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Empirical Evidence from the Fixed-Income Market

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Diskussionsbeitrag Nr. B-15-14

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Abstract

This paper studies the empirical early exercise behavior of Individual Investors in non-tradable putable bonds. Analyzing circa 31 million holding and exercise decisions of more than 220,000 Individual Investors over 13 years, our major findings are: (i) Individual Investors use their early exercise right predominantly at points in time that are not economically advisable, which results on average in negative excess returns from exercising. (ii) Only a small fraction of attractive exercise opportunities are exploited over time. (iii) Exercise behavior differs significantly among investor groups and is related to personal characteristics. (iv) The demand for liquidity and financial flexibility is apparently a more important investment and exercise motive than performance seeking.

Keywords: early exercise; failure to exercise; liquidity demand; putable bond

JEL classification: G10, G11

1 Introduction

Individual Investors' use of stocks and equity derivatives has been a major field of research over the last two decades. A variety of papers have investigated Individual Investors' trading and exercise behavior (e.g., Shefrin and Stratman, 1985; Odean, 1999; Grinblatt and Keloharju, 2001; Poteshman and Serbin, 2003; Barber and Odean, 2011; Barraclough and Whaley, 2012), have analyzed investors' performance (e.g., Barber and Odean, 2000; Barber et al., 2009; Bauer et al., 2009), have studied differences dependent on personal characteristics (e.g., Barber and Odean, 2001; Dorn and Huberman, 2005) and examined the influence of exogenous effects, such as taxes (e.g., Badrinath and Lewellen, 1991; Ivkovic et al., 2005). In contrast, surprisingly little is known about Individual Investors' empirical behavior with regard to fixed-income products and derivatives,[1] even though interest-earning products, such as bonds, redeemable long-term deposits or savings bonds, are a common part of many Individual Investors' portfolios (see Bricker et al., 2012).

This paper therefore contributes to the literature by providing a comprehensive empirical analysis of Individual Investors' use of early exercise rights in German governmental non-tradable putable bonds. Moreover, as we provide several new insights into the general exercise behavior of Individual Investors, we expect our results also to be of considerable interest for, e.g., banks and other issuers that offer similar products with embedded options to this specific investor class.

We basically cover three research questions. First, we analyze determinants of early exercises. In this context we focus on the following dimensions: economic benefit of exercising, investment history, environmental circumstances, product characteristics and investors' personal

[1] A notable exception is the broad strand of papers on mortgages (e.g., Green and Shoven, 1986; Schwartz and Toruos, 1989; Stanton, 1995; Deng et al., 2005), which however focus mostly on rather specific questions related to prepayments, defaults or refinancing.

characteristics. Second, we examine the economic reasonableness of Individual Investors' exercise behavior and its determinants. More specifically, we analyze how often the empirically observed exercise decisions are financially reasonable according to theory, how often investors fail to exploit attractive opportunities and what excess returns investors achieve through early exercising. Third, we aim at discovering general investment and exercise motives of Individual Investors in putable bonds.

Our study is based on a not-publicly available data set that comprises circa 31 million decisions of more than 220,000 Individual Investors to hold or exercise putable bonds (German Federal Saving Notes, GFSN) over a time horizon of 13 years.[2] Besides the immense size and the long sample period our data set offers additional advantages, which allow us to draw a very comprehensive picture of Individual Investors' financial behavior. First of all, the fixed-income products we analyze (GFSN) are sold only to Individual Investors. Therefore, unlike many studies on the equity market (e.g., Poteshman and Serbin, 2003; Pool et al., 2008; Barraclough and Whaley, 2012) we do not have to distinguish between different market participants, but can exclusively analyze Individual Investors' decisions. Moreover, GFSN cannot be traded on a secondary market. Hence, as an investor's only possibility to monetize a GFSN investment is to use the early exercise right, we obtain a more comprehensive picture of Individual Investors' exercise behavior than in the case of tradable products, such as tradable equity options. Finally, due to the detailed structure of the data set we can conduct analyses on an individual account level, whereas adjacent studies (e.g., Overdahl and Martin, 1994; Finucane, 1997; Lakonishok et al., 2007; Barraclough and Whaley, 2012) must typically rely on aggregated data sets or netted volumes. Consequently, this paper is, to the best of our knowledge, also first in studying the relations of individual exercise decisions to, e.g., an investor's experience, former decisions

[2]Our data set is similar to the data analyzed in Eickholt et al. (2014). Yet, in this paper we focus on a subsample of holding and exercise decisions on an individual account level, whereas the study of Eickholt et al. (2014) uses consolidated exercise ratios per product.

on the investment position and personal characteristics.

As indicated, we start our analysis with examining the determinants of Individual Investors' early exercises of putable bonds. Using pooled and random-effects logit regressions, our main findings are as follows: first, the economic benefit is an important determinant. The probability of an exercise increases significantly with a diminishing ratio of present value to exercise value. Second, the exercise probability depends on the investment and decision history. We observe delayed reactions to market changes within the last 6 months. Third, strong movements in the equity market are accompanied by enhanced exercise activities in GFSN, which indicates that Individual Investors use the early exercise right to liquidate investments so as to participate in attractive growth phases of other markets. Similarly, our results suggest—in an analogy to the equity market (e.g., Badrinath and Lewellen, 1991; Grinblatt and Keloharju, 2001; Ivkovic et al., 2005; Liedtka and Nayar, 2012)—that the exercise option is broadly used to optimize tax payments. Fourth, we find differences in the exercise probability related to product characteristics. Besides a product's maturity, the steepness of the coupon structure and the time until the next coupon payment also seem to have an influence on Individual Investors' decision-making. Our analysis shows that investors prefer—valuation, maturity and all else being equal—products with a high final coupon payment to products with a flatter coupon structure, which we attribute to psychological reasons. Moreover, it becomes obvious that investors hesitate to exercise a GFSN shortly before a coupon payment date, which—referring to the mental accounting concept (e.g., Shefrin and Statman, 1984; Szymanowska et al., 2009)—implies that investors differentiate between accrued interests and cash payouts. Fifth, the exercise frequency varies depending on an investor's portfolio and personal characteristics. For instance, we note that experience in early exercising a GFSN investment leads to an increased probability of another exercise, which might be due to lower information costs or learning effects (compare Nicolosi et al., 2009). As another

example, we find that investors between 20 and 40 years of age have a significantly higher exercise probability than other investors groups. We ascribe this to a potentially increased liquidity demand at that stage of life due to, e.g., the purchase of a house.

Next, we study the economic reasonableness of Individual Investors' exercise behavior. Evaluating all decisions to hold or exercise early for each month and each product, our major result is that the broad majority of early exercises (between 76% and 86%) occur at times where it is not beneficial, i.e. where the exercise value lies (significantly) below the continuation value. In addition, we find that Individual Investors regularly fail to exercise (more) attractive exercise opportunities. Throughout our sample period more than 98% of exercise rights in GFSN that should have been used remain unexercised. This extent of "suboptimal" decisions in both directions is remarkably larger than in comparable studies for the equity market (e.g., Poteshman and Serbin, 2003; Pool et al., 2008; Barraclough and Whaley, 2012). Not surprisingly, we calculate an on average negative excess return of exercising of circa -0.117% to -0.300% per year for our sample and conclude—consistent with the study of, e.g., Bauer et al. (2009) for equity options—that only a small number of Individual Investors achieves a better performance through early exercising putable bonds. While this holds true for almost all investor subgroups, we again find differences depending on personal characteristics. For instance, investors between the ages of 20 to 40 show an even poorer exercise performance than other investor groups. In contrast, investors who use the direct distribution channel stand out with a significantly higher share of economically reasonable exercise decisions, which we attribute to a presumably higher financial literacy.

To sum it up, our main empirical findings in the first two analyses are that a broad range of factors determines early exercises of GFSN and that Individual Investors use their option right predominantly when it is not economically advisable while they frequently forfeit (more)

attractive exercise opportunities. All this indicates that maximizing profit is not the main motive of exercising. Literature typically relates such a non-performance-oriented behavior to irrationality (e.g., Poteshman and Serbin, 2003; Pool et al., 2008; Barraclough and Whaley, 2012), a non-continuous monitoring of the investment (e.g., Stanton, 1995; Barraclough and Whaley, 2012; Liao et al., 2013) and transaction costs (e.g., Stanton, 1995; Finucane, 1997; Koziol, 2006). Yet, several patterns in the data let us assume that—besides these arguments—a further factor influences Individual Investors' decisions in the fixed-income market. Our results suggest that the demand for liquidity and financial flexibility, driven by, e.g., exogenous events or personal needs, is an important driver of early exercises.

Consequently, our third research interest is to further explore the general motives of Individual Investors' for holding and exercising putable bonds. For this, we run an exploratory factor analysis based on consolidated information on investors' investment and exercise strategies in GFSN. Passing several robustness checks, the factor analysis isolates four to five latent factors, which underlines our former argument that performance is not the sole decision criterion. We interpret the latent factors as follows: the first and most important factor comprises investors' wish for liquidity and financial flexibility. The second factor represents the importance of the mid- and long-term value of an investment. The third factor isolates the desire for performance and is associated with positive excess returns. In contrast, a fourth factor summarizes an active "trading" strategy that does not result in higher investment yields, for which reason we label this factor "activism". Finally, the fifth factor represents an investor's sensitivity to changes in taxation. Not surprisingly, the relevance of these identified latent factors differs among the investor base. Still, the overall results of the factor analysis suggest again that Individual Investors in putable bonds interpret their early exercise right more as a financial flexibility feature than as an option to improve the investment performance.

