt with our sample derivatives. We assume the trading strategy to be as follows: each retail derivative is purchased at the spot ask quote at *Börse Stuttgart* and sold at the spot bid quote.[40] For investment products, we assume the investor to hold each product for 252 trading days which appears to be a reasonable assumption given the observed trading patterns.[41] For warrants, we assume the investor to hold each product for 5 trading days which has been documented to be the average holding period for individual investors warrant trading strategies (see e.g. Schmitz et al., 2009; Dorn, 2010) and is also supported by our observations.[42] We then calculate the performance difference between the purchased product and a benchmark portfolio according to

$$PD^{i}_{t,t+T} = R^{i}_{t+T} - \frac{1}{S}\sum_{j \in S} R^{j}_{t+T} \qquad (3)$$

where R^{i}_{t+T} is the buy-and-hold return of retail derivative *i* purchased on trading day *t* with *T=252* for investment products and *T=5* for warrants and the subtrahend denotes the buy-and-hold return of an equally weighted benchmark portfolio that consists of derivatives with

[40] Note that this introduces a slight inconsistency due to time difference between the observed trade and our trading strategy. However, the impact for our results should be neglibigle.

[41] Note that some of the (capped) bonus certificates have been knocked out during our sample period and therefore were not traded until maturity. In this case, the buy-and-hold return was calculated using the last quoted price at EUWAX.

[42] In cases where the time to maturity on the actual trading day is below 252 (5 for warrants) trading days, we assume the investor to hold the product until the last recorded bid quote at EUWAX. Note that we obtain qualitatively similar results for holding periods ranging between 2 and 15 trading days.

similar product characteristics that are available to retail investors at the time of the observed purchase. As benchmark portfolio, we use two different portfolios: the first benchmark portfolio, labelled $BPF_{similar}$, consists of all securities with payoff characteristics that are most similar to the product purchased (including the purchased product). For discount certificates, $BPF_{similar}$ includes all products with equal time to maturity and cap level within a +/- 100 index point range as the purchased product.[43] For (capped) bonus certificates, as there are less products available for retail investors, $BPF_{similar}$ includes all products with time to maturity within a +/- 5 trading day range around the product purchased in the secondary market and closest barrier level as the purchased product. For warrants, $BPF_{similar}$ includes all products with equal time to maturity and a moneyness level within a +/- 5 percent moneyness range as the purchased product.[44] As second benchmark portfolio, labelled BPF_{all}, we use all available products at trading day *t* (including the product purchased) with equal time to maturity. For (capped) bonus certificates we consider all products with similar time to maturity (+/-5 trading day range).

Summary statistics for the return differences are presented in table 6.[45] For the entire sample period, we observe that discount certificates chosen by investors on average outperform $BPF_{similar}$ by a statistically significant 5 basis points. This somehow surprising result is even higher when using the broader portfolio BPF_{all} as benchmark portfolio with 45 basis points. However, considering the time consistency of this observation in figure 4 and panel B of table 6, we observe that this result is driven by a strong increase of the performance difference after 2007. For the time period until June 2007, the return differences relative to BPF_{all} is significantly negative with an average of 68 basis points for discount certificates with DAX as underlying (77 bp for ESX). In contrast, we observe a positive average return difference of 4.64 percent for discount certificates with DAX as underlying (4.4 percent for ESX) between July 2007 and June 2008 which can be explained by the low cap level chosen by retail investors.[46] For bonus certificates, we observe that $BPF_{similar}$ (BPF_{all}) on average outperforms the selected products in the secondary market by 60 bp (114 bp) for the entire sample period. In contrast to discount certificates and due to the barrier option, the underperformance of selected products strongly increased after June 2007. The results for warrants shows that on average, both benchmark portfolios outperformed the purchased products when assuming a buy-and-hold strategy with holding period of 5 trading

[43] Note that we obtain qualitatively similar results for +/- 200 index points range.
[44] Note that we obtain qualitatively similar results for a +/-10 percent range.
[45] Note that the results have been winsorized at the 1 percent level to account for outliers.
[46] See panel B of table 5.

days. For call warrants, we observe an underperformance of 45 bp with $BPF_{similar}$ as benchmark portfolio and 160 bp with BPF_{all} as benchmark portfolio. Similar as for bonus certificates, we observe an increase in the underperformance after June 2007. For put warrants, the underperformance is even higher with 100 basis points for $BPF_{similar}$ as benchmark portfolio and 404 bp with BPF_{all} as benchmark portfolio. Taken together, these results suggest that the derivative choices of retail investors tend to be poor. The magnitude of the observed underperformance is rather surprising since retail investors face additional costs when investing in retail derivatives (e.g. from mispricing in the secondary market or brokerage fees). However, our results have to be interpreted with due care since they are based on the assumption of a constant holding period which understates in particular the trading activity of warrant investors.[47]

To analyze to which extend the observed performance differences are related to the trading patterns that have been documented in the previous section, we employ a panel regression with the performance difference (BPF_{all} as benchmark portfolio) as dependent variable and the market variables of our previous model (X_2) as explanatory variables. Table 7 shows the results of the panel regression. For investment products, we observe the performance differences being most *negative* when purchase propensities *increase* (after price *decreases* of the underlying index). In contrast, the results show that the performance differences for call and put warrants are most *positive* when purchase propensities *increase.* These result support the notion that the trading behaviour of investment product investors is likely to result in a performance loss and driven by retail investors' reliance on a continuation of past price trends. In contrast, leverage derivative choices appear to anticipate to some extend changes in the price process of the underlying index and therefore benefit from a contrarian trading strategy. This effect seems to be most pronounced for call warrants with high (relative) leverage as indicated by the interaction terms. Our results therefore suggest that the information content of observed derivative choices with respect to the underlying index is highest for warrants and likely to be low for investment derivative choices.

[47] Note however, that similar results have been reported by Bauer et al. (2008) and Dorn (2010) who both analyze the individual investor gains from plain vanilla option trading. Furthermore, the tax treatment of the products provided presented a strong incentive for a buy-and-hold strategy with one year holding period for investment product investors.

5 Retail derivative choices and retail investor sentiment

The finding that derivative securities selected by retail investors on average underperform a benchmark portfolio that consists of similar securities suggest that the market timing abilities of retail investors on average tend to be weak. In fact, a large strand of the literature documents that security choices of individual investors suffer from behavioural biases such as the representativeness bias (Tversky and Kahnemann, 1974), overconfidence (Odean, 1999) or the disposition effect (Shefrin and Statman, 1985). The impact of systematic biases in the financial decision behaviour of individual investors on asset price dynamics has been studied extensively, both theoretically (see e.g. De Long et al., 1990; Barberis et al., 1998; Hong and Stein, 1999; Shleifer and Summers, 1990) and empirically (see e.g. Neal and Wheatley, 1998; Lee et al., 1991). The empirical studies on investor sentiment differ in particular in the way investor sentiment is measured. While some use direct measures such as surveys (see e.g. Baker and Wurgler, 2007), other studies rely on indirect measures for investor sentiment that are derived from e.g. trading imbalances (see e.g. Barber et al 2009, Andrade et al., 2008) or option prices (Han, 2008; Rehman and Vilkov, 2008; Buskirk, 2009, Xing et al. 2009). Two recent studies also use derivative choices of retail investors from the German market to measure investor sentiment. Schmitz et al. (2009) derive a sentiment measure based on the aggregated warrant holdings of a sample of retail investors from a German discount broker. Similar to our results, they find contrarian tendencies among warrant investors and also some weak predictive power of their sentiment measure for (very) short term future returns of the underlying asset (1 trading day) which they attribute to the warrant trading of experienced and most sophisticated investors in their sample.[48] Burghardt and Riordan (2009) use trading imbalances of aggregated order volumes of leverage derivatives from *Börse Stuttgart* and also find contrarian tendencies among leverage derivative investors. However, a methodological drawback of the sentiment measures used in both studies is that these neglect the heterogeneity among purchased products *within* a payoff category.[49] Given the large number of available products retail investors can choose from, a sentiment measure that accounts for the heterogeneity among selected products *within* a payoff category is likely to be more sensitive to changes in investor sentiment and therefore likely to provide additional insights on the role of (retail) investor sentiment for the price dynamics of the underlying. To analyze

[48] Note that our previous observation for call warrants is also consistent with sophisticated 'day traders' that tend to purchase a larger fraction of call warrants with high (relative) equity exposure.
[49] In essence, both studies use an imbalance measure between short and long positions on the underlying.

this notion, we propose a sentiment measure that considers the differences of purchased products within a particular payoff category by calculating the following sentiment measure

$$SENT_t^k = \frac{\sum_{i|t,D_{High=1}} Purchases}{\sum_{i|t,k} Purchases} \qquad (4)$$

where $SENT_t^k$ denotes the sentiment measure of product type *k* on trading day *t,* and *Purchases* the number of purchased products on trading day *t*. D_{High} is a dummy variable that separates our sample products according to their equity exposure and is equal to one whenever the omega of the investment product is above the median omega of products within the same payoff category during our sample period. For warrants, we use, as in section 4.1, the moneyness conditional on the time to maturity to separate the products in each payoff category in two groups. In other words, our retail investor sentiment measure shows the fraction of retail derivatives on trading day *t* with 'high' equity exposure bought in the secondary market relative to all other purchases of retail derivatives with equal payoff profile on trading day *t*.

