The Order Flow of Discount Certificates and Issuer Pricing Behavior

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Abstract

We analyze the order flow of discount certificates, its dependence on the product's age, and the implications for issuer pricing behavior. Based on a unique data set of exchange trades and issuer quotes, we find that investors prefer to buy products that mature in just over 1 year from the purchase for tax reasons. Furthermore, they tend to sell products back preferably close to maturity. These patterns in the trade direction allow us to separate the issuer pricing behavior from (i) the life cycle and (ii) the order flow. We find evidence that 7 out of 11 issuers anticipate the order flow and price in an additional margin in phases of positive expected net sales.

Keywords: discount certificate, life cycle, order flow, structured financial product

JEL Classification: D40, G13, G21

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1 Introduction

Discount certificates are financial instruments which enable the investor to buy an underlying security—e.g., a stock or a stock index—at a discount to the respective market price. As a compensation for this discount, the investor has to abandon participating in the underlying performance above a certain cap level. These certificates form a very popular subgroup of structured financial products for retail investors.[1] Beginning in the mid-nineties, structured retail products became a triumphant success in several European countries, in particular Germany and Switzerland. According to the German Derivatives Association, the outstanding volume at the end of 2007 was 135 billion Euros. Although its market volume shrank to 80 billion as of December 2008, given the overall decline in market values due to the financial markets crisis, the importance of structured retail products as an asset class remains beyond question. As of year-end 2010, the market volume has recovered to a value of 110 billion Euros.

Usually, structured retail products—in particular discount certificates—are traded on a stock exchange. Most discount certificates issued in Germany are listed either at the European Warrant Exchange (EUWAX), a market-maker-based segment of the Stuttgart Stock Exchange, or at Frankfurt Smart Trading, a specialized segment of Deutsche Börse AG—many of them at both. With market makers continuously quoting binding bid-ask prices, it is convenient for individual investors to buy and sell discount certificates on the secondary market. As certificates issuers are the market makers, observed prices at the secondary market do not necessarily reflect the fair value of the certificates but the price-setting policy of the issuers.

In this paper we investigate whether issuers anticipate the behavior of investors when setting prices. If issuers know in advance when investors tend to buy or sell a particular product,

[1] In contrast to financial instruments like asset-backed securities, which are also often named structured financial products, the subject of this paper are investment certificates for small investors with investment volumes of a few thousand Euros.

they could use this knowledge to quote higher prices in the first situation and lower prices in the second. As gross margins (defined as the difference between quoted price and fair value[2]) have declined in recent years, anticipating the trade direction could be an important source of additional profit.

Wilkens, Erner, and Röder (2003) already assumed that issuers utilize their market experience of order flow to influence price-setting, which is subject of the “order flow hypothesis”. The order flow hypothesis states that, assuming a close relationship between the order flow and the product age, issuers base their pricing on the relative product age, i.e., the relation of time since issuance to total lifetime. The authors present evidence of decreasing margins within a product's life as support for this hypothesis.

It is significant, however, that the order flow itself, i.e., the net sales of the issuer, has not been observable so far.[3] Therefore, the order flow hypothesis was based on the assumption that order flow is closely related to product age. Although Wilkens, Erner, and Röder (2003) offer well-grounded arguments, due to a general lack of data, this assumption has never been proved. Subsequent papers that analyze the margin composition of structured retail products therefore refer more cautiously to the “life cycle hypothesis”. In this paper, for the first time, we use a data set of exchange-based trades to directly analyze the order flow hypothesis for discount certificates.

We focus on discount certificates for three reasons: First, discount certificates form the most popular subclass of structured retail products in Germany. Second, discount certificates are

[2]The fair value is the market price of a duplication portfolio which the issuer can construct to generate the payoff of the certificate. The given definition of margin refers to a gross margin, as no costs for structuring, marketing, etc. are incorporated.

[3]Following the terminology of the literature, we refer to the signed trading volume (issuer sales minus issuer rebuys) as “order flow”, although in the case of limit orders, orders need not coincide with actual trades.

covered by Wilkens, Erner, and Röder (2003) and subsequent papers that support the life cycle hypothesis. Third, discount certificates can easily be duplicated by components for which very similar hedge instruments are liquidly traded. Therefore, we can keep model error to a minimum.

Our investigation of trade data reveals clear patterns in order flow: First, investors prefer to buy discount certificates that will mature in a little over 1 year. The tax regime in our sample period, where capital-gains on discount certificates held for more than 1 year are tax-free, explains this behavior. Second, investors often sell certificates back to the issuers within the last few months before maturity. In the later stages of a product's lifetime, the risk-return profile can become less interesting, which leads to increasing sell-back rates. Our analysis shows that the majority of issuers anticipate these patterns when setting prices. The additional margin ranges between 3 and 21 base points, amounting to 10–20 percent of the overall margin.

This paper contributes to the literature in several ways. While existing studies solely focus on the pricing policy of issuers, we also consider the trading behavior of investors. Our paper is the first to determine the order flow and aggregate trade direction, revealing well-defined structures in investor preferences for timing their trades. We then link this investor trading behavior to issuer pricing behavior, confirming the order flow hypothesis, which, while a well-grounded assumption, has never been proved so far.

The outline of the paper is as follows. Section 2 provides an overview of the existing literature on the pricing of structured retail products. Section 3 presents a basic theoretical framework. We refine the widely discussed life cycle hypothesis and formulate three hypotheses on the connection between order flow, product age ("life cycle"), and margin in Subsection 3.1. The data sample used to analyze these hypotheses is introduced afterwards in Subsection 3.2. Section 4 briefly reviews the fundamentals of valuing discount certificates and describes our method to calculate margins. Section 5 presents the empirical findings: First, the average size of margins within our sample is discussed (5.1). Then, we analyze the dependency of order flow on product age

(5.2). In Subsection 5.3, we investigate the order flow and life cycle hypotheses. In parallel, we investigate whether the pricing can also be attributed to the degree of competition for a certificate. Subsection 5.4 takes a closer look at the order flow hypothesis and furthermore functions as a robustness analysis. Section 6 concludes the paper.