The paper proceeds as follows. In Section 2 we introduce the data set. Section 3 analyzes the determinants of early exercising (Section 3.1), evaluates the economic reasonableness of Individual Investors' exercise behavior (Section 3.2), examines investors' performance (Section 3.3) and discusses implications (Section 3.4). Following these, Section 4 runs a factor analysis to gain further insights into Individual Investors' motives and decision-making on putable bonds. Section 5 concludes.

2 Data

2.1 Product description

For our analyses we are able to utilize a large and unique data set from the German Finance Agency ("Bundesrepublik Deutschland Finanzagentur GmbH")[3], which covers investment and early exercise decisions of Individual Investors in German Federal Saving Notes ("Bundesschatzbriefe", in the following GFSN). GFSN are basically standard putable bonds issued by the Federal Republic of Germany for financing the government,[4] which—most interesting for our study—incorporate an early exercise option that gives the investor the right to reclaim his investment plus accrued interests at any time during maturity after an initial one-year blocking period.[5] No fees or penalty payments are charged in the case of an early exercise. At each issuance date two types of GFSN are offered: Type A, a step-up bond with a maturity of 6 years and yearly coupon payments and Type B, a step-up bond with a maturity of 7 years where all coupons are accrued and paid at maturity.

[3]The German Finance Agency is a state-owned central service agency for Germany's governmental borrowing.

[4]While GFSN accounted for a significant share of Germany borrowing until the 1990s, the relevance has decreased since then. Finally, due to high administrative costs, the German government decided in 2012 to stop offering products exclusively for Individual Investors and stopped issuing new GFSN. Nevertheless, similar products are still sold by, e.g., banks.

[5]An additional restriction applies: the maximal exercise value per investor is capped at €5,000 within 30 interest days, which we ignore in the following.

Investors can purchase the current issuance of a GFSN at any time at nominal value plus accrued interests. Regularly, following significant changes in market conditions, all open issuances are closed and new GFSN of both Type A and Type B are issued with identical coupon structures for the first six years. GFSN can be acquired in two ways. First, it is possible to invest directly through the German Finance Agency via telephone, postal order or online order. Second, GFSN can be purchased at banks, which however typically claim custody fees for administering GFSN positions. Investors can shift their investments from an account at a bank to a cost-free account at the German Finance Agency at any time.

Several advantages make GFSN a natural choice to analyze Individual Investors' exercise decisions in the fixed-income market. Most importantly, GFSN are sold exclusively to Individual Investors,[6] hence we do not have to distinguish in our analysis between different investor types as in many adjacent studies (e.g., Poteshman and Serbin, 2003; Pool et al., 2008; Barraclough and Whaley, 2012). Next, GFSN cannot be traded on a secondary market. The only possibility of monetizing an investment is to use the exercise right and return the product to the issuer, which gives us a very comprehensive picture of investors' exercise activities. Finally, GFSN are simple and standardized fixed-income products that have been continuously offered in the same structure since the 1970s, which allows us to conduct consistent cross-sectional and time-series analyses.

2.2 Summary statistics

Our data set comprehends—on a daily and single-account basis—all GFSN transactions and early exercise decisions of 223,017 Individual Investors booked between July 1996 and February

[6] Additionally, GFSN can also be acquired by resident institutions serving public benefit, charitable or religious purposes, which we neglect in the following due to the very small share of overall investments.

2009 in the German Finance Agency's debt register account.[7][8] Overall, these transactions are spread over 204 issuances of Type A and B GFSN in the observation period on 102 issuances dates. In addition, we have some information on each investor's personal characteristics. This detailed data structure on an individual account and daily level allows us to link individual transactions to, e.g., an investor's age, gender or investment history, which is not possible in studies that must rely on aggregated data sets or ratios (e.g., Overdahl and Martin, 1994; Finucane, 1997; Lakonishok et al., 2007; Barraclough and Whaley, 2012). Table 1 presents selected summary statistics for the investor sample.

[Table 1 about here.]

In general, we have a broad and relatively balanced investor base that is very similar for both Type A and Type B GFSN structures. For instance, there is an almost equal representation of male (33.469% for Type A, 38.406% for Type B) and female (38.362%, 37.995%) investors (no information for 28.169%, 23.598%). Similarly, we have a wide range of investor ages (on average 43.551 years, 32.711 years) with a slightly positively skewed distribution, i.e. there are somewhat more older than younger investors in our data set. There is also a significant share of very young investors (in particular for the zero-bond structure of Type B GFSN), which we mainly interpret as savings accounts in a child's name for, e.g., education costs. Concerning investors' educational background, the data provides us with information on doctoral degrees and professorships, which taken together form 4.150% (3.499%) of the investors. Geographically, the investor base is widespread over Germany. We classify all investors into four clusters of residence areas[9] based on the first two digits of an investor's zip code, which we have in the data, and

[7] Our data set is a randomly drawn sample of the original data that represents circa 25% of all accounts at the German Finance Agency.

[8] We exclude accounts with an average transaction volume below €300 since for such small volumes the early exercise right is of comparatively low importance.

[9] As a proxy we use the average population density per sq. km according to German Federal Statistics Office (2009) and define the following clusters: <250 = sparsely, 250-750 = moderately, >750 = highly populated area.

conclude that the majority of investors in GFSN live in less populated areas (51.371%, 51.417%), while a smaller number (15.380%, 15.089%) lives in highly populated areas or cities. Finally, we note that more than half of the investors prefer to acquire GFSN indirectly (59.181%, 54.011%) via banks and transfer their accounts later to the German Finance Agency, even though typically custody and administration are only cost-free at the German Finance Agency.[10] Next, Table 2 summarizes the activities of our investor sample.

[Table 2 about here.]

The statistics show that most investors invested rarely or only once in GFSN during the sample period. The average number of investments is comparatively small with only 3.147 investments per investor for Type A and 2.790 for the less popular structure of Type B GFSN. Furthermore, we find small median overall investment volumes of only €10,226 and €4,090 respectively, whereby the high variances for both product types indicate that there are also investors with significantly higher investment volumes and trading frequencies. In general, we attribute the low activity level in our sample to the strict restriction of GFSN to Individual Investors. With institutional investors we would expect considerably more transactions and higher investment sums.

The right to redeem early a GFSN investment is frequently used (fourth to sixth row). On average each investor in Type A GFSN exercised early 0.526 times (0.517 for Type B) throughout the sample period resulting in a mean overall exercise volume of €1,812 (€1,284). Again the standard deviation is high with 1.491 (1.483) exercises per investor, which is also emphasized by

In a fourth cluster we group investors living in large cities, which we identify by their short double-digit zip codes that are allocated only to major cities in Germany.

[10]Indirect distribution means in this paper that an investor purchases a GFSN at a bank and transfers his investment later to the German Finance Agency. In contrast, we define the preferred distribution channel as direct if an investor executes at least one direct transaction in the overall observation period. We are aware that this classification might produce a bias towards direct distribution since some investors use both channels. On the other hand we do not have direct transactions in our data set from 1996 to 1999 as these were not possible during these times.

the median of 0 (0) and the 95 percent quantile of 2.000 (2.000) exercises per investor account. The high variance here is a first indicator that Individual Investors use early exercise rights very heterogeneously. We further discuss this issue in a later section.

Finally, the last two rows of Table 2 outline investors' use of the exercise option over time. As proxy we calculate a monthly early exercise rate per GFSN, defined as the ratio of number of exercises to the number of overall investments ($\frac{\text{Number of exercises}}{\text{Number of investments}}$). On average this rate amounts to circa 0.626% (0.518%) per month and GFSN, whereby the median value is smaller due to several exercise peaks throughout our observation period. Interestingly, a quite constant base exercise rate seems to exist over all GFSN. Even the 5 percent quantile of the exercise rates still lies at around 0.081% (0.081%), which implies that exercises occur independently of the market environment.

2.3 Variables

To investigate Individual Investors' decisions in the course of time and to identify determinants of early exercises we convert the described transaction data to a longitudinal structure on a monthly basis. The resulting data panel comprises circa 31 million decisions by the investor base to hold or exercise a GFSN, which is a noticeably larger sample than that in most studies on early exercises so far. Moreover, we comprehend the data set with several variables and ratios (Table 3 contains a detailed overview) in the following categories to account for potential influences on investors' decisions: economic benefit, investment history, environmental circumstances, product characteristics, portfolio and personal characteristics.

[Table 3 about here.]

Economic benefit

We use the ratio of present value of a GFSN to its exercise value (PVEV) to measure the

economic advantage of a potential early exercise:

$$PVEV = \frac{\text{Present value of GFSN}}{\text{Exercise value of GFSN}}. \tag{1}$$

According to standard theory it is optimal to use the exercise right as soon as the present value equals the exercise value. This means only an early exercise at a PVEV-ratio of 1 can be classified as economically reasonable,[11] whereas an exercise is the more disadvantageous the higher the PVEV-ratio rises above 1.

The exercise value of a GFSN is simply the notional amount plus accrued interests. For the calculation of the present value, we have to determine the value of the respective early exercise right, which basically equals an American put option. Our first step in this valuation is to model the underlying interest rate dynamics, applying an essentially affine 3-factor term structure model $\text{EA}_1(3)$ on a weekly basis according to Dai and Singleton (2000). We utilize here the parameterization by Eickholt et al. (2014), who calibrate this model to German term structures over the period from 1996 to 2009. Subsequently, we refer to standard option theory and apply the least-squares simulation approach as suggested by Longstaff and Schwartz (2001), carrying out Monte-Carlo simulations with 10,000 paths, whereby we use Euler discretization on a monthly basis and take the first four monomials as basis function. Moreover, we apply the interleaving estimator according to Glasserman (2004) to mitigate the effects of a potential high bias due to the backward induction approach and of a potential low bias due to a suboptimal stopping rule.