Panel A of table 8 shows summary statistics for the sentiment measure, figure 5 depicts it graphically.[50] As can be seen for the two sub-periods in panel A, the average fraction invested in investment products with high (relative) equity exposure decreased during our sample period, indicating a decrease in optimism among investment product investors after June 2007 which re-confirms our previous finding of momentum tendencies among investment product investors. In contrast, for call warrants we observe an increase for our sentiment measure, indicating an increase in optimism among call warrant investors. For put warrants, we observe a lower fraction invested in put warrants with low strike-price ratio during the second sub period, which confirms the contrarian tendencies that have been observed in the previous section. Panel B of table 8 also shows the correlations with alternative sentiment measures. The sentix is a survey based measure, where individual and institutional investors are asked once a week about their belief on the future trend of DAX and ESX (bullish, bearish or neutral) for the next month. The VDAX is an index that is designed to measure the expected DAX volatility and is derived from at-the-money EUREX options. We also show the correlation of our sentiment measure with the option implied volatility skew (OIVS) which has been documented to contain information about future price movements of the underlying

[50] Note that we restrict the following analyses to the sample period between January 2004 to June 2008 since our measure crucially depends on a sufficient number of trades on each day.

(see e.g. Bakshi et al., 2003; Xing et al. 2008; Rehman and Vilkov, 2009).[51] The correlations show the following pattern: all sentiment measures based on investment product choices are negatively related with the returns of the underlying index, $Sentix_{value}$ and positively related with $Sentix_{neutral}$. This suggests that our sentiment measure is well in line with alternative measures of investor sentiment. For discount certificates, we further observe our sentiment measure being negatively related with the VDAX and positively related with the OIVS derived from EUREX options.[52] For leverage products, our sentiment measure is negatively related with the returns of the underlying index and $Sentix_{value}$ and positively related with $Sentix_{neutral}$ which re-confirms our previous findings of contrarian tendencies among warrant investors. For call warrants, we also observe the VDAX being positively related with our sentiment measure, again supporting the idea that high volatility is associated with higher trading activity of high leverage call warrant investors.

To further investigate whether our sentiment measure has predictive power for subsequent returns of the underlying index, we employ a vector autoregressive (VAR) model with our sentiment measure and index returns as dependent variable. The methodology is similar to previous studies on investor sentiment (see e.g. Brown and Cliff, 2004; Wang et al., 2006; Dorn et al., 2008; Bauer et al., 2008). Our VAR model is given by

$$\Delta\mathrm{SENT_t} = \alpha_1 + \sum_{i=1}^{P} \beta_{1i} \Delta\mathrm{SENT_{t-i}} + \sum_{i=1}^{P} \delta_{1i} R_{t-i}^{Index} + \varepsilon_{1t} \qquad (5)$$

$$R_t^{Index} = \alpha_2 + \sum_{i=1}^{P} \beta_{2i}\, \Delta SENT_{t-i} + \sum_{i=1}^{P} \delta_{2i} R_{t-i}^{Index} + \varepsilon_{2t} \qquad (6)$$

where $\Delta\mathrm{SENT_t}$ denotes our payoff specific sentiment measure and R_t^{Index} is the (log)return of the underlying index and p the number of lags. We use the first differences for our sentiment measure and employ standard information criteria to determine the optimal number of lags (Akaike, Schwarz). We further employ Granger causality tests (Granger, 1969) to analyze the influence of our sentiment measure and index returns. The results are presented in table 9 and confirm our previous notion that the information content of derivative choices for subsequent returns of the underlying is low. As can be seen, our results do not indicate any significant influence of our sentiment measure on the returns of the underlying index. Furthermore, the results from Granger causality tests re-confirm our previous observation of an influence of past returns on derivative choices, but do not indicate any significant influence of our sentiment measure on the returns of the underlying index. Therefore in line with our previous

[51] We derived the option implied volatility skew from the volatility surface of EUREX options using the difference between an out-of-the-money put option with a strike/price ratio of .95 and an at-the-money call option with 12 month to maturity (see e.g. Xing et al., 2008, Buskirk, 2009).
[52] See also section 4.1.1.

observations, the derivative choices of retail investors therefore appear to reveal more information about the trading behaviour of retail investors rather than the future price level of the underlying.

6 Conclusion

In this study, we analyze the derivative choices of retail investors that can be observed in the German secondary market. Using an extensive data set that includes product and trading data, we analyze the trading patterns of retail derivatives with three popular payoff profiles that are well established in the German and other European retail derivative markets. We analyze a number of determinants that are likely to affect the purchase propensity of retail derivatives and compare the performance of a buy-and-hold strategy of each purchased product with a benchmark portfolio that consists of similar products that have been available to retail investors at the time of the observed purchase. Furthermore, we propose a new payoff-specific retail investor sentiment measure and study its information content for subsequent returns of the underlying.

We find the derivative choices of retail investors to support three lines of arguments that have been provided to explain the observed popularity of the instrument in financial retail markets. First, we find the tax treatment for products that provide only little equity exposure to be a strong determinant in the purchase propensity of those products. Second, we find an increase in search costs due to an increased need for specifying the characteristics of financial products to explain several patterns in the purchase propensity for retail derivatives in the secondary market. Third, we find the derivative choices to be consistent with momentum tendencies among investment product investors and contrarian tendencies among leverage product investors. This is in line with previous studies, that relate the differences in the trading behaviour of individual investors to the extend to which these are subject to biases in their financial decision making. We document that derivatives chosen by retail investors on average underperformed a more diversified portfolio that consists of similar products and show that the performance differences can be related to the momentum and contrarian tendencies that are observed in the derivative choices. The analysis of our proposed sentiment measure further supports our finding that the information content of derivative choices tends to be low for subsequent returns of the underlying.

Our finding that investor specific as well as situational specific factors are likely to affect the derivative choices of retail investors observed in the secondary market raises the question, to which extend the increase in the need for specifying the characteristics of financial products emphasizes their importance for the portfolio choices of individual investors. The potential role of factors that are related with search costs of individual investors found in this study emphasizes the need for an adequate disclosure regime in financial retail markets to exploit the welfare improving potential of this instrument. The observed impact of retail derivatives' payoff profile on derivative choices calls for further research as it is unclear to which extend this effect is driven by situational or investor specific factors. Future research therefore should focus on the role of the security design on actual portfolio choices of retail investors. This not only would provide further insights about the portfolio choices of retail investors but also help to assess the limitations of financial retail markets to perform additional functions.[53]

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Table 1: Sample overview

This table reports the number of active products and new issued products in our sample for each year (panel A). Panel B reports the number of sample derivatives for each issuer. Panel C reports summary statistics for the number of available retail derivatives with equal time to maturity and payoff profile whenever a (retail investor) purchase is observed in our sample.

Payoff profile	**Discount certificates**		**Bonus certificates**		**Capped bonus certificates**		**Call warrants**	**Put warrants**
Underlying	DAX	ESX	DAX	ESX	DAX	ESX	DAX	DAX
Panel A: New issuances /Active products								
2003	111 / 121	79 / 96		17 / 17		1 / 1	37 / 2875	28 / 2625
2004	516 / 637	392 / 488		30 / 47	1 / 1	1 / 2	149 / 2838	108 / 2597
2005	952 / 1589	909 / 1397	36 / 36	148 / 195	23 / 24	53 / 55	317 / 2689	306 / 2489
2006	1476 / 2821	1001 / 2184	135 / 171	390 / 584	129 / 153	123 / 178	745 / 2372	701 / 2183
2007	1788 / 3905	846 / 2513	134 / 303	270 / 849	131 / 281	173 / 331	1152 / 1627	1090 / 1482
2008	880 / 3583	728 / 2443	0 / 283	0 / 760	0 / 229	0 / 272	475 / 475	392 / 392
2009	80 / 2039	79 / 1445	0 / 196	0 / 515	0 / 83	0 / 113		
Panel B: Sample derivatives grouped by issuer								
HSBC T. & B.	361	204	4	91	4	46		
ABN Amro	204	168		6				
Bay. Landesbank	11	9						
BHF	131	5						
BNP Paribas	675	547	92	106	70	50		
Citigroup	352	237	25	94	13	28		
Commerzbank	534	327	54	81	24	26	1715	1529
Deutsche Bank	1021	533	13	51	13	21	1160	1096
Dresdner Bank	476	192						
DZ Bank	211	244		28		7		
Goldman Sachs	70	85	72	78	10	10		
Hypovereinsbank		2		24		2		
Landesb. Berlin	19	9						
LBBW	30	31				5		
Merril Lynch	9	5						
Morgan Stanley		96						
Sal. Oppenheim	465	346	105	113	80	73		
Societe Generale	138	136	57	109	44	49		
UBS	899	794	5	57	5	8		
Vontobel	69	45						
WestLB	12	16	21	62	21	26		
WGZ	108	17						
Panel C: Summary stats number of available products								
Mean	66.3	39	6.9	12.2	4.8	7.9	32.9	31.45
Std	60.8	28.3	8.1	11.1	3.6	7.1	16.06	15.52
Median	50	32	5	8	4	6	33	31

Table 2: Trading volume of sample trades

This table reports summary statistics for the trading volume of our sample trades for discount and (capped) bonus certificates as well as for call and put warrants in thousand EUR. Panel A (B) reports the results for sample trades with DAX (ESX) as underlying index.