2 Literature Overview

The price-setting behavior of issuers of discount certificates and similar structured retail products has been the subject of several empirical studies in recent years.[4] Prior to the establishment of structured retail products as an asset class in Europe, singular products were issued on the U.S. market. These early certificates were capital-guaranteed and promised an additional payoff linked to a market index—basically, a combination of a bond plus an index option (see Baubonis, Gastineau, and Purcell, 1993). Chen and Kensinger (1990) present a first empirical study of these market index certificates of deposit. At two valuation dates, they compare the implied volatilities of several certificates offered by two different banks. The results show large differences to a reference market volatility, as well as between the two issuers, indicating that investors are willing to pay margins for structured products. Chen and Sears (1990) observe a single product, the S&P index note, over a period of 16 months. Splitting the observations into three subperiods, they already find decreasing margins over time, turning from positive values in the first subperiod to negative values in the last subperiod. Although their results are disturbed by the 1987 market crash, this is an early indication for the life cycle hypothesis. Similar results are found by Wasserfallen and Schenk (1996) for capital-guaranteed products linked to the Swiss

[4] Francis, Toy, and Whittaker (2000) provide an overview of equity-based structured products. As noted in the introduction, the term "structured products" is usually applied in a broader context, including asset-backed securities and similar instruments. See, e.g., Fabozzi and Choudhry (2004), Fabozzi, Davis, and Choudhry (2006), or Servigny and Jobst (2007) for an overview of this asset class.

Market Index: At issuance, prices are above theoretical values, while in later periods margins are negative.

While these early papers focus on a small number of products, Burth, Kraus, and Wohlwend (2001) present a comprehensive study of a whole market subsegment, the discount certificates and reverse convertibles[5] in Switzerland. Furthermore, they enhance the valuation method by considering the implied volatility surface instead of simply using historical or implied at-the-money volatilities. They find a significant overpricing of discount certificates and reverse convertibles, but do not relate this overpricing to the life cycle.

Wilkens, Erner, and Röder (2003) are the first to systematically investigate the structure of margins over the life cycle of a product. They analyze the quotes of all reverse convertibles and discount certificates on the German DAX and NEMAX as underlyings over a one month period. Based on the observation that margins in the secondary market tend to be lower when the product matures, they formulate their order flow hypothesis. Assuming a close relationship between the order flow and the relative age of a product, they argue that decreasing margins are evidence of issuer anticipation of order flow. In their empirical study, by means of regression analysis they find decreasing margins with the relative age of discount certificates and reverse convertibles.

However, as the connection between order flow and product age was only based on assumptions, subsequent papers focusing on the connection between margins and product age do not interpret their results as evidence of an anticipation of order flow. Stoimenov and Wilkens (2005) analyze the pricing of various types of structured products, including products with embedded exotic options. They study the cross-section of all certificates in their sample on a single date and find a significant decrease in margin with respect to the product relative age ("life cycle hypothesis").

[5] Basically, reverse convertibles can be seen as discount certificates with an additional unconditional coupon payment.

Grünbichler and Wohlwend (2005) apply a different methodology for their study of non-capital-guaranteed products in Switzerland, separated into discount certificates, reverse convertibles, and "exotic" products. Similar to Chen and Sears (1990), they distinguish three time phases: products within the first 4 months of their life, within the last 4 months, and in between. Based on implied volatilities, they find a significant decrease in the overpricing over the three phases for all product types. Baule, Entrop, and Wilkens (2008) revisit discount certificates on the German market with an improved valuation model, adequately considering the products' credit risk. They find decreasing margins with respect to the product's relative age and thus support the life cycle hypothesis. Finally, Szymanowska, ter Horst, and Veld (2009) analyze reverse convertibles on the Dutch market. Without presenting a formal analysis, they conclude from a graph that an initial overpricing at issuance is persistent for about half a year, before margins tend to decrease.

Thus there is widespread evidence for the hypothesis of decreasing margins over the lifetime of investment certificates.[6] However, none of the papers mentioned could establish a direct link between issuer margins and order flow. The present paper is the first to analyze the order flow of investment certificates, using a sample of exchange-based trades. By means of this data set we separately study the relations between (i) order flow and product age, (ii) margin and product age, and (iii) margin and order flow. While Relation (ii) is already addressed by the papers mentioned above, research on the other relations is new. In particular, we address the idea that issuers utilize their market experience of order flow to influence their price-setting in order to

[6]Things are a little bit different for speculative "knock-out" certificates. Wilkens and Stoimenov (2007) argue that due to the stochastic lifetime of these products (which cease to exist when the underlying touches a (lower or upper) barrier), patterns of decreasing margins cannot be expected. Indeed, Muck (2006) does not find evidence for the life cycle hypothesis in his sample of knock-out certificates on the German market. Entrop, Scholz, and Wilkens (2009) demonstrate theoretically, based on issuer pricing formulas, how issuers earn margins over the life of these products.

make additional profits—the order flow hypothesis: In periods of positive net sales they quote higher margins than in periods of negative net sales.

3 Framework and Data

3.1 Hypotheses

As a starting point for our analysis, we form a basic theoretical framework of investor trading behavior. Consider an investor who wants to invest in discount certificates. A discount certificate is characterized by its maturity, T, and its cap level, X, relative to the current underlying level, S—represented by the moneyness $m = (S - X)/X$.[7] The investor has a certain preference in terms of maturity and moneyness. Furthermore, the investor has an aversion to trading costs u. Additionally, preferences might depend on market conditions, determined by the risk-free rate, r, and volatility, σ. Any other preferences, for instance regarding the offering bank, are summarized in an abstract variable Θ. For an initial buy decision, with given market conditions r^0, σ^0, the investor chooses a certificate with features T^0, m^0, u^0, Θ^0 which maximizes the preference function $\Phi(T, m, u, r, \sigma, \Theta)$.