[11] For simplicity, we define an exercise decision as reasonable if the PVEV-ratio equals 1 at the exercise date regardless of the investment history, even though the exercise decision is theoretically only "optimal" if the exercise happens at the first feasible opportunity. This means, the estimated numbers in this paper represent a lower bound for the share of economically disadvantageous exercise decisions.

Investment history

Considering the investment history allows us to set Individual Investors' behavior in relation to, e.g., former valuation movements and former decisions. Accordingly, our first variable MISSEDALL measures for each GFSN and month how many economically attractive exercise opportunities an investor has ignored so far, quantified by the number of months when the PVEV-ratio equaled 1. The second variable MISSED6, defined as the number of economically reasonable exercise months omitted within the last half year, controls for short-term effects and examines whether investors react sluggishly to former exercise opportunities, which is a well known pattern for small traders in equity products (e.g., Hvidkjaer, 2011). Finally, we also incorporate the investment volume (VOLUME).

Environmental circumstances

We control for four environmental factors. First, we consider the development of the German stock index CDAX as proxy for potential investment yields in the equity class. Based on the assumption that mainly large changes of the CDAX may have an influence on early exercises in the fixed-income market, the dummy variables CDAX10+ and CDAX10- signal increases or decreases of the CDAX of more than 10% within one month. Focusing on longer trends, the dummy variables CDAX25+ and CDAX25- cover index changes of more than 25% within 6 months. Second, VOLDAX and VOLINT measure the option-implied 45-day volatility of the German stock market (using the VDAX index) and the volatility of the German 5-year spot rate estimated from weekly returns over a 6-month window to encompass investors' reaction to uncertainties in the markets. Third, the dummy variable NEWMARKET controls for abnormal capital outflows to the "New Market" between 1998 and 2000, a new stock segment in Germany which attracted considerable attention among Individual Investors during this period. Fourth,

we account for tax effects, whereby we focus on Type B GFSN since changes in the tax legislation have a much higher relevance for products with a zero-bond structure—as all coupon payments are taxed at the same time—than for coupon-paying products for which personal tax allowances can be utilized each year. During our observation period two major changes occurred in the German tax legislation. In both years 2000 and 2006 Individual Investors' tax allowances were severely reduced, which might have made it attractive for investors to exercise GFSN positions early shortly before the new regulations became effective—even when a valuation was clearly above the exercise value—to optimize personal tax debts. Accordingly, our variables TAX99 and TAX06 are designed to capture potential extraordinary exercise activities in November and December 1999 and 2005, respectively. In addition, the dummy YEAREND controls for tax-motivated early exercises at the end of the year when Individual Investors typically review their tax burdens and allowances.

Product characteristics

While the general structure of GFSN remains constant over all issuances in our sample period, the offered coupons are typically adapted to current market circumstances with every issuance. Accordingly, we have a broad range of coupon structures among the 204 GFSN offerings in our sample. To determine if visual or psychological factors, such as the shape of the coupon structure or shortly awaited coupon payments affect an investor's behavior, we consider three variables. First, we calculate the average yearly growth of coupon payments until maturity as an indicator for the steepness of the coupon structure (UPSTEEP). Second, we compute for each GFSN and month the duration in years (DURATION) of the bond component, which we interpret as the weighted average time until an investor receives all coupon payments and the initial investment. For the calculation we refer to the definition of Fisher and Weil (1971). Third, the dummy vari-

able COUPON, which is only relevant for Type A GFSN, signals if a coupon payment occurs within the next 60 days.

Lastly, we incorporate the dummy variables BLOCK and LIFETIME (for Type A GFSN). BLOCK controls for potential increased exercise activities in the first month after the initial one-year blocking period. LIFETIME is the elapsed time since issuance.[12]

Portfolio characteristics

Besides personal attributes, such as age or gender, we also account for an investor's experience in GFSN. We define four proxies: the number of former personal investments in GFSN (INVESTS), the sum of overall investment volumes so far (INVESTSUM), a dummy variable indicating whether the investor has made use of the early exercise right once before for a GFSN investment (EXERCISED) and a dummy variable signaling if he has exercised early at an economically opportune time once before (PERFORMED) as indicated by a PVEV-ratio at exercise of 1.

3 Analysis of early exercise decisions

3.1 Determinants

In this section we use the described panel data set to examine determinants of Individual Investors' early exercise decisions. We apply pooled and random-effects logit regressions to estimate the influence of our above-mentioned variables (see Table 3) on the probability of an exercise. For the panel regression we consider that each GFSN per investor represents an own

[12]Due to the zero-bond structure of Type B GFSN the variables LIFETIME and DURATION are for this type perfectly correlated, wherefore we neglect the LIFETIME variable for Type B in the following regressions. For Type A GFSN the lifetime is also correlated to the duration, which might potentially result in inflated standard errors. However, running the following regressions with orthogonalized regressors leads to similar findings, so that we decided to continue with the described variables.

group of observations, whereby the number of observations ranges from 1 for GFSN that are exercised early in the first month after the blocking period, to a maximum of 60 (72 for Type B) for investments held until maturity.

Our analyses are positioned at the very low end of the logit distribution due to the small number of exercise events compared to non-exercise events (as shown in Table 2, the exercise rate for most GFSN lies below 1% per month), which could lead to biased coefficient estimates and standard errors (see King and Zeng, 2001). Yet, rare-event regressions as introduced by King and Zeng (2001) result in only minor deviations in the estimates, wherefore we choose to continue with standard estimators due to the better handling and improved comparability. We also run several robustness checks—not reported here—based on time and investor subsamples, which lead to consistent findings. Table 4 contains the regression results on our overall data set and the respective marginal effects (dy/dx) at means indicating the ceteris paribus effect of changes of the respective variable (fourth and seventh column). We use robust standard errors in this and all following regressions (see Huber, 1967; White, 1980, 1982).

[Table 4 about here.]

Beginning with the overall model output, we get a pseudo-R^2 of 17.00% for the pooled regression and 19.78% for the panel analysis (15.17% and 19.27%). We emphasize six regression results: first, the probability of the option being exercised is related to the economic benefit of an early exercise. A decreasing PVEV-ratio goes hand-in-hand with an increasing exercise probability, which implies that the average investor is sensitive to changes in the value of his investment. Second, the investment history has a statistically significant influence. The positive coefficients for MISSED6 and MISSEDALL indicate that the probability of an exercise increases with the number of missed economically advantageous exercise opportunities. While the influence of MISSED6 might be attributed to delayed or sluggish responses to earlier market

or value changes, the positive loading for MISSEDALL is a more surprising result, as we would expect Individual Investors who aim to maximize their investment performance to utilize one of the first economically reasonable exercise opportunities to shift investments or re-arrange their portfolio. We further investigate this issue and how frequently investors exploit arising exercise chances in Section 3.2.

Third, environmental influences have a strong impact. We find that significant movements in the equity segment (CDAX) and the launch of the "New Market" in Germany are accompanied by increasing exercise activity, which suggests that investors use the early exercise right to liquidate investments so as to participate in attractive growth phases of other markets. On the other hand, the exercise probability diminishes in times of severe equity market drops (CDAX25−) and high volatility in the interest term structure (VOLINT). We trace this to a higher attractivenesses of fixed-income investments in times of bear equity markets and in times of higher uncertainty. Finally, the significantly positive coefficient for the tax variables indicates that—in an analogy to the equity market (e.g., Badrinath and Lewellen, 1991; Grinblatt and Keloharju, 2001; Ivkovic et al., 2005; Liedtka and Nayar, 2012)—Individual Investors use the exercise right broadly to react to tax changes and to optimize their tax debt.

Fourth, the probability of an early exercise depends on product characteristics. We find a in general positive influence of the duration (DURATION) and a (in most cases) negative loading regarding the steepness of the upcoming coupon structure (UPSTEEP). Additionally, we note that investors hesitate to exercise early shortly before a coupon payment date (COUPON). Such behavior cannot be justified with standard economic arguments as, according to theory, an exercise decision should only be based on the current valuation regardless of the upcoming coupon structure. Similarly, there is no structural advantage to waiting until a coupon payment, as accrued interests are considered at an early exercise. Hence, we interpret the empirical patterns

related to the product structure as psychological effects. Apparently, Individual Investors value GFSN with increasing coupon payments more highly than almost identical products that offer a flatter coupon structure. Moreover, the reduced exercise probability before coupon payment dates implies that investors differentiate between accrued interests and cash payouts and thus use "mental accounting" (e.g., Shefrin and Statman, 1984; Szymanowska et al., 2009). Lastly, we note that there is a peak in exercise rates in the first month after the blocking period.

Fifth, the early exercise frequency differs among investor groups. The regressions reveal that experience in exercising is associated with a higher early exercise probability (EXERCISED). This effect is even stronger if the investor has exercised at an economically reasonable point in time (PERFORMED). We attribute both effects to experienced investors having greater financial literacy, lower information costs and less inhibition in using the right to exercise. On the other hand, our two more general portfolio variables—the number of investments and the overall investment volume so far—show negative coefficients, which might be due to less exercise activity of the part of wealthy investors (see also Dhar and Zhu, 2006).

Sixth, male investors and investors between 20 and 40 years of age use the exercise right more often, while investors holding a doctoral degree and investors who acquire directly through the German Finance Agency are slightly less likely to exercise. An investor's geographical location has no statistical influence. We further discuss the apparent differences in exercise probability among the investor base at the end of this section.

Our main conclusion in this first analysis is that a broad range of factors cause Individual Investors to exercise early. As economic arguments are only one determinant among several other influence factors, it seems natural to assume that not all early exercises of GFSN are financial advantageous. Hence, the next section focuses on examining the economic reasonableness of investors' decision-making.