Payoff profile	**Discount certificates**		**Bonus certificates**		**Capped bonus Certificates**		**Call warrants**		**Put warrants**	
Underlying index	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell
Panel A: DAX Performance index										
Mean	36.2	50.7	30.50	37.46	24.50	28.85	7.23	8.47	5.87	7.37
Std	118.2	144.7	116.17	133.80	54.48	86.60	25.40	25.90	19.46	23.05
25th percentile	7.9	8.2	5.15	31.39	5.14	23.64	0.93	1.11	0.86	0.93
Median	14.9	16.8	9.97	12.99	10.03	10.45	2.10	2.62	1.85	2.16
75th percentile	29.9	41.9	24.32	6.16	20.47	5.55	5.00	6.40	4.30	5.28
Min	0.02	0.03	0.45	2998.15	0.57	2008.00	0.10	0.10	0.10	0.1
Max	14,001.2	7,441.7	2,659.43	0.50	1,022.56	0.48	2,009.50	1,266.25	1,305.50	1,224.03
Obs	45,334	18,222	947	1,000	1,774	1,769	50,076	44,694	44,094	36,844
No trade [%]	32.67		52.46		30.99		35.13		31.66	
Panel B: DJ EUROSTOXX 50 Price index										
Mean	43.99	53.80	25.71	27.96	24.14	26.20				
Std	144.63	155.68	84.60	108.18	48.56	59.03				
25th percentile	9.05	8.72	5.15	24.57	5.87	23.22				
Median	16.46	18.27	10.15	11.49	10.64	10.54				
75th percentile	34.90	44.11	22.61	5.77	23.71	5.40				
Min	0.03	0.02	0.08	8,103.60	0.45	1,510.32				
Max	7,712.82	4,431.00	4,510.00	0.15	1,080.04	0.34				
Obs	24,817	14,347	12,837	20,019	3,556	3,359				
No trade [%]	12.48		31.23		31.62					

Table 3: Time to maturity and time since issuance of securities at trading time

This table shows summary statistics for the time to maturity and time since issuance of the products in our sample conditional of an observed purchase in our sample (in years).

Payoff profile	**Discount certificates**				**Bonus certificates**				**Capped bonus certificates**				**Call warrant**		**Put warrant**	
Underlying index	DAX		ESX		DAX		ESX		DAX		ESX		DAX			
Classification	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell
Panel A: Time since issuance																
Mean	0.91	1.40	0.97	1.61	0.58	1.20	0.82	1.62	0.57	1.17	0.63	1.29	0.50	0.52	0.71	0.73
Std	0.77	0.89	0.84	1.04	0.62	0.67	0.78	0.82	0.67	0.84	0.50	0.69	0.52	0.51	0.84	0.83
Median	0.74	1.26	0.74	1.39	0.38	1.19	0.59	1.53	0.32	1.11	0.54	1.25	0.35	0.37	0.42	0.45
Panel B: Time to maturity																
Mean	1.25	0.74	1.50	0.93	1.59	1.15	2.56	2.13	1.66	1.33	1.48	0.94	0.50	0.45	0.40	0.37
Std	0.58	0.69	1.12	1.10	0.91	0.91	1.51	1.46	1.13	1.20	0.90	0.85	0.56	0.51	0.46	0.43
Median	1.17	0.61	1.19	0.61	1.42	0.95	2.07	1.92	1.25	0.99	1.24	0.70	0.32	0.29	0.25	0.23
Obs	24,110	5,101	13,415	3,373	947	1,000	12,837	20,018	1,774	1,769	3,556	3,358	50,022	44,588	44,031	36,751

Table 4: Disaggregated purchase volume

This table shows the disaggregated mean purchase volume for our sample trades for various moneyness and time to maturity ranges. For discount certificates, the moneyness is defined as the strike/price ratio between the cap level and the closing price of the underlying. Similarly, the moneyness level for (capped) bonus certificates denotes the ratio between the barrier level of the embedded down-and-out put option and the closing value of the underlying.

Payoff profile	**Discount certificates**		**Bonus certificates**		**Capped bonus certificates**		**Call warrants**	**Put warrants**
Underlying index	DAX	ESX	DAX	ESX	DAX	ESX	DAX	DAX
Moneyness range / Time to maturity	0 – 0.8 years							
<25th percentile	77.2	71.5	39.4	56.8	45.7	26.7	11.8	4.7
25th – 50th percentile	61.12	83.19	13.7	47.7	24.6	35.1	6.2	4.3
50th – 75th percentile	88.93	103.90	11.5	31.3	24.8	29.8	5.7	4.2
>75th percentile	82.25	71.06	26.6	42.3	69.6	28.6	4.6	8.2
Obs	4,078	2,753	130	684	233	494	40,448	37,814
Moneyness range / Time to maturity	0.8 – 1.6 years							
<25th percentile	41.0	42.2	54.3	33.4	21.9	21.6	12.1	7.6
25th – 50th percentile	29.76	34.03	27.3	25.6	23.1	21.8	7.5	10.1
50th – 75th percentile	27.96	37.65	26.0	23.4	21.2	27.1	8.2	10.2
>75th percentile	31.94	41.08	43.6	22.8	17.7	28.6	3.9	9.1
Obs	36,729	17,828	478	3,981	972	2,083	7,715	5,219
Moneyness range/ Time to maturity	1.6 – 8 years							
<25th percentile	43.7	37.6	18.7	22.2	25.5	19.2	12.3	6.8
25th – 50th percentile	31.10	30.51	21.6	22.3	17.5	18.4	10.3	9.9
50th – 75th percentile	29.75	37.19	24.1	25.9	20.5	20.3	6.0	7.2
>75th percentile	34.20	34.87	28.7	25.1	31.1	21.3	3.1	6.5
Obs	4,527	4,236	339	8,172	569	979	1,890	1,045

Table 5: Determinants of retail investor choices

This table presents the results of a panel logit model with dummy variable as dependent variable that is equal to one whenever a purchase of the retail derivative *i* is observed on trading day *t* in the secondary market and zero otherwise. "*Time to maturity*" denotes the remaining time to maturity on day *t* in years. "*Time since issuance*" is the time passed since issuance of the product in years. "D_{Tax}" denotes an indicator variable that is equal to one whenever the remaining time to maturity is below one year and zero otherwise. "D_{Ratio}" is an indicator variable that is equal to one whenever the certificate does not refer to a fraction of 0.01 of the underlying index. "*Credit risk*" is the the spread of credit default swap on 3 year senior debt of the issuer. "*Costs of Investing*" denotes the (relative) price deviation between the market price of the derivative in the secondary market and the theoretical value of a duplication strategy. "*Omega*" is the (lagged) effective leverage of product i. "*Moneyness*" is the strike/price ratio of the warrant. "*IV*" denotes the (implied) volatility of an at-the-money EUREX call option with one year time to expiration. "R_{Day}" denotes the return of the underlying index of the previous day/ week/ month/ quarter or year respectively. "D_{High}" ("D_{Low}") is an indicator variable that is equal to one whenever the omega (moneyness) of the product is above the upper (below the lower) tercile of the omega (moneyness) of all available products on day t with equal time to maturity and payoff profile and zero otherwise. Not shown are the coefficients that control for the observation year and the (unconditional) probability of a product being purchased on day t. Robust *z-statistics* that are adjusted for within-cluster correlation (Williams, 2000) are reported in parantheses. */**/*** denote significance at 5/1/0.1 percent level respectively.