After an initial buy, the characteristics of the certificate change due to movements in the underlying level. The investor can react to these changes by selling the original certificate back and buying a new one which better meets the preference function. However, transaction costs occur with such a replacement. The investor will therefore only replace the original certificate when the increase in the preference function adequately compensates for the transaction costs, i.e., when

$$\Phi(T^0, m^0, 0, r^t, \sigma^t, \Theta^0) < \max_i \Phi(T^i, m^i, u^i, r^t, \sigma^t, \Theta^i), \tag{1}$$

[7] Similar to options, the characteristics of a product are not driven by its absolute strike price (or, cap), but by its moneyness, i.e., the extent to that a product is “in the money” or “out of the money”.

where the index i runs over all available discount certificates, and r^t, σ^t reflect the new market conditions.

Within this framework, we analyze the trading activity of investors. Wilkens, Erner, and Röder (2003) argue that in early stages of a certificate's life cycle investors tend to buy the product, while in later stages they tend to sell back the product. According to their argumentation, the order flow decreases with the product age. This statement can be split into two parts:

H1a. Investor buy orders (issuer sales) decrease with the product age.

H1b. Investor sell orders (issuer rebuys) increase with the product age.

For the first part (H1a.), there is no justification in our basic framework. For instance, if a certificate is issued with 5 years to maturity, but most investors prefer a maturity of 2 years, then we can expect no monotonic decrease in the investors' demand for the certificate over it's life cycle. So we expect H1a. *not* to hold.

Concerning the second part (H1b.), we can argue that the probability that an investor sells back a product increases over its life cycle. Under stochastic movement of the underlying security, the moneyness of the certificate will more likely come to deviate from the investor's preference, so that the reduction in preference value will more likely exceed transaction costs. Hence we expect H1b. to hold.

The issuer has information about the trading behavior of investors (due to market experience) and can react by setting prices to maximize profits. Consider the price-setting at the beginning and the end of a certificate's life: Initially, issuers must sell their products with a positive margin to cover operational costs and to make a profit. Hence, at issuance, margins must be positive on average. Close to maturity, the redemption amount and thus the product value is almost transparent to the investor: If the underling level is below the cap, the value will be close to this underlying level, and if it is above the cap, the value will be close to the cap level. Hence, near maturity, there is no space for a margin, so the margin must be almost zero. Overall, the margin should decrease over the product's life cycle. This is subject of the life cycle hypothesis:

H2. The margin decreases with the product age.

The above-mentioned studies verify this hypothesis. However it is *not* related to the order flow. The actual order flow hypothesis postulates an anticipation of investors' trading direction by issuers. If issuers know about patterns in the order flow from their market experience, they can increase their profits by relating the quoted prices (and thus margins) to the order flow:

H3. The margin increases with the order flow.

As market makers, issuers dominate the market of their respective products and are able to quote prices with a margin on top of the theoretical values. Nonetheless, issuers face competition from each other. Therefore, margins cannot be arbitrarily large, because investors have the choice of buying from a different issuer with a lower margin. Accordingly, products with unique features in terms of cap and maturity could trade at higher margins than certificates which are offered by a larger number of issuers. We therefore also test the hypothesis

H4. The margin decreases with the degree of competition.

3.2 Certificates Data

We analyze these hypotheses using a data set of trades at the EUWAX in Stuttgart and at Frankfurt Smart Trading.[8] Together, these two exchanges account for 99.9% of the exchange-based trading volume of certificates in Germany.[9] According to the German Derivatives Association,

[8] Data were provided by the financial service company Deriva GmbH Financial IT & Consulting, a company specialized in providing and processing data of structured financial products.

[9] Besides exchange trading, most issuers also offer an over-the-counter trading based on their own internet platforms. These trades are not part of our data sample.

EUWAX reached a market share of 71.7% in 2007, while the market share of Frankfurt was 28.2%. The data sample consists of all discount certificates on the DAX issued by 22 European banks. The time frame covers the period from November 2006 through December 2007. Within this time frame, we analyze all trades at the EUWAX and at Frankfurt Smart Trading. We omit trades from those issuers with less than 50 certificates outstanding, which leaves a number of 4451 certificates from 11 issuers.

For our analysis it is of crucial importance to know whether a single trade is a sale or a rebuy by the issuer. For such a classification, we apply the quote rule[10], i.e., we match the trade data with the corresponding bid-ask quotes: For each trade of a certificate, we assign the bid-ask quote at the same date and time (to a second). If no exact match exists, we assign the last quote prior to the trade time. For cases where no such quotes exist for the same day, we omit the trade. If the trade price equals the assigned bid quote, we classify the trade as a rebuy; if it equals the assigned ask quote, we classify it as a sale. Due to gaps in the quotes data, there are trades where the price neither equals the bid nor the ask quote. Therefore, we extend the sale classification to cases where the trade price is higher than the assigned ask quote, and the rebuy classification to cases where the trade price is lower than the bid quote. If the trade price is between the assigned bid and ask quote, or all three values are identical, we do not classify and omit the trade.[11] The validity of this procedure is sound; based on a control sample of 5 days, with the correct classification provided by an issuer, the error rate is below 3%.[12]

Table 1 provides a data overview. Only 3.5% of the trades had to be dropped because they are

[10]See Chakrabarty et al. (2007) for an overview of trade classification rules.

[11]We refrain from classifying trades within the spread, as these classifications suffer from a high error potential (see Ellis, Michaely, and O'Hara (2000) on stock trades). For our purposes, data quality is more significant than completeness.

[12]129 trades are correctly classified as sales, 30 as rebuys. 2 trades are classified as sales although they are actually rebuys, 2 are classified as a rebuy although they are actually sales. 10 trades are omitted.

unclassifiable. However, there are large differences among the issuers. For example, we had to omit nearly half of DZ Bank's trades.

The largest players in this market segment are Commerzbank, Deutsche Bank and UBS with a total turnover above 500 million Euros, followed by BNP Paribas, Dresdner Bank and Citibank with a turnover above 200 million Euros. Overall, the number of issuer sell trades exceeds the number of issuer (re)buy trades by a factor 4–5. This indicates that the majority of certificates are not sold back, but are held by the investor until maturity. However, one should be cautious when interpreting these figures for two reasons: First, issuer rebuy trades could also be executed over the counter via the issuers' trading platforms. Second, as the ratio of sell to buy *volumes* is considerably smaller, investors tend to buy certificates over time with several trades and sell them with a single trade.