3.2 Economic reasonableness

In this section we investigate the economic reasonableness of Individual Investors' exercise behavior. According to standard theory a putable bond should be exercised as soon as its present value equals the exercise value, which implies a PVEV-ratio of 1. In contrast, there should occur no early exercises if the PVEV-ratio is greater than 1. We use this definition to determine how many early exercise decisions in our data set are economically reasonable and how many attractive exercise opportunities investors exploit or forgo over time. Table 5 contains the results of this economic analysis.

[Table 5 about here.]

The left part of Panel A shows that the majority of early exercises take place when it is not economically reasonable. For Type A GFSN, about 75.674% of early exercises are financially disadvantageous. For Type B, this share even amounts to 86.061%. In other words, only 24.326% (13.939%) of the empirical exercise decisions in our data set comply with the considerations in standard option pricing theory, namely that exercises should occur only at a PVEV-ratio of 1. Instead, we observe exercises at a broad range of valuations. In fact, a more detailed analysis—not reported here—reveals that the largest share of exercises (45.778% and 50.743%) can be construed as clearly economically disadvantageous, with a PVEV-ratio of greater than 1.03. This extent of "suboptimal" decisions of Individual Investors in GFSN is markedly larger than in comparable studies for equity derivatives (e.g., Poteshman and Serbin, 2003). It is also another indicator that enhancing the investment performance is not the primary motive of Individual Investors' exercise decisions.

Next, we use the calculated PVEV-ratio per month and GFSN to determine how frequently Individual Investors take advantage of upcoming attractive exercise opportunities (right part of Panel A). This means we extend our analysis beyond the investor's final early exercise and also

consider all previous decisions to continue holding the investment. In line with our former findings the results reveal that Individual Investors act with much less financial sophistication than we would expect from, for example, institutional investors. In fact, overall only 1.856% (1.829%) of the attractive exercise opportunities that arise are utilized by Individual Investors. In other words, this implies that for both GFSN types investors waive more than 98% of their chances to increase the investment yield through re-arranging their portfolio, resulting in significant opportunity costs. This finding is also supported by the above-defined variable MISSEDALL (see Table 3), which counts for each investment at maturity or at an early exercise how many economically reasonable exercise months the investor has let pass and instead decided to continue holding the investment. In a separate analysis not shown here, we find that at an early exercise of a Type A GFSN an investor has already missed on average 3.920 economically reasonable exercise opportunities (2.425 for Type B), thereof 1.609 (1.000) within the last half year. While such a general "failure to exercise" is also well documented for retail investors in equity derivatives (Pool et al., 2008; Barraclough and Whaley, 2012), the incidence of missed exercises in our study is again—as for the share of economically disadvantageous exercise decisions—significantly higher. A possible reason might be the more conservative character of fixed-income products compared to other investment classes, as these are presumably preferred by a different type of investor with other investment horizons and motives.

Panel B of Table 5 again analyzes what if any differences exist in the reasonableness of exercise behavior among selected investor groups. For this, we run two logit regressions. First, we regress a dummy variable indicating whether or not an early exercise is reasonable on portfolio and personal characteristics of investors (left part), whereby we control also for the investment volume, for tax influences and for a potentially increased demand in the first month after the blocking period. In the second regression we use a dummy variable that denotes if an investor

fails to exercise at an economically attractive opportunity or not (right part). In this case we also consider the investment history as dependent variable (MISSEDALL, MISSED6) to determine whether earlier decisions to forgo similar opportunities have an influence. Moreover, we control for the effect of a shortly upcoming coupon payment date (COUPON), account for different product characteristics (UPSTEEP, DURATION) and incorporate the lifetime of a GFSN.

The pseudo-R^2 for the first regression is 19.31% (12.90% for Type B GFSN) and 20.49% (18.79%) for the second regression. In general, the results demonstrate that the economic reasonableness of Individual Investors' holding and exercise decisions in our sample differs broadly depending on the investment history, environmental influences, product characteristics and on portfolio and personal characteristics. Beginning with the investment history, the regression output supports our former finding that investors tend to respond sluggishly to market changes. The likelihood of an investor missing a good opportunity to exercise declines if that investor has recently left out some attractive exercise chances (MISSED6). Regarding the product variables, we observe that the probability that an economically attractive exercise opportunity will be ignored is higher if the product characteristics of the respective GFSN match investors' preferred payment profile (see Section 3.1), i.e. if the GFSN has a steeply rising coupon structure and a low capital duration. This is consistent with our results in the last subsection. Similarly, the positive coefficient for COUPON corresponds to the already discussed (irrational) tendency among Individual Investors to ignore (attractive) early exercise opportunities shortly before coupon payment dates. Finally, the regression returns negative loadings for the last two product variables BLOCK and LIFETIME. The negative coefficient for BLOCK in the first regression implies that in the first month after the blocking period a significantly higher number of exercises than usual are economically unreasonable, which we attribute to accumulated requests to exercise, due perhaps to liquidity constraints, that pile up until the first exercise possibility.

The negative loading for the LIFETIME variable for Type A GFSN in the second regression indicates that the probability of a failure to exercise increases over time, which might perhaps be due to a lack of attention to products that mature in the near future.

Moreover, we note that the economic reasonableness of an early exercise decision depends on an investor's portfolio and personal characteristics. One reason for this is that experience apparently plays an important role in investors' decision-making as shown by the high coefficients for the portfolio variables PERFORMED and EXERCISED in both analyses in Panel B. The positive influence of PERFORMED in the first regression shows that investors who have already exercised at an economically beneficial point in time once before are much more likely to make further sophisticated exercise decisions, whereas the negative loading for EXERCISED in the first regression implies that a previous poor decision to exercise at an inopportune time (i.e. the PERFORMED dummy is 0) is regularly followed by a decreasing probability of an economically rational exercise decision on other investments. Similar relationships appear in the second regression, where we observe that the probability of an investor missing an exercise opportunity drops significantly if he has exercised a GFSN before and decreases even more if his earlier exercise decision was economically reasonable (i.e. both the EXERCISED and the PERFORMED dummy equal 1). Overall, the patterns in both regressions indicate that investors' exercise behavior is in principle consistent over time.

Looking at personal characteristics, we summarize that female investors tend to act more cautiously and thus miss more potential chances than men, but achieve economically better results if they do decide to exercise. This finding is in line with several studies on Individual Investors' trading behavior in stocks (e.g., Barber and Odean, 2001; Grinblatt and Keloharju, 2001). Differences also exist related to the age of an investor. Most striking, we detect that investors between 20 and 40 years of age employ their exercise rights considerably more often

than other investor groups but also more often at points in time where it is not economically advantageous. A possible reason might be a higher demand for liquidity in that stage of life due to, e.g., costs for purchasing a house, increased expenses of raising a family or repayment of education debts.

We do not find that investors' geographical location has any statistical influence on the economic reasonableness of the exercise behavior. However, differences appear regarding the preferred distribution channel. Investors who prefer to acquire directly through the German Finance Agency make markedly better exercise decisions. This is consistent with the usually higher financial literacy of investors who skip intermediaries. Still, direct investors show also an increased probability to fail to utilize upcoming economically attractive opportunities. As our last finding, we note that investors holding a doctoral degree have a similar investment profile as the just described direct investors, which we also ascribe to a higher financial literacy of this investor group.

3.3 Excess returns of exercising

To quantify the observed differences in investors' exercise strategies and to check the robustness of our results, we determine in this section the performance of each GFSN investment and each respective exercise in our data set. As performance measure we use the difference ("excess return") between the yearly internal rate of return of a buy-and-hold strategy and the yearly internal rate of return of the empirically observed investment behavior. We assume in the calculation of the latter that at an early exercise the whole investment is directly reinvested in a fixed-income product with the same (remaining) maturity that pays the market par-yield.[13] Moreover, we ignore any potential transaction costs for buying bonds. Table 6 provides the results.

[13]This implies that the fictive re-investment product has a market value of 1.

[Table 6 about here.]

As already indicated by the low number of economically reasonable exercises and the high number of missed beneficial opportunities (see Panel A of Table 5), the results show that only few investors achieve a positive yearly excess return through exercising GFSN. This finding is similar to the study of Bauer et al. (2009), who analyze Individual Investors' trading returns for equity options. On average, exercises in our data sample lead to negative excess returns against a buy-and-hold strategy of circa -0.117% per year for Type A and circa -0.300% for Type B GFSN. Not surprisingly, a separate analysis—not reported here—again finds differences in investors' exercise performance related to personal and investment characteristics, whereby the general patterns are in line with our former discussions. For example, investors between 20 and 40 years of age show an even poorer exercise performance (mean excess returns of -0.302% and -0.438%) than, e.g., investors between the ages of 0 and 20 (-0.029% and -0.243%). Furthermore, investors who prefer direct distribution (0.119% and -0.096%) markedly outperform those who prefer to invest at banks (-0.372% and -0.498%). Finally, we note that the best exercise performance for both GFSN types tends to be achieved by investors that exercise early only selected investments, whereas investors that have a high ratio of early exercises to investments regularly realize poor excess returns.