Payoff profile	**Discount certificates**		**Bonus certificates**		**Capped bonus certificates**			**Call warrants**	**Put warrants**
Underlying	DAX	ESX	ESX	DAX	ESX	DAX		DAX	DAX
	(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)
Time to maturity	-0.821***	-1.079***	-0.205**	-1.419***	-0.562**	-0.435**	*Time to maturity*	-1.462***	-1.479***
	(-7.04)	(-11.67)	(-2.75)	(-5.25)	(-2.66)	(-3.28)		(-10.17)	(-12.74)
Time since issuance	0.354***	0.248***	-0.001***	-0.005***	-0.003*	-0.005***	*Time since issuance*	0.51***	-0.108
	(8.65)	(7.16)	(-4.24)	(-7.27)	(-2.32)	(-6.4)		(8.96)	(-1.21)
D_{Tax}	-3.577***	-3.421***	-1.089***	-1.244***	-1.549***	-1.918***	D_{Tax}	-0.081	-0.059
	(-57.49)	(-26.06)	(-6.71)	(-4.26)	(-6.58)	(-9.03)		(-0.75)	(-0.53)
D_{Ratio}			-0.061		1.007*	1.166***			
			(-0.31)		(2.57)	(3.59)			
Credit risk	-0.01***	-0.005**	-0.006*	-0.003	-0.006	-0.004	*Credit risk*	-0.001	-0.005**
	(-6.11)	(-3.36)	(-2.55)	(-0.82)	(-1.75)	(-1.15)		(-0.48)	(-2.8)
Costs of Investing	11.504*	-3.805	5.571**	22.081***	-0.851	-10.425	*Costs of Investing*	-1.248***	
	(2.00)	(-0.85)	(2.73)	(3.87)	(-0.22)	(-0.56)		(-10.83)	
Omega	-2.95***	-2.692***	-2.04***	-0.031	0.169	-0.067	*Moneyness*	0.965*	-0.139
	(-18.89)	(-21.45)	(-7.22)	(-0.03)	(0.42)	(-0.13)		(2.55)	(-0.41)
IV	-2.076	-23.415***	-11.731**	-12.183	8.436	4.504	*IV*	3.666*	11.17***
	(-0.4)	(-6.69)	(-3.35)	(-1.72)	(1.57)	(1.13)		(2.24)	(6.24)
R_{Week}	-0.001	0.001	-0.019	-0.014	-0.04	-0.03	R_{Day1}	-54.636**	3.791**
	(-0.17)	(0.1)	(-1.3)	(-0.31)	(-1.47)	(-0.92)		(-3.14)	(3.19)

Table 5: (continued)

R_{Month}	-0.007	-0.089*	-0.241**	-0.247	0.043	-0.261*
	(-0.26)	(-2.38)	(-3.1)	(-1.62)	(0.36)	(-2.45)
$R_{Quarter}$	0.112*	-0.24**	-0.278	-0.328	-0.117	-0.289
	(2.01)	(-3.04)	(-1.91)	(-1.04)	(-0.43)	(-1.21)
R_{Year}	-0.14	0.28	-0.443	0.189	0.226	0.043
	(-0.87)	(1.17)	(-0.85)	(0.24)	(0.28)	(0.05)
D_{Low}	22.57*	113.065***	0.812	0.199	-2.065	0.365
	(2.26)	(11.39)	(0.95)	(1.1)	(-1.25)	(1.76)
D_{High}	-4.383	-41.924***	1.699*	-0.143	1.954*	-0.184
	(-0.64)	(-9.99)	(2.56)	(-0.71)	(2)	(-1.06)
$D_{Low} * R_{Week}$	-0.026**	-0.058***	-0.007	-0.021	0.083*	-0.033
	(-2.8)	(-3.62)	(-0.32)	(-0.37)	(2.4)	(-0.67)
$D_{Low} * R_{Month}$	-0.265***	-0.393***	-0.059	-0.119	0.03	-0.109
	(-7.22)	(-7.68)	(-0.51)	(-0.66)	(0.18)	(-0.52)
$D_{Low} * R_{Quarter}$	-0.5***	-0.873***	-0.288	0.053	0.414	-0.336
	(-6.51)	(-7.59)	(-1.31)	(0.15)	(1.29)	(-0.99)
$D_{Low} * R_{Year}$	-1.572***	-3.101***	0.211	0.122	0.717	-0.539
	(-9.71)	(-12.25)	(0.29)	(0.12)	(0.55)	(-0.5)
$D_{High} * R_{Week}$	-0.057***	-0.06**	-0.055*	-0.08	-0.002	0.017
	(-4.59)	(-3.14)	(-2.54)	(-1.49)	(-0.06)	(0.49)
$D_{High} * R_{Month}$	-0.086*	-0.023	-0.039	-0.056	-0.125	0.247*
	(-2.24)	(-0.4)	(-0.41)	(-0.32)	(-0.81)	(1.98)
$D_{High} * R_{Quarter}$	0.097	0.265*	-0.174	0.072	0.021	0.356
	(1.27)	(2.41)	(-0.9)	(0.23)	(0.06)	(1.39)
$D_{High} * R_{Year}$	-0.135	-0.561	-0.002	-1.536	-0.734	-0.371
	(-0.77)	(-1.91)	(0)	(-1.28)	(-0.83)	(-0.42)

R_{Day2}	-9.9	2.593*
	(-0.45)	(2.29)
R_{Day3}	4.217	0.062
	(0.21)	(0.06)
R_{Day4}	24.097	-0.366
	(0.99)	(-0.33)
R_{Week2}	-6.526	-3.175***
	(-0.54)	(-4.38)
R_{Month}	-2.358	-2.187***
	(-0.23)	(-3.58)
D_{Low}	2.206	-7.613***
	(1.38)	(-5.26)
D_{High}	2.244	6.298***
	(1.59)	(3.85)
$D_{Low}*R_{Day1}$	128.946**	-1.002
	(3.36)	(-0.62)
$D_{Low}*R_{Day2}$	6.074	-0.38
	(0.14)	(-0.24)
$D_{Low}*R_{Day3}$	2.102	2.253
	(0.05)	(1.4)
$D_{Low}*R_{Day4}$	-67.465	2.57
	(-1.51)	(1.58)
$D_{Low}*R_{Week2}$	-30.92	2.797**
	(-1.25)	(2.95)
$D_{Low}*R_{Month}$	-20.446	4.253***
	(-0.99)	(5.37)
$D_{High}*R_{Day1}$	-70.059**	-6.82**
	(-3.33)	(-2.6)
$*D_{High}*R_{Day2}$	-3.938	-12.347***
	(-0.17)	(-5.94)
$D_{High}*R_{Day3}$	-9.357	-4.801*
	(-0.41)	(-2.3)
$D_{High}*R_{Day4}$	34.434	-7.063***
	(1.36)	(-3.51)
$D_{High}*R_{Week2}$	31.426*	-8.979***
	(2.35)	(-6.87)

Table 5: (continued)

							D_{High}*R_{Month}	19.885	-6.053***
								(1.74)	(-5.5)
D_{Low} *IV	-310.354***	-691.856***	-5.128	1.429	10.797	-1.932	D_{Low}*IV	-13.762***	-4.196***
	(-6.03)	(-16.55)	(-1.25)	(0.89)	(1.37)	(-1.42)		(-23.45)	(-11.45)
D_{High}*IV	140.052***	263.033***	-9**	-0.175	-12.577**	0.341	D_{High}*IV	1.189***	-8.098***
	(3.99)	(12.9)	(-2.77)	(-0.11)	(-2.69)	(0.24)		(3.58)	(-15.04)
Intercept	-3.404**	2.04**	2.213**	1.344	-3.803***	-1.675	*Intercept*	-6.636***	-2.745**
	(-3.23)	(3.02)	(2.95)	(0.61)	(-3.48)	(-1.8)		(-8.7)	(-3.04)
Obs	1420300	1059854	281325	112199	88354	86442	Obs	219700	271089
Groups	4984	3468	707	298	288	273	Groups	1923	1916
Chi^2	7786.5	3144.11	658.23	689.96	323.14	403.94	Chi^2	1985.30	1346.27
Prob Chi^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	Prob Chi^2	0.0000	0.0000

Table 6: Performance of retail investor choices

This table reports the average performance differences between a buy-and-hold strategy of a purchased retail derivative and two different benchmark portfolios ($BPF_{closest}, BPF_{All}$) in percent. For discount certificates, $BPF_{closest}$ includes all discount certificates available on day *t* with equal time to maturity and cap level within a +/- 100 index point range as the product for which a purchase is observed in our sample. For (capped) bonus certificates, $BPF_{closest}$ includes all (capped) bonus certificates on day t with similar time to matuity (+/- 5 trading days) and closest barrier level as the purchased product. For warrants, $BPF_{closest}$ includes all warrants with equal time to maturity and moneyness within a +/- 5 percent range as the moneyness of the purchased product. BPF_{all} includes all available products at trading day *t* with equal time to maturity (within a +/-5 trading day range for (capped) bonus certificates). All results have been winsorized at the 1 percent level. Standard deviations are reported in parantheses.