[INSERT TABLE 1 ABOUT HERE]

4 Valuing Discount Certificates

4.1 Valuation Formula

To analyze the quoted margins, we need to calculate the theoretical value of a discount certificate as a benchmark. In essence, a discount certificate promises the investor a payoff at maturity T, which equals the price of the underlying security if it does not exceed a fixed cap X, or the cap otherwise. In practice, this amount is often multiplied by a cover ratio α, so that one certificate refers to a fraction or a multiple of the underlying. Furthermore, the repayment is usually determined a few days prior to maturity at the so-called reference date τ. Hence, the promised payoff at maturity is given by

$$DC_T = \alpha \min\{S_\tau; X\}, \tag{2}$$

where S_t denotes the underlying price at time t.[13]

The promised payoff of a discount certificate can be duplicated by a long position in the underlying security, adjusted for intertemporal dividend payments, and a short position in a European call option. For the valuation of this payoff, we use the synchronous market prices of the underlying and the option, whenever there exists a traded option with exactly identical strike price and time to maturity. However, in practice the characteristics of the embedded option may slightly differ from those traded in the market. In these cases, the embedded option value must be interpolated between observed prices of traded options with similar characteristics.

For the purpose of this interpolation, we use the classical framework of Black and Scholes (1973), calculating implied volatilities of traded options, interpolating between these implied volatilities, and calculating the value of the embedded option with the interpolated implied volatility. Hence, the application of the Black-Scholes model is nothing more than a method of interpolating observed market prices. It is not assumed that the restrictive assumptions of the Black-Scholes model hold. The interpolation of implied volatilities instead of the market prices themselves just leads to a higher smoothness. Model error is kept to a minimum, as we use market prices for instruments which are very similar to those in the replicating portfolio.[14]

In particular, we calculate implied volatilities of options with strike and maturity close to the respective parameters of the discount certificate and apply a two-dimensional interpolation.[15] Let T^- and T^+ denote the maturity dates of the option series closest before and after (or equal) the reference date τ. Then we select four options with parameters $(T^-, X^-_{T^-})$, $(T^-, X^+_{T^-})$, $(T^+, X^-_{T^+})$, $(T^+, X^+_{T^+})$, so that the strike prices are those with the smallest distance which fulfill

[13] This payoff assumes cash settlement, which is common for indices as underlyings. For stocks, also physical settlement is usual.

[14] Similar approaches are applied e.g. by Wilkens and Stoimenov (2007) or Baule, Entrop, and Wilkens (2008).

[15] Basically, the approach is similar to that described in ter Horst and Veld (2008).

$X^-_{T^-} \leq X < X^+_{T^-}$ and $X^-_{T^+} \leq X < X^+_{T^+}$, respectively. If $\sigma(\cdot,\cdot)$ denotes the implied volatilities depending on maturity and strike, we first interpolate in strike dimension for both maturities:

$$\sigma(T^-, X) = \frac{(X^+_{T^-} - X)\sigma(T^-, X^-_{T^-}) + (X - X^-_{T^-})\sigma(T^-, X^+_{T^-})}{X^+_{T^-} - X^-_{T^-}}, \tag{3}$$

$$\sigma(T^+, X) = \frac{(X^+_{T^+} - X)\sigma(T^+, X^-_{T^+}) + (X - X^-_{T^+})\sigma(T^+, X^+_{T^+})}{X^+_{T^+} - X^-_{T^+}}. \tag{4}$$

Then, we interpolate in time dimension:

$$\sigma(\tau, X) = \frac{(T^+ - \tau)\sigma(T^-, X) + (\tau - T^-)\sigma(T^+, X)}{T^+ - T^-}. \tag{5}$$

Because discount certificates are unsecured securities, we must take into account the default risk of the issuer. Therefore, we apply the approach of Hull and White (1995).[16] According to their model, the value of a defaultable contingent claim equals the value of an equivalent non-defaultable claim, discounted with the issuer's credit spread s.

In our analysis, we concentrate on certificates on the German market index DAX. Because the DAX is a performance index, no dividend payments have to be considered. If c_t denotes the value of a European call option on the underlying, with maturity τ and strike price X, at time t, the Black-Scholes formula, adjusted for credit risk and the delay of payment between the reference and maturity date, reads

$$\begin{aligned} DC_t &= \alpha e^{-s(T-t)-r(T-\tau)}(S_t - c_t) \\ &= \alpha e^{-s(T-t)-r(T-\tau)}\Big(S_t N(-d_1) + X e^{-r(\tau-t)} N(d_1 - \sigma\sqrt{\tau - t})\Big) \end{aligned} \tag{6}$$

with

$$d_1 = \frac{\ln(S_t/X) + (r + \sigma^2/2)(\tau - t)}{\sigma\sqrt{\tau - t}}. \tag{7}$$

Hereby, r denotes the risk-free rate.

[16]See Baule, Entrop, and Wilkens (2008) for a discussion of alternative approaches to incorporate credit risk.

4.2 Margins

The market-based fair values DC_t are compared to the observed certificate prices, which equal either the bid or the ask quote. Usually, both the bid and the ask quote are above fair value. This is remarkable for two reasons: First, why is the issuer able to achieve a positive margin at all? Second, why does the issuer quote a bid price above fair value, resulting in potential losses? Both questions can be explained by the characteristics of the market for investment certificates. Certificates are engineered by the issuer and can be sold to the investor with a margin on top of the theoretical value, because the investor is not able to directly buy the consisting elements—underlying, options, etc.—due to market restrictions and higher transaction costs. The margin is a compensation for the issuer's service of constructing the certificate. An arbitrage by short-selling the product and buying the duplicating portfolio is not possible, because each product is engineered and initially sold by the issuer. Hence, there are no lenders and thus no repo markets for investment certificates.