3.4 Discussion

Summing up the empirical and economic results of our last three subsections, two key insights emerge. The first is that Individual Investors in GFSN most frequently use their early exercise rights when it is not economically advisable. The second is that they typically forgo numerous attractive exercise opportunities throughout the lifetime of their investments. The equity derivatives literature typically classifies such a non-performance-oriented behavior as "subopti-

mal" and refers to irrationality (e.g., Poteshman and Serbin, 2003; Pool et al., 2008; Barraclough and Whaley, 2012), non-continuous monitoring of the investment (e.g., Stanton, 1995; Barraclough and Whaley, 2012; Liao et al., 2013) and transaction costs (e.g., Stanton, 1995; Finucane, 1997; Koziol, 2006).[14]

However, two further findings in our analyses are that investors react very sensitively to environmental influences and that exercise behavior significantly differs among the investor base. For instance, we observe strongly increased exercise activity during the introduction of the "New Market" in Germany and during bullish periods in the equity market. As an example for differences that depend on personal characteristics, we find for investors aged between 20 and 40 years suspiciously high exercise activity at times that are frequently unreasonable from an economic point of view and that result in markedly poorer average excess returns from exercising, compared to other investor groups. Such reactions to environmental changes and such age-related behavior are difficult to reconcile with the standard reasoning in the literature. In fact, the literature seem to offer only weak explanations why the degree of irrationality, the monitoring behavior or transaction costs should differ so substantially dependent on, e.g., the development of the equity market or the affiliation to a specific age cohort. Hence, we suggest that—besides the common factors in the literature—a further factor drives Individual Investors' exercise decisions in fixed-income products. This factor is the desire for liquidity and financial flexibility.

Indeed, the liquidity and flexibility argument fits well to the described empirical patterns in the data. We link it to five observations in our former analyses. First, the significantly higher probability of early exercise of a GFSN by investors between the ages of 20 to 40 might be due to their higher liquidity requirements at that stage of life, due, for example, to raising a family

[14]Further examples of motives for non-performance oriented exercises are typically gambling and entertainment (e.g., Lakonishok et al., 2007; Bauer et al., 2009), which we ignore here since GFSN are quite conservative medium-term fixed-income products that are obviously less suitable for short-term gambling purposes.

or purchasing a house. Second, the higher early exercise activity in the first month after the initial blocking period can be attributed to investors' demand for liquidity that has accrued over the first twelve months of maturity. Third, the increased exercise rates during strong growth phases in the equity markets can be interpreted as a direct reaction of investors in GFSN who use the early exercise right to liquidate their investments so as to benefit from bullish trends in other markets.

Fourth, only very few early exercise decisions in our data seem to be driven by economic or performance reasons, as most GFSN are exercised early at economically inopportune times. Moreover, we observe a relatively constant base exercise rate, independent of market movements or valuation changes. Besides irrationality, both patterns—the high number of exercise decisions at a PVEV-ratio above 1 and the base exercise rate—can obviously also be attributed to investors' demand for liquidity, in which case the current value of a product is of secondary importance. Fifth, consistency in taking advantage of attractive exercise opportunities is low. Investors have typically already missed several (better) opportunities when they exercise. As the literature states (see, e.g., Barraclough and Whaley, 2012), this might be due to time-dependent transaction costs, non-continuous monitoring or irrationality. On the other hand, the low rate of realizing exercise chances combined with the tendency to exercising early at inopportune times rather than somewhat later when the investment would have worth more also fits very well to investors who follow a conservative buy-and-hold strategy and only exercise to meet liquidity needs or due to environmental influences such as tax changes. The latter argument seems to be particularly relevant as GFSN are medium-term government bonds with a low risk profile and hence presumably attract mainly conservative investors.

4 Investment and exercise motives

Our analyses so far show that investors' use of the exercise right deviates from the theoretically optimal exercise strategy—even to a higher extent than in the equity market—and that the demand for liquidity and financial flexibility might be important reasons for early exercising. Consequently, in this section we aim to cast further light on the motives of Individual Investors for holding and exercising GFSN. We perform our analysis in two steps. First, we compile a new data set that describes the average investment and exercise strategy of each Individual Investor in our data set. We then conduct an exploratory factor analysis to extract the main dimensions of variation in the data and to isolate latent factors that drive investors' investment and exercise behavior. Second, we examine the relevance of the identified latent factors for each investor and determine whether there are any statistically significant relationships to personal and financial attributes.

4.1 Exploratory factor analysis

While we have concentrated in this paper so far on decisions and transactions at an individual account and product level, we now focus on the general behavior of Individual Investors. Hence, our first step is to create a new data set that consolidates the individual transaction data for each investor into a few explicit characteristics of behavior. Table 7 provides an overview of the variables we calculate for each account, whereby the selection adheres closely to the identified determinants of early exercising (see Table 4).

[Table 7 about here.]

In short, we consider three kinds of variable. First, we compute economic indicators and ratios that describe an investor's average investment and exercise strategy. For instance, we determine what percentage of his exercises occurs at times when the PVEV-ratio equals 1 (PVEVLOW),

which implies—as discussed—an economically rational exercise. Similarly, we calculate the variables PVEVMED and PVEVHIGH, which represent the share of early exercises at medium ($1<PVEV\leq 1.03$) or high PVEV-ratios ($PVEV>1.03$). Second, we account for the average reaction to environmental influences, such as the percentage of exercise opportunities used when the CDAX has moved by more than 25% during the previous 6 months or the percentage of investments an investor liquidates in the months before changes in the tax environment become effective. Third, we subsume information on the products an investor chooses to purchase. Here, we consider, for instance, the average steepness of the coupon structure over all chosen investments or the average value of the bond component without the option right. Finally, we also incorporate an investor's number of investments and early exercises.

In this analysis we have to cope with missing data, because some of the defined variables in Table 7 depend on economic or environmental circumstances that may not have arisen during an individual's investment period. For example, we cannot calculate the percentage of exercised investments in the months before changes in the tax legislation become effective if an investor did not hold a GFSN at such a time. According to the classification of Rubin (1976), such data is missing at random (MAR), since its absence is not related to the value of the respective variable but only to other variables, such as the market or tax environment. The literature suggests several methods of handling data missing at random (see, e.g., Allison, 2002; Enders, 2010), yet there seems to be no best commonly accepted approach. We apply multiple imputation algorithms and the full-information maximum likelihood method here, but find only small differences in the results. We proceed with the likelihood estimator for efficiency reasons, whereby we implicitly assume that Individual Investors, for whom we may lack some data, do not systematically make decisions that are widely different from the other investors in our data set, which seems reasonable considering the broad and large investor base.

An exploratory factor analysis, using the maximum-likelihood extraction method and applying robust standard errors to correct for non-multivariate normally distributed data (see Yuan and Bentler, 2000), isolates four factors that primarily drive the investment and exercise behavior of Type A GFSN investors, while five factors seem most suitable for Type B GFSN investors (see Table 8).[15] For both analyses the model fit is satisfying. The standardized root mean square residual (SRMR) lies at 5.2% for Type A GFSN (3.7% for Type B), the root mean square error of approximation (RMSEA) lies at circa 6.5% (5.0%) and the comparative fit index (CFI) approaches 88% (92%). Overall, the identified factors account cumulatively for circa 55.227% (59.000%) of the overall variance. Table 8 contains details on the factor selection and on the rotated standardized factor loadings, which we estimate via the direct geomin oblique rotation algorithm.

[Table 8 about here.]

The factor analysis returns distinct and strong loading patterns for all identified factors. It is remarkable that the estimated factors and factor structures are very similar for the independently conducted analyses of Type A and Type B GFSN investors, which we take to indicate the economic robustness of our results. The first and most important factor, which in the case of Type A GFSN accounts for about 19.153% of the variance in all variables (17.819% for Type B), shows positive loadings for all three PVEV variables. This indicates that the factor is related to both economically reasonable and disadvantageous exercise decisions, which is plausible if exercises are triggered by exogenous factors such as the introduction of new market segments or strong movements in the equity market. In fact, for this factor we observe statistical positive coefficients for all market variables (CDAX10, CDAX25 and NEWMARKET) and for

[15] To determine the number of latent factors, we consider the Kaiser-criterion (Kaiser, 1960), a parallel analysis and a scree plot. For a clear presentation of the results we decided to keep factors with an eigenvalue larger than 1.0, although the results do not differ significantly in the case of other selection criteria.

the BLOCK variable, which indicates an increased exercise rate in the first month after the blocking period. Based on these observations and on our discussion above, we interpret the first factor as being due to an investor's need for liquidity and financial flexibility.

The second factor represents the importance of the mid- and long-term value of an investment and thus stands for a conservative strategy. It is associated with an investment behavior focusing on steep coupon structures and a high valuation at issuance. The third latent factor consolidates the desire for high investment performance. It loads strongly on the ratio of early exercises at a PVEV-ratio of 1 (PVEVLOW) and accordingly on positive excess returns of exercising (EXCESSRETURN). In contrast, the fourth factor summarizes a highly active investment behavior with a high number of early exercises that, however, do not result in positive excess returns—hence we label this factor "activism". Finally, the fifth factor, which appears only for Type B GFSN, captures the sensitivity to changes in the tax regulation. It loads mainly on the tax (TAX9906) and the year-end variable (YEAREND).

Overall, we note that the results of the factor analysis coincide with our previous finding that the desire for a better yield performance is only one of several factors in the decision-making of Individual Investors. In fact, the factor analysis suggests again that other motives, such as the need for financial flexibility, play a more important role.

4.2 Importance of latent factors

Following the general analysis, we also estimate personal factor scores for each Individual Investor in our data set. To determine whether any differences exist in the relevance of latent factors related to personal characteristics, we regress the computed scores on selected personal and financial characteristics (average investment volume per investment). Table 9 shows the results.

[Table 9 about here.]