Benchmark portfolio	**BPF_{Close}**	**BPF_{All}**
Panel A: - June 2008		
Discount certificates (DAX)	0.053*** (0.349)	0.452*** (5.141)
Discount certificates (ESX)	0.074*** (1.038)	0.433*** (5.784)
Bonus certificates (ESX)	-0.596*** (3.461)	-1.14*** (5.078)
Bonus certificates (DAX)	0.239** (1.611)	0.091 (4.104)
Capped bonus certificates (ESX)	-0.015 (4.506)	-0.032 (6.647)
Capped bonus certificates (DAX)	-0.002 (2.035)	0.047 (6.039)
Warrants (long, DAX)	-0.452*** (12.186)	-1.644*** (22.487)
Warrants (short, DAX)	-1.03*** (11.778)	-4.042*** (20.722)
Panel B: - June 2007		
Discount certificates (DAX)	0.056*** (0.32)	-0.683*** (2.61)
Discount certificates (ESX)	0.096*** (0.88)	-0.773*** (3.39)
Bonus certificates (ESX)	-0.192*** (2.07)	-0.319*** (3.53)
Bonus certificates (DAX)		0.646*** (2.62)
Capped bonus certificates (ESX)	0.216*** (2)	0.305*** (4.04)
Capped bonus certificates (DAX)		0.969*** (2.52)
Warrants (long, DAX)	-0.215** (12.27)	-1.089*** (22.84)
Warrants (short, DAX)	-1.152*** (11.68)	-4.642*** (20.85)
Panel C: July 2007 – June 2008		
Discount certificates (DAX)	0.043*** (0.43)	4.64*** (8.77)
Discount certificates (ESX)	0.005 (1.45)	4.398*** (9.23)
Bonus certificates (ESX)	-2.532*** (6.66)	-5.074*** (8.43)
Bonus certificates (DAX)		-4.481*** (8.72)
Capped bonus certificates (ESX)	-0.369* (6.76)	-0.565** (9.35)
Capped bonus certificates (DAX)		-2.23*** (10.2)
Warrants (long, DAX)	-1.2*** (11.89)	-3.385*** (21.26)
Warrants (short, DAX)	-0.722*** (12.06)	-2.455*** (20.31)

Table 7: Determinants of performance differences

This table shows OLS (panel) regression results (within estimator) with the performance difference of a buy-and-hold strategy in a retail derivative for which a purchase is observed in the secondary markets and a benchmark portfolios (BPF_{All}) that consists of similar retail derivatives that have been available to retail investors at the time of the purchase. The variables are defined as in table 5. Not shown are coefficients for dummy variables for the observation year. *T-statistics* that are based on robust standard errors and are adjusted for within-cluster correlation (Williams, 2000) are provided in parantheses. */**/*** denote significance at 5/1/0.1 percent level respectively.

Payoff profile	**Discount certificates**		**Bonus certificates**		**Capped bonus certificates**			**Call warrants**	**Put warrants**
Underlying	DAX	ESX	ESX	DAX	ESX	DAX		DAX	DAX
	(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)
R_{Week}	0.049***	0.056**	0.066	-0.077	0.004	-0.204	R_{Day1}	-380.367	52.303**
	(4.19)	(2.93)	(1.49)	(-1.41)	(0.06)	(-1.28)		(-1.36)	(3.07)
R_{Month}	0.415***	0.512***	0.161	0.518	0.322	-0.821	R_{Day2}	-274.454	30.242
	(9.36)	(6.33)	(0.91)	(1.26)	(1.35)	(-1.23)		(-0.86)	(1.73)
$R_{Quarter}$	1.227***	1.603***	0.142	0.35	1.589*	3.767**	R_{Day3}	-645.761*	19.051
	(11.32)	(8.65)	(0.33)	(0.73)	(2.44)	(2.79)		(-2.5)	(1.23)
R_{Year}	2.508***	2.279**	1.537	3.729	5.045*	25.013**	R_{Day4}	-551.7	43.018**
	(6.6)	(3.29)	(1.05)	(0.76)	(2.41)	(3.51)		(-1.68)	(2.78)
							R_{Week2}	-125.905	-2.123
								(-0.71)	(-0.23)
							R_{Month}	-181.362	3.326
								(-1.17)	(0.45)
IV	2.733	14.847*	-38.918**	-32.038	14.86	-82.174*	IV	-162.527***	41.826*
	(0.89)	(2.27)	(-3.06)	(-0.91)	(0.62)	(-2.31)		(-7.02)	(2.57)
D_{Low}	1.462***	2.226***	-2.086*	0.709	-1.791	0.158	D_{Low}	-14.602	-182.579***
	(9.52)	(8.57)	(-2.35)	(0.79)	(-1.4)	(0.18)		(-0.79)	(-6.76)
D_{High}	1.131***	-0.325	1.446*	-0.13	-0.023	-1.254	D_{High}	4.493	179.894***
	(6.24)	(-0.96)	(2.33)	(-0.16)	(-0.02)	(-1.36)		(0.36)	(9.03)
$D_{Low} * R_{Week}$	0.039*	0.08*	0.091	-0.241	-0.07	0.338*	$D_{Low}*R_{Day1}$	124.092	-12.834
	(2.5)	(2.29)	(0.99)	(-0.83)	(-0.61)	(2.19)		(0.17)	(-0.51)
$D_{Low} * R_{Month}$	-0.23***	-0.317**	0.853	-0.588	-1.106	0.569	$D_{Low}*R_{Day2}$	667.501	63.74*
	(-3.52)	(-2.61)	(1.62)	(-0.78)	(-1.62)	(0.57)		(0.78)	(2.45)
$D_{Low} * R_{Quarter}$	-1.718***	-1.88***	2.69*	1.25	-0.054	-3.287	$D_{Low}*R_{Day3}$	1647.196*	26.236
	(-10.4)	(-6.04)	(2.45)	(0.92)	(-0.04)	(-1.86)		(2.14)	(1.01)
$D_{Low} * R_{Year}$	-3.866***	-10.725***	15.079***	-0.9	19.979*	-4.658	$D_{Low}*R_{Day4}$	906.525	-4.537
	(-7.11)	(-8.8)	(3.89)	(-0.2)	(2.37)	(-0.69)		(1.02)	(-0.18)
							$D_{Low}*R_{Week2}$	455.979	-0.851
								(0.97)	(-0.06)
							$D_{Low}*R_{Month}$	604.669	3.218
								(1.4)	(0.28)
$D_{High} * R_{Week}$	-0.043*	0.202	-0.259***	-0.174	0.06	0.048	$D_{High}*R_{Day1}$	198.577	-46.129
	(-2.03)	(1.56)	(-3.58)	(-0.92)	(0.27)	(0.28)		(0.48)	(-1.24)
$D_{High} * R_{Month}$	-0.291**	0.502*	-0.103	-0.756	1.541**	1.398	$D_{High}*R_{Day2}$	-400.957	-42.523
	(-3.45)	(2.35)	(-0.35)	(-1.31)	(2.79)	(1.76)		(-0.81)	(-1.1)
$D_{High} * R_{Quarter}$	-0.502*	1.411**	0.744	-1.92*	1.616	-2.532	$D_{High}*R_{Day3}$	-914.325	70.745*
	(-2.18)	(2.86)	(1.14)	(-2.31)	(1.36)	(-1.23)		(-1.96)	(2.2)
$D_{High} * R_{Year}$	-0.262	7.838***	-4.171	-6.51	1.554	-12.566*	$D_{High}*R_{Day4}$	-361.233	19.497
	(-0.47)	(4.91)	(-1.57)	(-1.74)	(0.23)	(-2.03)		(-0.71)	(0.52)
							$D_{High}*R_{Week2}$	-310.698	-11.303
								(-1.05)	(-0.51)
							$D_{High}*R_{Month}$	-381.36	-13.752
								(-1.5)	(-0.78)
$D_{Low} * IV$	-55.12	-11.887	-0.144	-6.026	3.163	4.185	$D_{Low}*IV$	-8.382	-4.653
	(-1.96)	(-0.31)	(-0.11)	(-0.93)	(1.07)	(0.37)		(-1.93)	(-1.56)

Table 7: (continued)

D_{High}*IV	30.053	-2.905	1.843	11.421	-2.44	13.216	D_{High}*IV	19.87***	-4.317
	(1.94)	(-0.12)	(1.58)	(1.74)	(-0.96)	(1.28)		(5.99)	(-0.81)
Intercept	0.693	0.232	4.808*	3.404	-4.964	12.341	*Intercept*	33.204***	-30.907*
	(0.92)	(0.29)	(1.99)	(0.39)	(-1.03)	(1.61)		(3.9)	(-2.37)
Obs	41,834	23,059	10,144	836	3,351	1,583	Obs	19276	18405
Groups	3,347	2,211	493	112	210	175	Groups	1,101	1,119
R^2	0.0709	0.1234	0.1228	0.0831	0.1255	0.145	R^2	0.0178	0.0304

Table 8: Investor sentiment and contemporaneous correlations

This table reports descriptive statistics of our payoff-specific sentiment measure for various sample periods (Panel A) and pairwise correlations with alternative measures of investor sentiment and the return of the underlying index (Panel B).