For the same reason, issuers do not necessarily face a loss when they rebuy a certificate above its theoretical value. An issuer who buys a certificate has previously sold this certificate to an investor. If the margin decreases over the certificate's life—in line with the life cycle hypothesis—the issuer realizes a positive net profit as the difference between the margins at sale and at rebuy (plus the bid-ask spread).[17]

However, for the sake of our analysis, in determining the trade price we need to correct for effects of the bid-ask spread. If we applied the trade price directly for comparison, we would face a natural bias, as for ask trades (i.e., issuer sales) the average difference between fair value and trade price would naturally be larger than for bid trades (i.e., issuer rebuys). As a result,

[17]The fact that both bid and ask quotes are above the theoretical value is well documented in the literature, see e.g. Wilkens and Stoimenov (2007). Entrop et al. (2009) explain in detail, based on issuer pricing formulas, how issuers earn the margin over the investor's holding period in the case of leverage certificates.

we would observe larger margins for issuer sales than for issuer rebuys, which can however not be attributed to the order flow hypothesis.

The question for our investigation is, do issuers anticipate order flow in their quotes, i.e., do they quote higher ask prices when they expect ask trades to occur, and/or quote lower bid prices when they expect bid trades to occur. Essentially, there are two ways to apply such a policy: First, issuers could move only one side of the quote, which would mean increasing the bid-ask spread. Second, they could move both the bid and the ask quote in the intended direction, i.e., leave the spread constant.

There is no evidence for the first variant of increasing bid-ask spreads. The spreads are virtually non-varying for a single certificate over the course of time.[18] This is not surprising, as the size of the spread is directly visible to the retail customer, serving as a signal for quality. Hence, only the second variant is feasible. We can therefore base our analysis on the mid quote, which is a non-observable, but simply calculated figure: In the case of an issuer's sale, the mid quote is defined as the trade price minus half the size of the bid-ask spread, and in the case of a rebuy, as the trade price plus half the spread size.

Based on this mid quote DC_t^{obs}, we define the margin as the price difference relative to fair value:[19]

$$MARGIN_t = \frac{DC_t^{obs} - DC_t}{DC_t}. \tag{8}$$

These margins do not suffer from a bid-ask bias.

[18]One exception to this rule is Sal. Oppenheim. This issuer sometimes widely increases the spread. These trades are excluded from the sample (see Section 5.1).

[19]It should be mentioned that this figure is not an actual profit margin. The "margin" measures the relative difference between the fair value and the average of bid and ask quote. As such, it reflects the pricing policy of the issuer, which is the object of our investigation.

4.3 Market Data

For the calculation of margins, we need data on the replicating instruments, i.e., the underlyings and options. We take DAX tick data from the electronic trading system Xetra. We then match them to the trades by the exact time stamp (to a second) when the trade was recorded.

To estimate stock price volatility, we apply daily settlement prices of call and put options on DAX stocks traded on the EUREX. In general, implied call and put volatilities will not be identical because of market imperfections and a possible mismatching in the assignment of the underlying level. In the literature, often the simple average between call and put volatility is applied. However, the implied volatility of an in-the-money option is more sensitive to changes in the underlying level than its out-of-the-money counterpart, causing the out-of-the-money volatility to be more reliable. In extreme cases, the out-of-the-money implied volatility might be reasonable, while the corresponding in-the-money volatility does not even exist.

An alternative weighting approach between call and put volatility, which takes this asymmetry into account, makes use of put-call parity.[20] Given a call price c_t and a put price p_t for options with identical same maturity T and strike Y, put-call parity gives an "implied" level of the underlying which matches both the call and the put price:

$$S_t = c_t - p_t + Ye^{-r(T-t)}. \tag{9}$$

Calculating implied volatilities with this underlying level leads to identical values for calls and puts, which are between the implied call and put volatility calculated with an otherwise assigned underlying level, putting more weight on the out-of-the-money option. This procedure has the additional advantage of not requiring synchronization between the options market and the underlying spot market.

We determine the implied underlying levels separately for the four options with $T \in \{T^+; T^-\}$

[20] Utilizing put-call parity was suggested by Hentschel (2003).

and $Y \in \{X^{-}_{T-}; X^{+}_{T-}; X^{-}_{T+}; X^{+}_{T+}\}$, and use them to calculate the implied volatility surface as described above.

For the default-free spot rate structure, we apply the governmental spot rate curve, estimated by Deutsche Bundesbank, using the Svensson (1994) function as an extension of Nelson and Siegel (1987). Finally, we obtain credit spreads from the iBoxx index for corporate financials with a maturity of 1–3 years. This industry-average credit spread is equally applied for all issuers. Furthermore, the credit spread is assumed to be independent of maturity. As differences among issuers are small in the sample period and the credit spread curve increases only slightly with time to maturity, both simplifications seem to be reasonable.[21]

5 Empirical Results

5.1 Average Margins

Before we investigate the main hypotheses, we take a look at the average margins in our sample. Table 2 provides an overview of the margins averaged over all trades, grouped by issuer. In sum, margins are small with an overall average of only 0.42%. In a study based on a data sample from 2004, Baule, Entrop and Wilkens (2008) report average margins for discount certificates of 0.7% to 2.3% for five different issuers. However, they study discount certificates on single stocks instead of the index. There are three non-exclusive explanations for the lower margins we observe: First, DAX discount certificates are more cost-effective to hedge, because DAX options and futures are more liquid than derivatives on single stocks, and there is no dividend risk for the DAX. Second, because of the increased market volume of discount certificates and the standardization of issuance procedures, relative production costs have decreased, which enables

[21] Such an approach is common in the literature dealing with the pricing of structured retail products, see Stoimenov/Wilkens (2005) or Wilkens/Stoimenov (2007) for instance.

issuers to price more aggressively. And third, as the market has become more developed and competitive, issuers are forced to quote fairer prices.

[INSERT TABLE 2 ABOUT HERE]

An exception to the low margins is DZ Bank, which prices average margins of more than 1%. The reason for this could be due to the character of DZ Bank, which is the central institute for more than 1,000 local cooperative banks in Germany. DZ Bank structures certificates for sale by the local banks to their customers, who are often also shareholders. Due to the loyalty of this customer group, DZ Bank is able to achieve higher margins.

For comparison reasons, Table 2 also displays the annualized average margins. As the average time to maturity of a trade is close to 1 year for all issuers, the annualized values are close to the unadjusted average margins.