We emphasize five regression results relevant to points discussed in this paper. First, the relevance of the financial flexibility factor is most strongly pronounced for investors between 20 and 40 years of age. Additionally, this factor appears to be more important for male investors and for higher average investment volumes. Second, the desire for value mainly drives the decisions of investors with larger investments, who prefer to acquire GFSN indirectly at banks. We also observe that this factor is of higher relevance for investors younger than 20, compared to other age groups, which we attribute to GFSN accounts that are established as savings accounts in a child's name. Third, the performance factor is strongly marked for direct investors who omit any intermediary and presumably have a higher average financial literacy. In contrast, performance seems to be a less important motive for many investors between the ages of 20 and 40, which corresponds to the high relevance of the financial flexibility factor for this investor group. Fourth, activism is stronger associated with male direct investors and is closely related to low average investment volumes. As for all other factors, we find no clear relevance attached to an investor's residence area. Fifth, the tax factor is more relevant for investors with higher investment volumes, which seems very reasonable.

5 Conclusions

In this paper we analyzed Individual Investors empirical use of early exercise rights in the fixed-income market. In short, we find that a broad range of environmental and economic factors determine investors' exercise decisions, whereby distinct differences exist among the investor base that depend on portfolio and personal characteristics. Still, most investors have in common the fact that they use the exercise right at times that are not economically reasonable and that they frequently fail to exploit more favorable exercise opportunities. Consequently, a broad majority of exercises in our sample result in negative excess returns.

The observed behavior and several empirical patterns let us infer that performance seeking is not the sole or main driver of Individual Investors' exercise decisions in putable bonds. In fact, our results suggest that for Individual Investors performance is in general a less important motivator of exercise decisions than it presumably is for, e.g., professional or institutional traders. Instead of performance, the wish for financial flexibility, for example in the case of substantial changes in the equity market or liquidity constraints, seems to be a major motive for early exercising. The results of an exploratory factor analysis support this hypothesis. We identify five latent factors that mainly drive Individual Investors' investment and exercise strategy, of which the most important factor can in fact be interpreted as an investor's desire for flexibility.

In view of this, we derive three policy implications. First, sophisticated liquidity management is highly important for the issuers of fixed-income derivatives for Individual Investors. Issuers must anticipate that investors will use their exercise rights not mainly to optimize their investment yields, but also to react to things like environmental changes or liquidity constraints. This means early exercises frequently occur at times not predicted by standard theory. Second, information on personal characteristics of the investor base can be used to refine predictions of early exercise activity. For instance, the exercise behavior in our sample differs particularly regarding gender, age and the preferred distribution channel of an investor. Third, as Individual Investors fail to exercise the broad majority of attractive early exercise opportunities and use the option right—as noted—frequently at economically suboptimal points in time, the empirical value of the early exercise right is in general lower than its financial fair value. Hence, issuers gain a (significant) financial margin in pricing putable bonds for Individual Investors with standard financial models. Moreover, our study shows that issuers can increase this margin by offering specific product designs and exploiting the behavioral biases of Individual Investors. For instance, there are some indications that Individual Investors prefer bonds with a high final

coupon payment to financially fully equivalent products with a flatter coupon structure. Accordingly, our results suggest that investors more often fail to use attractive exercise opportunities that arise for bonds with a steep coupon structure, which is obviously advantageous for the issuer.

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Tables

Table 1: Statistics on investor base

	Type A GFSN		Type B GFSN	
	Percent	Absolute	Percent	Absolute
Personal characteristics				
Gender				
Male	33.469	52,717	38.406	35,595
Female	38.362	60,425	37.995	35,214
n/a	28.169	40,370	23.598	21,871
Age				
0 to 20 years	18.978	29,892	38.515	35,696
21 to 40 years	23.665	37,276	20.986	19,450
41 to 60 years	28.127	44,304	24.455	22,665
61 to 100 years	25.960	40,890	13.166	12,202
n/a	3.270	5,150	2.878	2,667
Doctoral degree				
Doctorate or professorship	4.150	6,536	3.499	3,243
No doctoral degree	95.850	150,976	96.501	89,437
Geographical location				
City	4.165	6,560	3.835	3,554
Highly populated	11.215	17,665	11.254	10,430
Moderately populated	28.547	44,965	29.252	27,111
Sparsely populated	51.371	80,916	51.417	47,653
n/a	4.702	7,406	4.243	3,932
Preferred distribution(1)				
Indirect (at banks)	59.181	93,217	54.011	50,057
Direct (via the German Finance Agency)	40.819	64,295	45.989	42,623
Overall	100.000	157,512	100.000	92,680

The table exhibits information on personal characteristics of all 223,017 Individual Investors in our data sample, whereof 27,175 investors hold both Type A and Type B GFSN. Investors are clustered in residence areas according to the first two digits of their zip code using an urbanization index and population density figures from German Federal Statistics Office (2009). We classify the population density per sqkm as follows: <250 = sparsely, 250-750 = moderately, >750 = highly populated. (1) We define the preferred distribution channel as direct if an investor executes at least one direct transaction. Indirect means that an investor purchases a GFSN at a bank and later transfers his investment to an account at the German Finance Agency.

Table 2: Statistics on investors' financial activities

	Type A GFSN					Type B GFSN				
	Mean	Med.	p5	p95	St.dev.	Mean	Med.	p5	p95	St.dev.
Investments per investor										
Number of investments	3.147	1.000	1.000	11.000	5.200	2.790	1.000	1.000	9.000	5.139
Overall investment volume in €	23,053	10,226	1,019	85,569	45,614	11,526	4,090	511	44,945	30,593
Volume per investment in €	8,818	5,266	639	25,565	14,789	5,085	2,505	460	17,663	6,693
Early exercises per investor										
Number of exercises	0.526	0	0	2.000	1.491	0.517	0	0	2.000	1.483
Overall exercise volume in €	1,812	0	0	10,178	4,761	1,284	0	0	6,647	3,547
Volume per exercise in €	4,094	4,090	511	10,000	2,742	3,017	2,540	511	7,669	2,610
Early exercises over time										
Exercise rate per month and GFSN in %	0.626	0.309	0.081	2.418	1.058	0.518	0.327	0.081	1.693	0.671
Exercise volume per month and GFSN in €	160,356	80,323	2,711	570,448	296,062	55,242	26,212	2,228	209,374	296,062

The table exhibits statistics on the investments and early exercises of all 223,017 Individual Investors in 204 issued GFSN (102 Type A, 102 Type B) during our sample period from July 1996 to February 2009. The early exercise rate is defined as the monthly ratio of number of exercises to the number of current investments in this GFSN.

Table 3: Variables considered for analysis of determinants

		Type A GFSN		Type B GFSN	
Abbr.	Variable description	Mean	St.dev.	Mean	St.dev.
Economic benefit					
PVEV	Ratio of present value to exercise value	1.034	0.027	1.0511	0.048
Investment history					
MISSEDALL	Number of economically reasonable exercise months (PVEV=1) since issuance	2.869	6.044	1.726	5.022
MISSED6	Number of economically reasonable months (PVEV=1) within the last 6 months	0.769	1.649	0.427	1.291
VOLUME	Investment volume in €	7,513	11,165	3,972	8,025
Environmental circumstances					
CDAX10+	Dummy, changes in CDAX > +10% points within a month	0.033	0.177	0.031	0.174
CDAX10-	Dummy, changes in CDAX < -10% points within a month	0.080	0.271	0.081	0.273
CDAX25+	Dummy, changes in CDAX > +25% points within 6 months	0.094	0.292	0.095	0.293
CDAX25-	Dummy, changes in CDAX < -25% points within 6 months	0.085	0.278	0.087	0.281
VOLDAX	45-day option-implied volatility of DAX measured by VDAX	24.045	9.846	23.888	9.877
VOLINT	Volatility of German 5-year spot rate estimated from weekly returns over a 6-month window	0.012	0.002	0.012	0.002
NEWMARKET	Dummy, introduction of new stock market "New Market" in Germany (January 1998 to December 2000)	0.197	0.398	0.176	0.381
TAX99	Dummy, change in tax legislation 2000 (November-December 1999)			0.012	0.109
TAX06	Dummy, change in tax legislation 2007 (November-December 2006)			0.017	0.129
YEAREND	Dummy, end of the year (each December)			0.086	0.280
Product characteristics					
UPSTEEP	Average yearly growth of coupon payments until maturity (last coupon minus current coupon divided by years to maturity)	0.005	0.002	0.004	0.002
DURATION	Fisher-Weil duration of bond component in years	2.585	1.315	3.300	1.711
COUPON	Dummy, coupon payment upcoming within the next 60 days	0.090	0.285		
BLOCK	Dummy, first month after blocking period	0.023	0.151	0.021	0.142
LIFETIME	Lifetime since issuance in years	2.315	1.450	2.672	1.711
Portfolio characteristics					
INVESTS	Number of former investments in GFSN	7.397	10.127	8.231	11.668
INVESTSUM	Sum of overall investments in € so far	40,087	73,561	27,156	64,055
EXERCISED	Dummy, signaling if investor has exercised early a GFSN once before	0.104	0.306	0.108	0.311
PERFORMED	Dummy flagging if investor has exercised early a GFSN once before when it was economically reasonable (PVEV=1)	0.037	0.189	0.032	0.176
N		19.089m		11.467m	

The table shows the variables and ratios we consider in our analysis of determinants of Individual Investors' exercise behavior. Overall 19.089m monthly observations are considered for Type A GFSN (11.476m for Type B). The one-year blocking period at beginning of a GFSN is excluded. Data sources are Deutsche Bundesbank for interest term structures, Thomson One Banker for environmental and equity market variables and the German Finance Agency for GFSN data. The descriptive statistics are calculated based on all observations of the data set, wherefore the figures differ from, e.g., the analysis on an individual investor level (see Table 2).