Payoff profile	**Discount certificates**		**Bonus certificates**		**Capped bonus certificates**		**Call warrant**	**Put warrant**
Underlying index	DAX	ESX	DAX	ESX	DAX	ESX	DAX	DAX
Panel A: Descriptive statistics								
	January 2004 – June 2008							
Mean	0.532	0.532	0.529	0.513	0.548	0.616	0.481	0.522
Std	0.209	0.209	0.439	0.253	0.400	0.302	0.187	0.192
Median	0.524	0.524	0.500	0.500	0.500	0.625	0.475	0.511
Obs	1,127	1,127	415	909	550	589	1,066	1,055
	January 2004 – June 2007							
Mean	0.576	0.576	0.585	0.505	0.655	0.610	0.448	0.542
Std	0.203	0.203	0.422	0.262	0.371	0.314	0.178	0.194
Median	0.579	0.579	0.600	0.500	0.750	0.652	0.438	0.530
Obs	874	874	303	658	340	346	820	809
	July 2007 – June 2008							
Mean	0.384	0.384	0.370	0.534	0.380	0.628	0.599	0.458
Std	0.146	0.146	0.452	0.226	0.388	0.284	0.167	0.166
Median	0.364	0.364	0	0.551	0.333	0.615	0.631	0.464
Obs	248	248	108	246	206	238	241	241
Panel B: Pairwise correlations								
R_t^{DAX}	-0.129***		-0.036		-0.103**		-0.197***	-0.151***
R_t^{ESX}		-0.117***		-0.097***		-0.155***		
VDAX	-0.098***		-0.093*		-0.024		0.517***	-0.026
VSTOXX		-0.098***		0.168***		0.217***		
$OIVS_{DAX}$	0.096***		-0.189***		-0.162***		0.042	0.039
$OIVS_{ESX}$		0.211***		0.028		0.049		
$Sentix_{neutral}^{DAX}$	0.038		0.294***		0.171***		0.116***	0.036
$Sentix_{neutral}^{ESX}$		0.078***		0.033		0.048		
$Sentix_{value}^{DAX}$	-0.101***		-0.03		-0.115***		-0.346***	-0.125***
$Sentix_{value}^{ESX}$		-0.083***		-0.147***		-0.164***		

Table 9: Vector autoregressive model retail investor sentiment and index returns

This table reports the results of a vector autoregressive model of retail investor sentiment and index returns for each payoff profile in our sample. The dependent variables are the return of the underlying index and the changes in the sentiment measure based on observed purchases of retail derivatives. For brevity, we do not report the coefficients that are the lags of the dependent variable. Standard errors are in parantheses. */**/*** denote significance at 10/5/1 percent level respectively. The table also reports the results from Granger causality tests between our sentiment measure and the returns of the underlying index with the χ^2 statistic and the respective p-values.

Payoff profile	**Discount certificates**		**Bonus certificates**		**Capped bonus certificates**		**Call warrants**	**Put warrant**
Underlying	DAX	ESX	DAX	ESX	DAX	ESX	DAX	DAX
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Dependent variable: R_t				
$\Delta SENT_{t-1}$	-0.003	-0.003	-0.01*	0.002	-0.002	0.001	0	-0.001
	(-1.32)	(-1.37)	(-2.09)	(0.87)	(-0.75)	(0.34)	(0.05)	(-0.64)
$\Delta SENT_{t-2}$	-0.002	-0.001	-0.002	-0.002	-0.005	0	0.001	0.003
	(-0.57)	(-0.51)	(-0.47)	(-0.62)	(-1.48)	(-0.08)	(0.47)	(1.08)
$\Delta SENT_{t-3}$	-0.001	-0.002	-0.006	-0.003	-0.007*	-0.001	0.005	0.002
	(-0.26)	(-0.72)	(-1.08)	(-1.09)	(-2.09)	(-0.22)	(1.83)	(0.79)
$\Delta SENT_{t-4}$	-0.003	-0.004	-0.005	-0.001	-0.006	-0.003	0.005	0.002
	(-1.03)	(-1.42)	(-0.85)	(-0.55)	(-1.99)	(-0.81)	(1.91)	(0.72)
$\Delta SENT_{t-5}$	-0.004	-0.003	0.001	0.00	-0.001	-0.001	0.00	0.00
	(-1.63)	(-1.45)	(0.36)	(0.09)	(-0.41)	(-0.25)	(0.05)	(-0.13)
Intercept	0.001	0.00	0.001	0.00	0.001	0.00	0.00	0.00
	(0.14)	(0.00)	(0.87)	(-0.04)	(0.97)	(-0.76)	(0.94)	(1.05)
Adj, R²	0.0054	0.01	-0.039	0.0133	0.0045	-0.0012	0.0077	0.0047
χ^2	5.13	4.66	6.02	4.02	6.2	1.14	6.66	3.88
p-value	0.3998	0.4584	0.3045	0.5464	0.2873	0.9504	0.2473	0.5674
				Dependent variable: $\Delta SENT$				
R_{t-1}	-1.451**	-1.297**	3.978	-1.41	-0.452	-2.271*	-1.41**	-0.801
	(-3.23)	(-2.78)	(1.16)	(-2)	(-0.23)	(-2.23)	(-2.76)	(-1.5)
R_{t-2}	-1.531**	-1.72**	0.816	-0.514	-3.076	-2.935 **	-1.33**	-1.127**
	(-3.38)	(-3.64)	(0.24)	(-0.72)	(-1.62)	(-2.87)	(-2.59)	(-2.1)
R_{t-3}	0.33	0.199	1.406	-0.468	0.701	-0.56	-0.277	-0.148
	(0.73)	(0.42)	(0.41)	(-0.65)	(0.37)	(-0.54)	(-0.54)	(-0.27)
R_{t-4}	0.45	0.443	-9.784**	0.733	3.323	-1.012	-0.384	0.561
	(0.99)	(0.94)	(-2.92)	(1.03)	(1.76)	(-0.99)	(-0.74)	(1.03)
R_{t-5}	1.652**	1.701**	5.24	2.265**	3.771*	0.631	0.014	0.425
	(3.67)	(3.62)	(1.44)	(3.19)	(2.12)	(0.62)	(0.03)	(0.79)
Intercept	0.001	0.001	0.01	0.005	-0.002	0.01	0.003	0.003
	(0.14)	(0.11)	(0.26)	(0.63)	(-0.11)	(0.81)	(0.52)	(0.5)
Adj, R²	0.393	0.3916	0.3911	0.368	0.282	0.3883	0.3614	0.3556
χ^2	35.93	33.64	10.77	15.66	10.6	13.8	14.07	7.99
p-value	0.000	0.000	0.0561	0.0079	0.0599	0.0169	0.0152	0.1568
Sample period	6/13/07 8/24/07	3/16/04 6/26/08	6/13/03 4/22/08	2/24/05 6/26/08	1/12/04 6/26/08	1/31/06 6/24/08	2/2/04 6/26/08	2/9/04 6/26/08
Obs	975	975	78	690	207	352	896	867

Figure 1: Payoff profiles

This figure depicts the payoff profile of our sample products. Figure (a) shows the payoff profile of discount certificates, figure (b) of bonus certificate, figure (c) of capped bonus certificate and figure (d) of call and put warrants.