Table 2 furthermore shows average bid-ask spreads (at the time of the trades). Here, the issuers fall into two groups: One group quotes bid-ask spreads of 0.02%–0.03%, equivalent to 1 DAX point, and one group quotes spreads of 0.07%–0.10%, equivalent to 2–5 points. An exception is Sal. Oppenheim, who quotes spreads of 1 DAX point in most cases, but quotes spreads of 50 points in other cases, resulting in an average relative spread of 0.21%.

To analyze the differences in average margins between the issuers, we investigate whether the market power of an issuer has an impact on the margin. Larger issuers could exploit economies of scale by distributing fixed costs over a larger range of products and thus quote lower margins. A regression of the average annualized margin per issuer with respect to its market volume, measured by total turnover of DAX discount certificates within the investigation period, shows a negative relationship between average margin and market power, which is however not significant. So although the intuition of using economies of scale seems to be plausible, there is no statistically rigorous proof.

5.2 Connection between Order Flow and Product Age

In this section we look at hypothesis H1., i.e., order flow with respect to the age of the certificates. In the following, we use the index i to refer to the i-th certificate. In line with Wilkens, Erner, and Röder (2003), we first consider the relative age,

$$AGE_{i,t} = \frac{t - t_i^*}{T_i - t_i^*}, \tag{10}$$

where t_i^* denotes the issue date.

Figure 1 displays the average issuer sale and rebuy amount for a single certificate, depending on its relative age. To build this graph, transactions were grouped by the percentile of the product's lifetime. While rebuys clearly increase with the relative age, average sales decrease only after an increase for the first quarter of the products' lifetime. In the last quarter, rebuys tend to dominate sales.

[INSERT FIGURE 1 ABOUT HERE]

The focus on relative lifetime has dominated the literature to date. However, to reveal the true nature of investor behavior we must look at absolute lifetime,

$$LIFE_{i,t} = T_i - t. \tag{11}$$

Figure 2 groups average sales and rebuys by the absolute remaining time to maturity (restricted to 2 years, in groups of 5 days). While we can observe a similar increasing behavior for rebuys, the picture for sales is completely different. Sales peak at about 1 year prior to maturity. Then sales fall dramatically, remaining at a low level until maturity.

[INSERT FIGURE 2 ABOUT HERE]

The reason for this pattern is the German tax law.[22] Gains from certificates are subject to

[22] The described tax regime was valid during the investigation period. As of 2009, all capital gains are subject to a flat compensation tax of 25%, independent of the holding period.

income tax if the time period between purchase and sale or redemption is shorter than 1 year, whereas for longer periods they are tax-free. The investor tendency to hold these certificates just a little beyond this so-called speculative period explains the sale increase peaking just after 1 year before maturity.

The graphs suggest that Hypothesis H1a. must be rejected, while they support Hypothesis H1b. To carry out a more formal analysis, we regress the daily issuer sale and rebuy volumes per certificate, $SALES_{i,t}$ and $REBUYS_{i,t}$, on time to maturity, controlling for potentially influencing factors.

In our basic framework, the moneyness $MONEY_{i,t}$ influences the investor's decision to sell back a certificate. As positive and negative deviations from the preferred moneyness can both trigger an investor's sale (i.e., an issuer rebuy), we also consider moneyness squared as a factor, which should have a positive impact on the issuer rebuy volume.

Furthermore, general market conditions can have an impact on investors' trading behavior. In particular, those market factor which influence the certificates' prices could also influence the trading volume. These are the risk-free interest rate and the market volatility. We therefore control for the one-year German treasury rate $RATE_t$, and the DAX volatility index VOL_t.[23]

As discussed above, the trade classification rule is not perfect, i.e., there are issuer sales which are misclassified as a rebuy and vice versa (with an error rate of 2%–3%). As a result, an observed increase in the rebuy volume could partially be driven by misclassified actual sales. Additionally, a reciprocal influence could arise from day traders for instance, who buy and sell the same certificate intraday. For these reasons, we include the rebuy volume as an explanatory factor in the sale volume regression and vice versa.

Finally, we consider a fixed effect for each certificate to cover all certificate-specific influences.

[23]This index, the VDAX-NEW, measures a 45-day implied volatility for at-the-money options.

We run the regressions

$$\begin{aligned} SALES_{i,t} &= \alpha_i + \gamma_1 LIFE_{i,t} + \gamma_2 MONEY_{i,t} + \gamma_3 MONEY_{i,t}^2 \\ &\quad + \gamma_4 RATE_t + \gamma_5 VOL_t + \gamma_6 REBUYS_{i,t} + \epsilon_{i,t} \end{aligned} \tag{12}$$

and

$$\begin{aligned} REBUYS_{i,t} &= \alpha_i + \gamma_1 LIFE_{i,t} + \gamma_2 MONEY_{i,t} + \gamma_3 MONEY_{i,t}^2 \\ &\quad + \gamma_4 RATE_t + \gamma_5 VOL_t + \gamma_6 SALES_{i,t} + \epsilon_{i,t}. \end{aligned} \tag{13}$$

Table 3 reports the results.[24] Regarding issuer sales (i.e., investor buys), there is no influence of time to maturity, so again no evidence for H1a. Besides a cross-influence of the issuer rebuys volume, we observe a significant negative impact of market volatility. Investors tend to buy fewer discount certificates when market volatility increases.

Regarding issuer rebuys (i.e., investor sales), time to maturity has a significant (0.1% level) negative impact. The rebuy volume increases when maturity approaches. Hence, the regression analysis supports H1b.

Furthermore, we observe a significant (1% level) positive impact of moneyness squared. According to the basic framework, investors tend to sell a certificate back when its characteristics move away from the preferred value, i.e., when the moneyness becomes too high or too low. A positive coefficient of moneyness squared is in line with this theory.

Consistent with the issuer sales regression, we also find a cross-influence between the issuer sales volume and a positive impact of market volatility. When volatility increases, investors tend to sell more discount certificates back. The positive impact of sales on rebuys (and vice versa) reflects potential misclassifications. When sales are high, and a few sales are erroneously classified as a rebuy, the measured rebuy volume tends to increase. Furthermore, the cross-effect can be driven by day trading, i.e., a buy and sale of the same certificate at the same day.