Table 4: Determinants of early exercise

	Type A GFSN			Type B GFSN		
	Observations per Investment			Observations per Investment		
	Mean	Min.	Max.	Mean	Min.	Max.
	42.370	1.000	60.000	48.770	1.000	72.000
	Logit Coefficient	*RE logit* Coefficient	Margin(1)	*Logit* Coefficient	*RE logit* Coefficient	Margin(1)
Economic benefit						
PVEV	-13.446*	-12.851*	-18.158*	-7.650*	-3.296*	-11.930*
Investment history						
MISSEDALL	0.022*	0.049*	0.029*	0.001	0.039*	0.002
MISSED6	0.059*	0.171*	0.079*	0.144*	0.224*	0.224*
VOLUME	0.011*	0.023*	0.014*	0.014*	0.031*	0.023*
Environmental circumstances						
CDAX10+	0.261*	0.323*	0.399*	0.289*	0.358*	0.518*
CDAX10-	0.157*	0.124*	0.228*	0.242*	0.194*	0.420*
CDAX25+	0.131*	0.122*	0.187*	0.318*	0.408*	0.568*
CDAX25-	-0.377*	-0.510*	-0.438*	-0.154*	-0.268*	-0.226*
VOLDAX	0.005*	0.007*	0.008*	-0.003*	-0.003*	-0.004*
VOLINT	-86.190*	-84.767*	-116.392*	-49.856*	-70.138*	-77.748*
NEWMARKET	1.010*	1.299*	1.924*	0.991*	1.357*	2.218*
TAX99				0.482*	0.584*	0.960*
TAX06				0.999*	1.118*	2.624*
YEAREND				0.349*	0.405*	0.633*
Product characteristics						
UPSTEEP	-4.943*	59.881*	-6.675*	-78.250*	-68.645*	-122.029*
DURATION	4.346*	12.028*	5.869*	0.204*	-0.177*	0.318*
COUPON	-0.140*	-0.089*	-0.179*			
BLOCK	0.368*	-0.259*	0.595*	0.407*	-0.617*	0.777*
LIFETIME	3.537*	11.025*	4.777*			
Portfolio characteristics						
INVESTS	-0.046*	-0.113*	-0.063*	-0.046*	-0.107*	-0.072*
INVESTSUM	-0.005*	-0.009*	-0.006*	-0.006*	-0.010*	-0.010*
EXERCISED	2.979*	6.445*	18.137*	2.977*	6.497*	20.612*
PERFORMED	0.428*	1.047*	0.709*	0.235*	0.618*	0.410*
Personal characteristics						
Gender						
Female	-0.059*	-0.144*	-0.078*	-0.105*	-0.169*	-0.160*
n/a	0.046*	0.048*	0.064*	0.041*	0.068*	0.067*
Age						
21 to 40 years	0.484*	0.870*	0.759*	0.641*	1.014*	1.139*
41 to 60 years	0.240*	0.362*	0.330*	0.427*	0.652*	0.677*
61 to 100 years	-0.008	-0.126*	-0.009	0.294*	0.348*	0.435*
n/a	-4.228*	-6.579*	-1.206*	-4.004*	-6.726*	-1.248*
Doctoral degree						
Doctorate or professorship	-0.125*	-0.244*	-0.160*	-0.122*	-0.327*	-0.181*
Geographical location						
City	-0.002	-0.118*	-0.003	-0.022	0.010	-0.035
Highly populated	-0.045*	-0.016	-0.061*	0.025	0.025	0.041
Moderately populated	-0.018*	-0.014	-0.025*	-0.054*	-0.053*	-0.084*
n/a	0.016	0.003	0.023	-0.028	-0.109*	-0.044
Preferred distribution						
Direct	-0.221*	-0.526*	-0.292*	-0.114*	-0.290*	-0.177*
Constant	-11.204*	-51.235*		1.599*	-3.465*	
Groups (Investments)		450,526			235,307	
N	19.089m	19.089m		11.467m	11.467m	
Pseudo-R^2 in %	17.00	19.78		15.17	19.27	

The table exhibits the results of a pooled logit and a random-effects logit regression on Individual Investors' exercise decisions in Type A and Type B GFSN. Only investments and decisions after the one-year blocking period are considered. For the pooled regressions robust standard errors are used. For the panel estimation we apply the Gauss-Hermite algorithm with 4 integration points. The lifetime variable is not considered for Type B GFSN as it is perfectly correlated to the respective product's duration. The marginal effects (dy/dx) are calculated at means based on the pooled logit regression. Pseudo-R^2 is the percentage improvement in the log-likelihood achieved by our model compared to a constant-only model. (1) Displayed at 1e+4. * signals statistical significance at the 5% level.

Table 5: Economic reasonableness of early exercise behavior

Panel A	Distribution of early exercises in %				Attractive exercise opportunities in %			
	Type A GFSN		**Type B GFSN**		**Type A GFSN**		**Type B GFSN**	
	PVEV=1	PVEV>1	PVEV=1	PVEV>1	Exploited	Missed	Exploited	Missed
	24.326	75.674	13.939	86.061	1.856	98.144	1.829	98.171

Panel B	*Logit*: Early exercise economically reasonable (PVEV=1, yes/no)				*Logit*: Failed to exercise when PVEV=1 (yes/no)			
	Type A GFSN		**Type B GFSN**		**Type A GFSN**		**Type B GFSN**	
	Coefficient	Margin(1)	Coefficient	Margin(1)	Coefficient	Margin(1)	Coefficient	Margin(1)
Investment history								
MISSEDALL					0.002	0.074	0.030*	0.128*
MISSED6					-0.068*	-0.202*	-0.033*	-0.143*
VOLUME	-0.011*	-0.002*	-0.011*	-0.002*	-0.006*	-0.018*	-0.011*	-0.048*
Environmental circumstances								
TAX99			-0.784*	-0.111*			0.387*	1.399*
TAX06			0.425*	0.082*			-0.508*	-2.828*
YEAREND			0.378*	0.072*			-1.050*	-7.426*
Product characteristics								
UPSTEEP					26.743*	78.972*	150.609*	654.423*
DURATION					-2.398*	-7.083*	-0.395*	-1.718*
COUPON					0.102*	0.291*		
BLOCK	-1.702*	-0.296*	-1.041*	-0.148*				
LIFETIME					-1.546*	-4.567*		
Portfolio characteristics								
INVESTS	0.012*	0.003*	0.012*	0.002*	0.043*	0.128*	0.043*	0.189*
INVESTSUM	0.003*	0.001*	0.003*	0.000*	0.002*	0.074*	0.002*	0.010*
EXERCISED	-0.624*	-0.137*	-0.562*	-0.100*	-2.403*	-20.308*	-2.455*	-31.188*
PERFORMED	1.873*	0.436*	1.778*	0.394*	-1.240*	-6.641*	-1.257*	-10.137*
Personal characteristics								
Gender								
Female	0.050*	0.011*	0.050	0.009	0.045*	0.130*	0.118*	0.495*
n/a	0.008	0.002	0.030	0.005	-0.121*	-0.375*	-0.119*	-0.563*
Age								
21 to 40 years	-0.641*	-0.138*	-0.650*	-0.115*	-0.149*	-0.487*	-0.241*	-1.143*
41 to 60 years	-0.310*	-0.071*	-0.389*	-0.074*	-0.048*	-0.150*	-0.098*	-0.432*
61 to 100 years	-0.006	-0.001	-0.182*	-0.036*	0.109*	0.314*	-0.027	-0.115
n/a	0.196	0.047	0.231	0.050	3.960*	2.968*	3.620*	4.091*
Doctoral degree								
Doctorate or professorship	0.069	0.015	0.157*	0.029*	0.077*	0.219*	0.062	0.265
Geographical location								
City	-0.012	-0.003	0.019	0.003	0.070*	0.202*	0.094	0.398
Highly populated	0.020	0.004	-0.009	-0.002	0.032	0.096	0.035	0.153
Moderately populated	0.013	0.003	0.037	0.007	0.010	0.031	0.040	0.175
n/a	0.083	0.018	-0.093	-0.016	-0.026	-0.079	0.090	0.384
Preferred distribution								
Direct	0.999*	0.215*	0.698*	0.123*	0.414*	1.274*	0.335*	1.507*
Constant	-0.767*		-1.228*		15.105*		5.803*	
N	82,787	82,787	47,900	47,900	3.028m	3.028m	1.114m	1.114m
Pseudo-R^2 in %	19.31		12.90		20.49		18.79	

The table shows four economic analyses of Individual Investors' exercise behavior in GFSN. In the left part of Panel A we compute the share of early exercises in our data set that are economically reasonable and the share of theoretically not beneficial exercises. Second, in the right part of Panel A we calculate the percentage of exploited and missed economically attractive exercise opportunities (PVEV=1). Third, the left part of Panel B presents the results of a pooled logit regression on a dummy variable that indicates if an exercise is economically beneficial. The second column displays the corresponding marginal effects (dy/dx) at means. Fourth, the right part of Panel B exhibits the results of a pooled logit regression on a dummy variable that indicates if an investor fails to use an attractive exercise opportunity. Again, the next column shows the marginal effects (dy/dx) at means. Robust standard errors are used. Pseudo-R^2 is the percentage improvement in the log-likelihood achieved by our model compared to a constant-only model. (1) Displayed at 1e+4.
* signals statistical significance at the 5% level.

Table 6: Excess returns of early exercising

	Individual Investors' excess return of early exercising in % p.a.	
	Type A GFSN	**Type B GFSN**
Mean	-0.117	-0.300
Median	-0.098	-0.289
p5	-1.306	-1.429
p10	-1.017	-1.124
p90	0.709	0.572
p95	1.023	0.868
St.dev	0.704	0.711
N	82,787	47,900

The table shows statistics on the average yearly excess return of early exercising based on the exercise decisions of all 223,017 Individual Investors in 204 issued GFSN (102 Type A, 102 Type B) during our sample period from July 1996 to February 2009. For the calculation we assume that an investment exercised early is directly reinvested in a product with an identical remaining maturity paying the market yield. The excess return is then calculated as the difference between the internal rate of return of the exercise strategy and a buy-and-hold strategy.