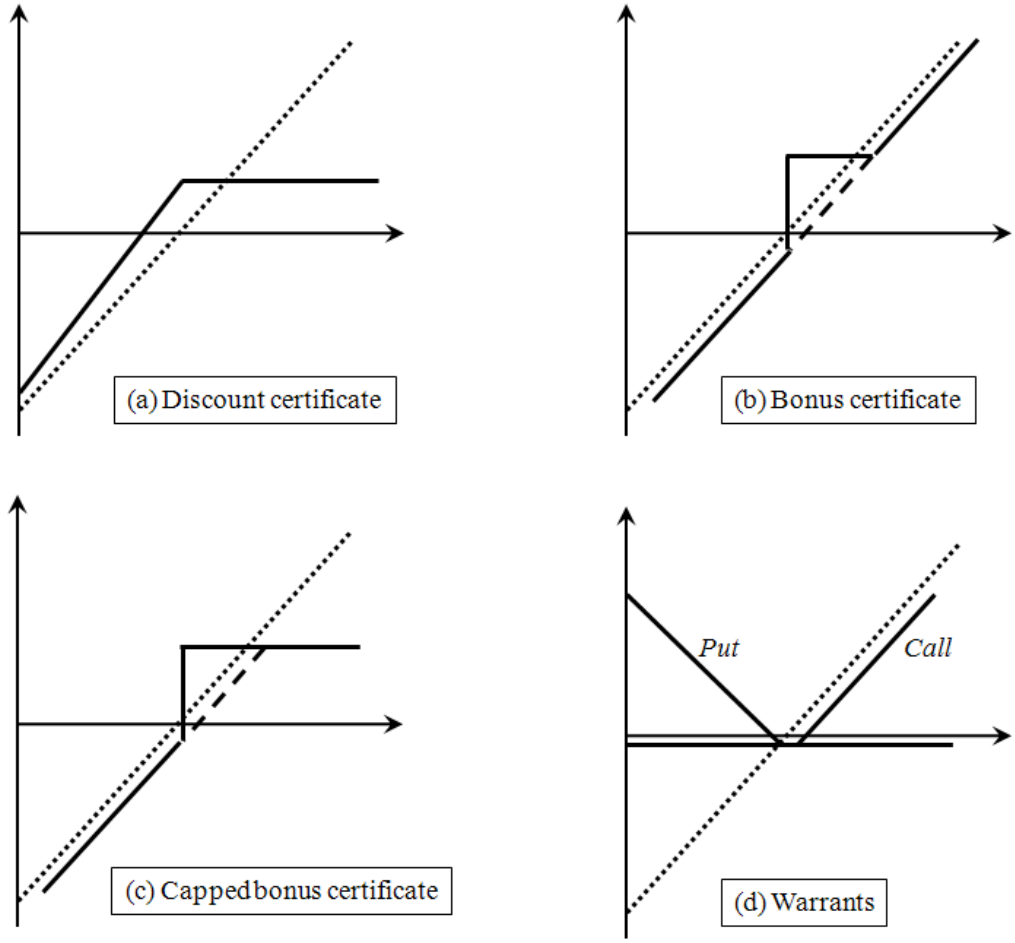

Figure 2a: Sample trades – retail investor purchases

This figure shows the weekly number of (retail) investor purchases for each payoff profile in our sample over time. The first grey shaded area (from left to right) shows the time period between July 30th to August 17th, 2007, the second grey shaded area shows the time period between January 1st to January 20th , 2008, the third grey shaded area shows the time period between September 7th and October 10th, 2008.

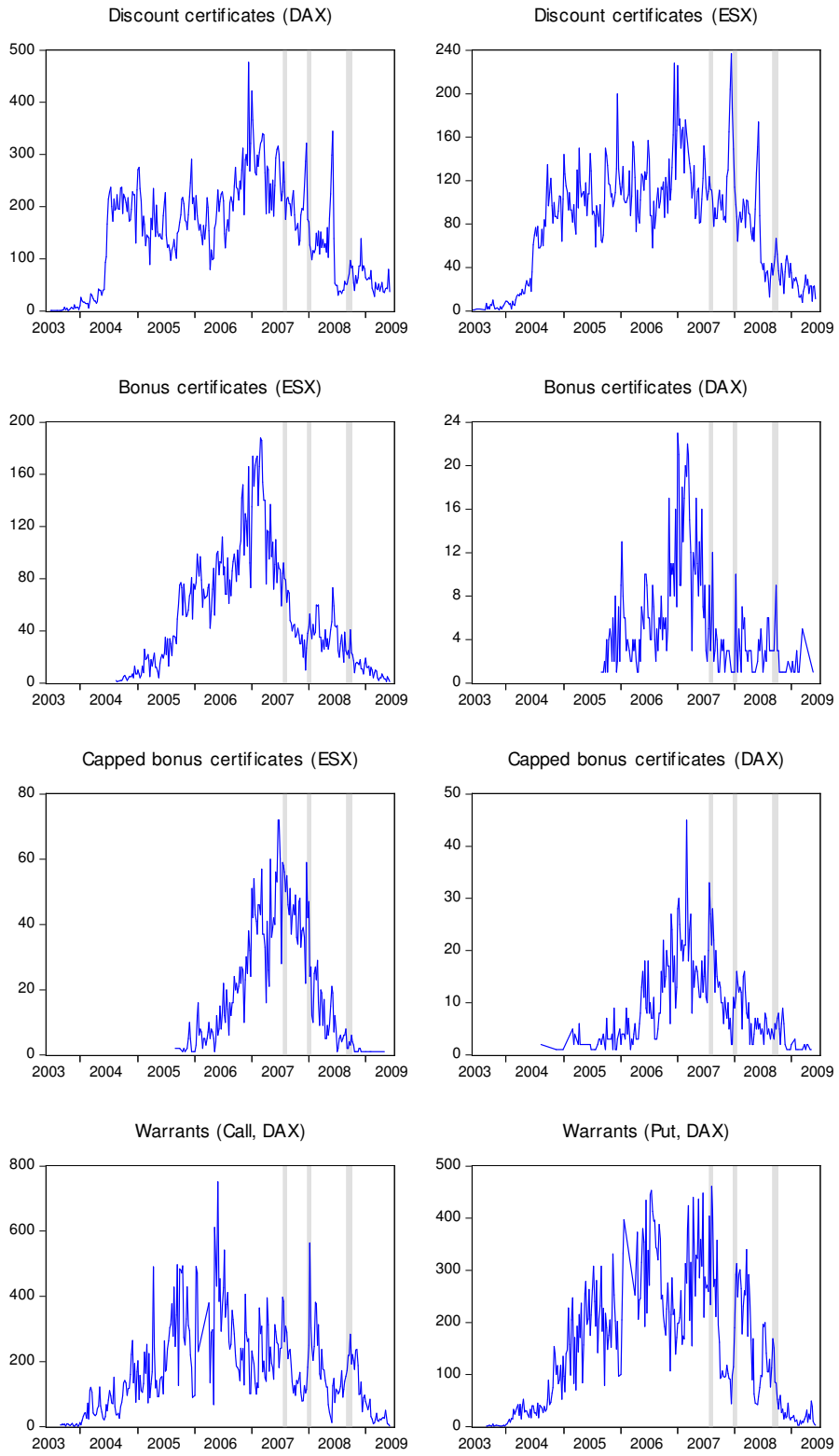

Figure 2b: Sample trades – retail investor sales

This figure shows the weekly number of (retail) investor sales for each payoff pattern in our sample over time. The first grey shaded area (from left to right) shows the time period between July 30th to August 17th, 2007, the second grey shaded area shows the time period between January 1st to January 20th , 2008, the third grey shaded area shows the time period between September 7th and October 10th, 2008.

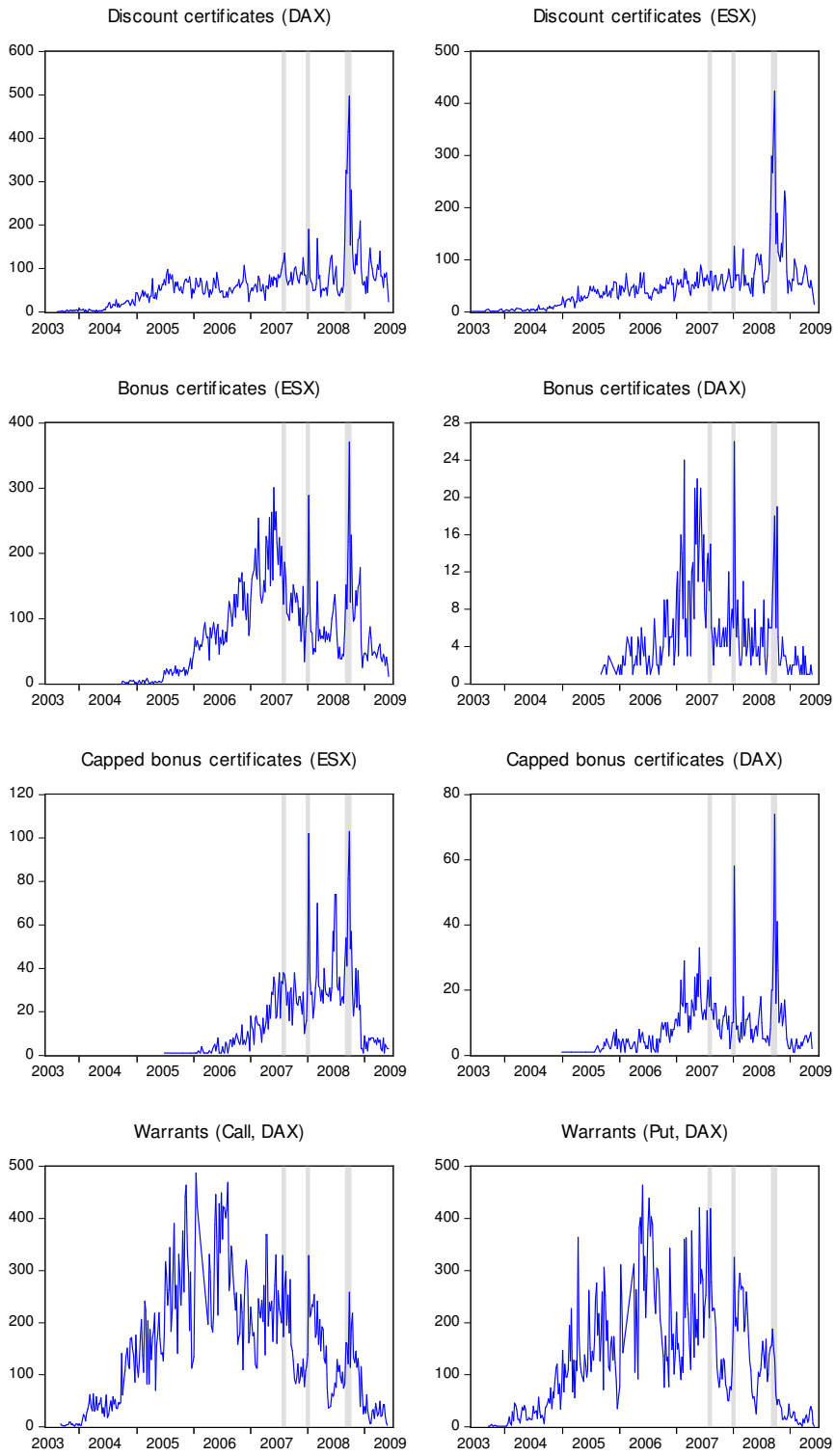

Figure 3: Volume of sample trades

This figure depicts the frequency of the transaction volume of our (classified) sample trades between +/-EUR 100 thousand (x-axis) for different payoff profiles of our sample products. For warrants, the figures shows the frequency of transaction volume between +/- EUR 20 thousand.