[24]For these regressions, outliers beyond the 99.95% quantile of the sale and rebuy volumes have been removed.

Summing up the findings, it is not the relative age but the absolute remaining time to maturity which primarily drives investors' trading behavior. With regard to H1a., there is no monotonic relationship between investor buy orders (i.e., issuer sales) and product age. Instead, buy orders peak about 1 year prior to maturity. Investor sell orders (i.e., issuer rebuys) on the other hand increase with decreasing time to maturity, in line with Hypothesis H1b.

5.3 Explanation of Margins

5.3.1 Regression Design

Finding non-monotonic relations between order flow and product age casts some doubt on the interpretation of decreasing margins as evidence for the order flow hypothesis. Our data allows us to test the order flow hypothesis H3. directly. The life cycle hypothesis H2. is analyzed in the same regression as a by-product. Furthermore, we test in parallel the competition hypothesis H4. The regression design is based on an explanation of the observed margins with the variables *product age*, *order flow*, and *competition*, which are operationalized as follows.

Given the results of the preceding subsection, the remaining time to maturity is a more relevant variable than the relative age. We therefore measure *product age* by means of the absolute remaining lifetime to maturity, $LIFE_{i,t}$.

To operationalize *order flow*, we follow two different approaches. For the first approach, we use the signed logarithm of the trading volume, i.e., +log(volume) for issuer sales and −log(volume) for issuer rebuys, with volume measured in thousands Euro. This variable is denoted $FLOW_{i,t}$. We take the logarithm because otherwise the regression would be dominated from few large trades.

For the second approach, we introduce the binary variable

$$SALE_{i,t} = \begin{cases} 1 & \text{if the trade of certificate } i \text{ at time } t \text{ is an issuer sale,} \\ 0 & \text{if the trade of certificate } i \text{ at time } t \text{ is an issuer rebuy.} \end{cases} \quad (14)$$

The variable *SALE* describes the result of the investors' supply or demand, which leads to the corresponding type of trade. If issuers anticipate order flow and quote higher prices at times when they expect a positive order flow, the variable *FLOW* and the variable *SALE* should have a positive impact on the observed margin.[25] The first approach has the advantage of measuring order flow more directly, while the second allows a better interpretation of the regression coefficient in terms of additional margins.

The reasoning for an influence of the order flow variables is illustrated in Figure 3. When sales dominate rebuys, the expected order flow is positive. That is, the *a priori* expected value of the variable *FLOW* is positive, and that of the variable *SALE* is closer to 1. At other times, the expected order flow is negative, i.e., *FLOW* is expected to be positive, and *SALE* is expected to be closer to 0. The life cycle hypothesis assumes a linear decrease in the margin with the product age. The order flow hypothesis that we test postulates an influence of order flow superimposed on the linear decrease.

[INSERT FIGURE 3 ABOUT HERE]

Concerning *competition*, we consider the range of similar products. A particular product offered for sale competes with certificates of other issuers with similar characteristics. We measure the degree of competition by the variable

$$COMP_{i,t} = 1 - \frac{1}{n_{i,t}}, \tag{15}$$

where $n_{i,t}$ is the number of "similar" certificates offered by other issuers at time t. Two certificates are considered similar, if the difference in their cap levels does not exceed a threshold K_C and the difference in their maturity dates does not exceed a threshold K_T. We use values of $K_C = 100$ index points and $K_T = 14$ days. By definition, *COMP* equals 0 if there is no

[25] As the margin calculation is based on mid quotes, there is no natural impact of the variables *SALE* and *FLOW*.

competition, i.e., the features of a certificate are unique, and *COMP* tends to 1 if the number of similar certificates increases.

In the regression, we control for some additional factors that may affect the margin. In some earlier papers, the moneyness was found to influence the margin. If the embedded option is at the money, the option price is most sensitive to volatility, which increases the issuer's leeway to incorporate a higher margin. For underlying prices above the cap level, this leeway shrinks, so the moneyness, defined above as

$$MONEY_{i,t} = \frac{S_t - X_i}{X_i}, \tag{16}$$

can have a negative impact on the margin.

Furthermore, we add the credit spread *CREDIT* as a control variable. As Baule, Entrop, and Wilkens (2008) point out, there are several ways to price the issuer's credit risk. If an issuer applies a different method than the Hull-White model used in this paper, differences in the calculated margins will occur, and these differences will increase with the credit spread.

Finally, we control for absolute calendar time $TIME_t = t - t^*$ since the starting date t^* of our data sample in order to check whether an issuer has changed its pricing policy within our investigation period.

So in summary we run the regressions

$$MARGIN_{i,t} = \alpha + \beta_2 LIFE_{i,t} + \beta_3 FLOW_{i,t} + \beta_4 COMP_{i,t} + \lambda_1 MONEY_{i,t} + \lambda_2 TIME_t + \lambda_3 CREDIT_{i,t} + \epsilon_{i,t} \tag{17}$$

and

$$MARGIN_{i,t} = \alpha + \beta_2 LIFE_{i,t} + \beta_3 SALE_{i,t} + \beta_4 COMP_{i,t} + \lambda_1 MONEY_{i,t} + \lambda_2 TIME_t + \lambda_3 CREDIT_{i,t} + \epsilon_{i,t}. \tag{18}$$

This regression allows us to formally test the order flow hypothesis

H3. $\beta_3 > 0$.

The life cycle hypothesis postulates a positive impact of *LIFE*. For the actual order flow hypothesis, a linear decrease modeled by this factor can be seen as a control variable, as the order flow hypothesis refers to margin changes superimposed on a linear decrease (see Figure 3). For the sake of completion, we also test the life cycle hypothesis

H2. $\beta_2 > 0$.

Finally, we test the competition hypothesis

H4. $\beta_4 < 0$.

Within our sample, trades may not be independent if they take place on the same day. Therefore, if several trades for one single certificate occur on the same date, we randomly select one trade. Additionally, we calculate robust standard deviations according to Newey and West (1987). We prefer the Newey-West estimator to the White (1980) estimator, as even after randomly selecting one trade per day and certificate, trades on successive dates could still be serially correlated. The Newey-West estimator not only adjusts for heteroskedasticity, but also for serial correlation.