Table 7: Variables calculated to summarize an investor's investment and exercise behavior

		Type A GFSN		**Type B GFSN**	
Abbr.	Variable description	Mean	St.dev	Mean	St.dev
Economic benefit					
PVEVHIGH	Percentage of early exercises employed where PVEV>1.03	0.147	0.334	0.163	0.348
PVEVMED	Percentage of early exercises employed where 1<PVEV≤1.03	0.056	0.205	0.066	0.221
PVEVLOW	Percentage of early exercises employed where PVEV=1	0.087	0.260	0.082	0.250
Ø EXCESSRETURN	Average excess return of early exercising p.a.	-0.001	0.004	-0.001	0.004
Ø MISSEDALL	Average number of missed attractive exercise opportunities before early exercise / maturity	5.790	5.823	4.383	5.086
Environmental circumstances					
CDAX10	Percentage of exercise opportunities used when CDAX moved by more than +/-10% in last month	0.008	0.047	0.007	0.042
CDAX25	Percentage of exercise opportunities used when CDAX moved by more than +/-25% over last 6 months	0.008	0.042	0.007	0.038
NEWMARKET	Percentage of exercise opportunities used in phase of "New Market" in Germany (January 1998 to December 2000)	0.009	0.060	0.008	0.052
TAX9906	Percentage of Type B GFSN exercise opportunities used in November / December 1999 and 2006			0.012	0.089
YEAREND	Percentage of Type B GFSN exercise opportunities used in December			0.007	0.042
Product characteristics					
Ø VALUE	Average value of GFSN investments at issuance	1.012	0.008	1.019	0.011
Ø BOND	Average value of GFSN bond component at issuance	0.987	0.010	0.986	0.014
Ø STEEPNESS	Average steepness of coupon structure of GFSN investments at issuance	0.027	0.010	0.027	0.010
Ø DURATION	Average Fisher-Weil duration of GFSN investments at issuance in years	5.544	0.188		
BLOCK	Percentage of exercise opportunities used in first month after the blocking period	0.022	0.116	0.018	0.099
Portfolio characteristics					
INVESTS	Number of investments in GFSN	3.755	6.210	4.039	6.961
EXERCISES	Number of early exercises	0.643	1.773	0.735	1.982
N		157,512		92,680	

The table gives an overview of the calculated variables and ratios we use to describe an Individual Investor's average investment and exercise strategy. The excess return is calculated according to the definition in Table 6. The descriptive statistics summarize an investor's average investment and exercise strategy over his whole portfolio, wherefore the figures differ from, e.g., the analysis on an individual investor level (see Table 2). The duration is not considered for Type B GFSN (zero-bond structure) as it always equals maturity.

Table 8: Exploratory factor analysis (EFA) on consolidated investment and exercise behavior

	Factor 1		Factor 2		Factor 3		Factor 4		Factor 5
	Liquidity / financial flexibility		*Value*		*Performance*		*Activism*		*Tax*
	Type A	**Type B**	**Type A**	**Type B**	**Type A**	**Type B**	**Type A**	**Type B**	**Type B**
Economic benefit									
PVEVHIGH	0.563*	0.519*	0.036*	0.028*	-0.415*	-0.491*	0.105*	0.100*	0.160*
PVEVMED	0.022*	0.017*	-0.028*	-0.056*	-0.104*	-0.081*	0.182*	0.217*	0.131*
PVEVLOW	0.111*	0.099*	-0.063*	-0.082*	0.285*	0.285*	0.347*	0.318*	0.130*
Ø EXCESSRETURN	-0.068*	-0.051*	-0.050*	-0.056*	1.402*	1.353*	0.042*	0.024*	-0.024*
Ø MISSEDALL	-0.313*	-0.231*	-0.122*	-0.159*	0.072*	0.084*	0.032*	0.012*	-0.113*
Environmental circumstances									
CDAX10	0.389*	0.398*	0.022*	0.016*	-0.124*	-0.104*	0.043*	0.073*	-0.027*
CDAX25	0.449*	0.478*	0.020*	0.026*	-0.024*	-0.051*	0.024*	0.043*	-0.023*
NEWMARKET	0.556*	0.508*	0.070*	0.072*	-0.138*	-0.135*	-0.041*	-0.041*	0.038*
TAX9906		0.051*		0.019*		-0.122*		0.031*	0.695*
YEAREND		0.073*		0.026*		-0.100*		0.050*	0.588*
Product characteristics									
Ø VALUE	0.020*	0.021*	1.666*	1.336*	-0.051*	-0.070*	-0.032*	-0.092*	0.000
Ø BOND	0.065*	0.007*	0.462*	0.564*	-0.029*	-0.021*	-0.102*	0.023*	0.020*
Ø STEEPNESS	0.089*	0.076*	0.311*	0.424*	-0.104*	-0.113*	-0.227*	-0.164*	0.027*
Ø DURATION	-0.080*		0.062*		0.031*		0.382*		
BLOCK	0.678*	0.673*	0.023*	0.002	-0.007*	0.029*	-0.013*	-0.013*	-0.009
Portfolio characteristics									
INVESTS	0.004*	-0.003	-0.093*	-0.129*	0.039*	0.053*	0.768*	0.652*	-0.040*
EXERCISES	0.248*	0.232*	-0.060*	-0.045*	-0.044*	-0.041*	0.734*	0.808*	0.073*
Eigenvalue	2.873	2.851	2.424	2.373	1.627	1.546	1.360	1.206	1.464
Proportion in %	19.153	17.819	16.160	14.831	10.847	9.663	9.067	7.583	9.150
Cumulative in %	19.153	17.819	35.313	32.650	46.160	42.313	55.227	49.850	59.000
Indicators for model fit									
SRMR	0.052	0.037							
RMSEA	0.065	0.050							
CFI	0.879	0.923							

The table shows the results of an exploratory factor analysis of Individual Investors' investment and exercise strategies in Type A and Type B GFSN. The results are based on the maximum-likelihood factor extraction method, whereby we keep factors with an eigenvalue larger than 1.0 (Kaiser-criterion). The geomin oblique algorithm is applied to rotate factors. RMSEA stands for root mean square error of approximation, SRMR for standardized root mean square residual and CFI for comparative fit index. * signals statistical significance at the 5% level.

Table 9: Relation of factor scores to investors' personal characteristics

	Factor 1		Factor 2		Factor 3		Factor 4		Factor 5
	Liquidity / financial flexibility		*Value*		*Performance*		*Activism*		*Tax*
	Type A	**Type B**	**Type A**	**Type B**	**Type A**	**Type B**	**Type A**	**Type B**	**Type B**
Personal characteristics									
Gender									
Female	-0.050*	-0.061*	-0.096*	-0.076*	0.006	0.031*	-0.045*	-0.036*	-0.012*
n/a	0.244*	0.008	0.071*	0.037*	-0.008	-0.030	0.019*	0.036*	0.024*
Age									
21 to 40 years	0.181*	0.208*	0.009	-0.042*	-0.345*	-0.305*	0.040*	0.097*	0.093*
41 to 60 years	0.086*	0.114*	-0.211*	-0.249*	-0.167*	-0.115*	0.100*	0.150*	0.047*
61 to 80 years	0.022*	0.079*	-0.462*	-0.517*	0.002	0.030	0.040*	0.119*	0.047*
n/a	-0.214*	-0.228*	-0.246*	0.351*	0.163*	0.303*	-0.186*	-0.024*	-0.130*
Doctoral degree									
Doctorate of professorship	-0.061*	-0.076*	-0.019	-0.164*	0.056*	0085*	0.039*	0.021	-0.076*
Geographical location									
City	-0.032*	-0.019	-0.046	-0.193*	-0.027	0.046	-0.005	-0.035*	-0.028*
Highly populated	-0.001	0.017	0.062*	-0.037*	0.030*	0.028	0.028*	0.005	-0.001
Moderately populated	0.011*	0.016*	0.049*	-0.006	0.017	0.025	0.029*	0.021*	-0.013*
n/a	-0.002	-0.001	0.518*	0.297*	0.092*	0.077*	0.036*	0.005	-0.023
Preferred distribution									
Direct	-0.033*	-0.049*	-1.019*	-1.395*	0.149*	0.103*	0.473*	0.236*	-0.011*
Average volume per investment									
€1,000-3,000	0.044*	0.039*	0.198*	0.034*	-0.005	-0.068*	-0.125*	-0.055*	0.047*
€3,000-10,000	0.087*	0.095*	0.258*	0.036*	0.060*	-0.138*	-0.182*	-0.089*	0.131*
> €10,0000	0.077*	0.064*	0.230*	-0.077	0.003	-0.136*	-0.283*	-0.177*	0.115*
Constant	-0.108*	-0.078*	0.254*	0.173*	0.048*	0.100*	-0.069*	-0.178*	-0.070*
N	157,512	92,680	157,512	92,680	157,512	92,680	157,512	92,680	92,680
R^2 *in %*	1.13	1.71	3.67	15.01	0.97	0.96	12.39	6.63	1.02

The table exhibits regression results for the estimated four (five) latent factor scores on the personal characteristics (as detailed in Table 1) of all 157,512 Individual Investors in Type A GFSN and of all 92,680 Individual Investors in Type B GFSN. The average investment volume is defined in four clusters. Robust standard errors are used. * signals statistical significance at the 5% level.

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