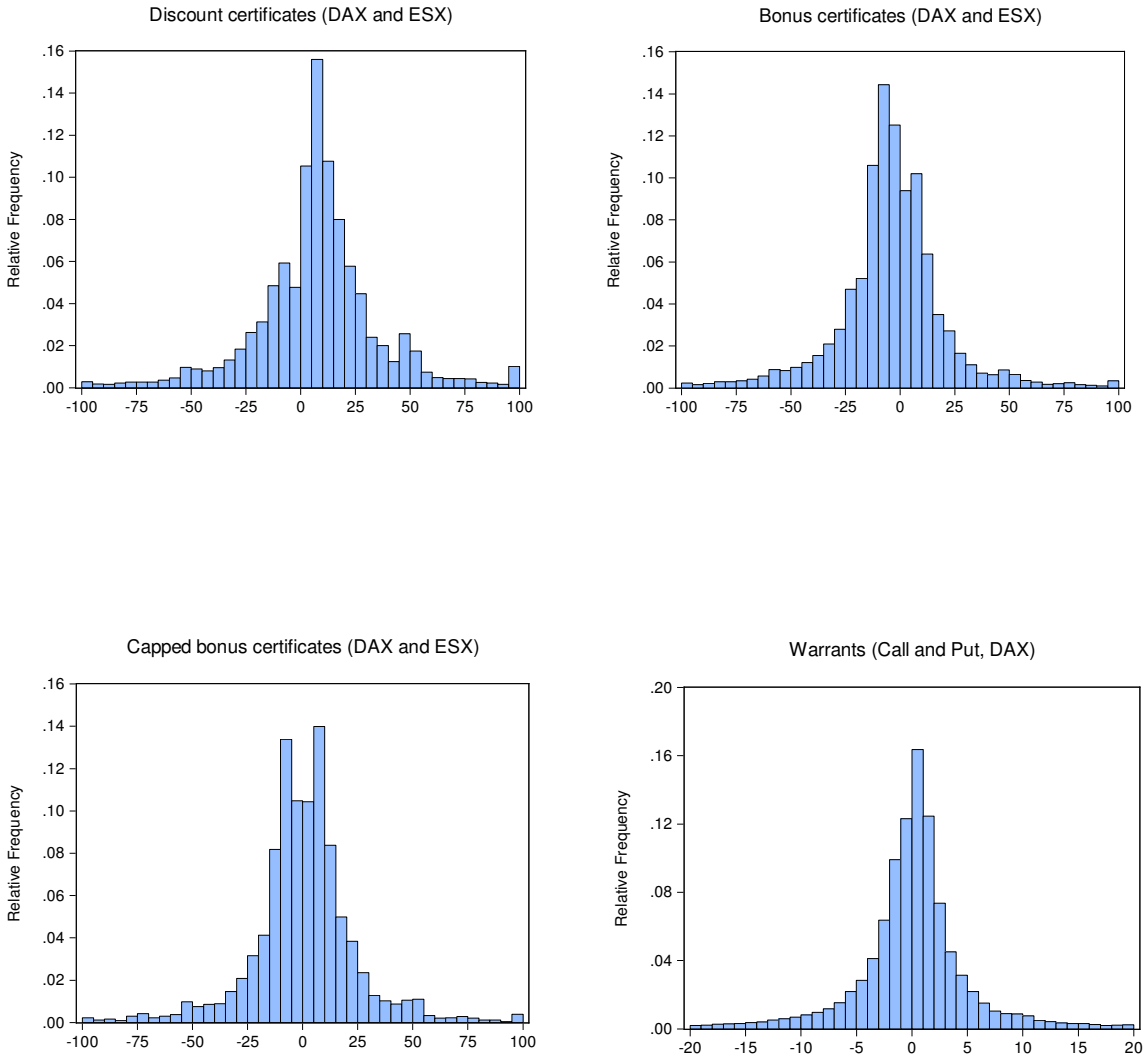

Figure 4: Performance of derivative choices over time

This figure depicts the average monthly performance of observed derivative choices in the secondary market in percent (y-axis) vis-à-vis a benchmark portfolio that consists of similar products that have been available to retail investors at the time of the observed purchase.

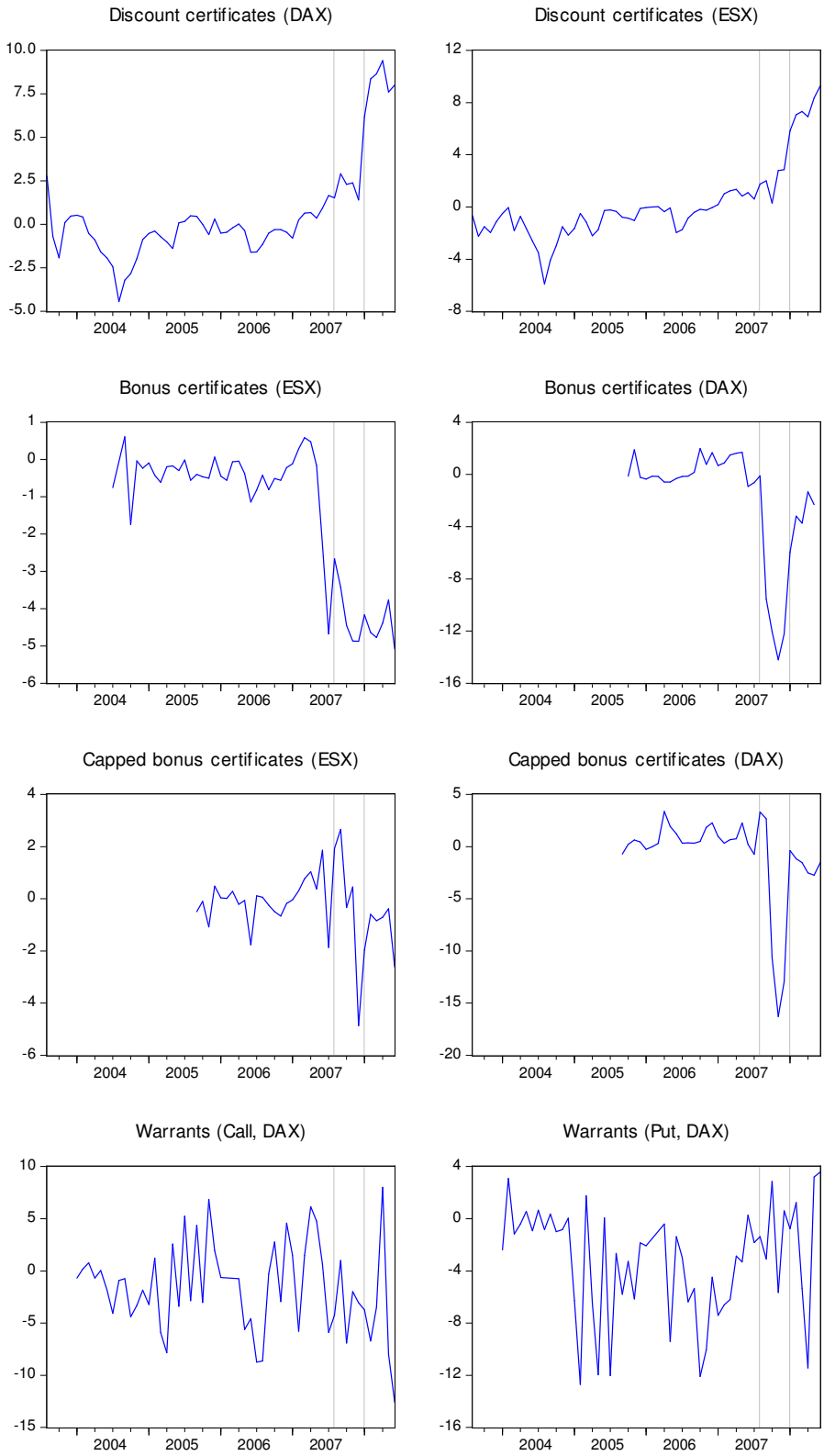

Figure 5: Retail investor sentiment

This figure shows the monthly average of our payoff specific retail investor sentiment measure that is based on the number of purchased products with exposure above the median exposure of our sample products relative to all observed purchases on trading day t.