5.3.2 Life Cycle, Order Flow, and Competition Hypotheses

Tables 4 and 5 show the results of the regressions. First, we can confirm the life cycle hypothesis H2. (variable *LIFE*) for all issuers. The decrease in the margin when maturity approaches (i.e., the positive relationship between margin and remaining time to maturity) is evident and significant at the 0.1% level for all issuers.

[INSERT TABLE 4 ABOUT HERE]

[INSERT TABLE 5 ABOUT HERE]

By the linear variable *LIFE*, we can conclude that margins decrease on average, yet the shape of the decrease is not specified. In particular, we are interested in whether the shape is related to order flow, which is subject of Hypothesis H3. Measured by both the variables *FLOW* and *SALE*, there is a significant positive influence of the expected order flow on the quoted margin for 6 out of 11 issuers. For HSBC Trinkaus, and UBS, the influence is significant at the 0.1% level in both regressions. For Commerzbank, Deutsche Bank, Dresdner Bank, and DZ Bank, it is significant at least at the 1% level. Thus, the issuers fall into two groups: these six mentioned, which indeed base their pricing on the anticipated investor behavior, as supposed by the order flow hypothesis, and the remaining five which do not.

While the size of this effect does not appear large initially, ranging from just 0.03% to 0.21%, measured by the coefficient of the variable *SALE*; we must relate these figures to the absolute size of the margins, which are themselves small, as discussed in Section 5.1. Furthermore, we must consider that the variable *SALE* measures the *expected* direction of order flow. So if issuers charge a surplus when they expect the next order to be a sale, there is of course a possibility that the next order will be a rebuy. If for instance the intended surplus is 10 basis points, and there is an error probability in the prediction of 20%, then the measured average surplus for sales would be 8 basis points. On the other hand, also for rebuys we would measure a surplus of 2 basis points, leading to a difference of only 6 basis points between sales and rebuys. Therefore, the regressed values indicate a lower threshold for the issuer's intended margin surplus.

The variables *LIFE* and *FLOW* (and *LIFE* and *SALE*) are positively correlated with a coefficient of +0.35 (+0.40) on average (see Table 6). We would anticipate this, given the fact that positive net sales usually occur earlier in the certificate's life cycle (more than 1 year prior to maturity), while negative net sales occur in the later stages. The correlations vary between +0.20 and +0.65 among the issuers. In any case, they are far from 1, confirming that order flow and life cycle are separate effects. To be sure of this, we have orthogonalized the variables *LIFE* and *SALE*, and rerun the regression (18). The results are virtually identical.

[INSERT TABLE 6 ABOUT HERE]

Concerning the competition hypothesis H4. for the majority (8 out of 11 issuers), the coefficient of the variable *COMP* is negative. For 5 issuers (ABN Amro, Deutsche Bank, DZ Bank, and HSBC Trinkaus, and UBS), the influence is significant at least at the 10% level. Although there are also 2 issuers with a weakly significant positive relationship between competition and margin, the majority of issuers recognize competition by trying to increase their market share by quoting comparably lower prices for certificates which compete with products from other issuers.

Table 6 also presents average correlations among the other regression variables. The values are calculated separately for each issuer and then aggregated by weighting them with the number of observations per issuer. Most correlations are small to moderate, persistently through the issuers.[26] An exception is the correlation between calendar time and credit spread, which reaches values about 0.8–0.9 in all cases. The reason for this is that during the investigation period, in particular during the second half of 2007, when the U.S. subprime crisis became evident, credit spreads increased market-wide. However, as both calendar time and credit spread are only control variables, our results are unaffected.

In sum, our regression results shed light on issuer pricing behavior with respect to life cycle and order flow. For all 11 issuers, there is a general decrease in margin over the life cycle of a product. For 6 issuers, we can confirm the order flow hypothesis H3, and for 5 issuers, we can confirm the competition hypothesis H4.

[26] In particular, also the correlation between calendar time and time to maturity is low with a value of −0.11. An additional regression without calendar time as a control variable showed very similar results and is not reported in detail.

5.4 A Closer Look at Order Flow

5.4.1 Separation of Tax and Maturity Effects

The preceding analysis is based on the variable *SALE*, which is defined on a micro level for each trade. We can assume that issuers cannot anticipate all fluctuations in order flow on a high-frequency basis, but instead use anomalies on a macro level.

In Figure 2, we can see that there are two major periods showing a clear pattern in the order flow: First, prior to 1 year before maturity, issuer sales dominate; we will henceforth term this pattern the "tax effect". Second, close to maturity, issuer rebuys dominate sales; we will term this pattern the "maturity effect". Do issuers anticipate both of these effects, or only one of them? To answer this question, we introduce the dummy variables

$$TAX_{i,t} = 1_{\{T_i - t > 1\}} \tag{19}$$

and

$$MAT_{i,t} = 1_{\{T_i - t < 0.3\}}, \tag{20}$$

which indicate whether the time to maturity, $T_i - t$, is above 1 year or below 0.3 years, respectively. These two dummies replace the variables *FLOW* and *SALE* in regression (17) and (18), respectively. We run the modified regression

$$\begin{aligned} MARGIN_{i,t} &= \alpha + \beta_2 LIFE_{i,t} + \beta_3^T TAX_{i,t} + \beta_3^M MAT_{i,t} + \beta_4 COMP_{i,t} \\ &\quad + \lambda_1 MONEY_{i,t} + \lambda_2 TIME_t + \lambda_3 CREDIT_{i,t} + \epsilon_{i,t}. \end{aligned} \tag{21}$$

If issuers price a surcharge prior to 1 year before maturity, superimposed on the linear function defined by the factor *LIFE*, we would expect a positive coefficient β_3^T for the factor TAX. And if they price a deduction within the last 0.3 years prior to maturity, we would expect a negative coefficient β_3^M for the factor MAT.

The results reported in Table 7 look impressive. For 10 out of 11 issuers, the *TAX* coefficient is positive, and for all issuers, the *MAT* coefficient is negative. For those 6 issuers for which we found evidence for the micro-level order flow hypothesis based on the variable *SALE* (Commerzbank, Deutsche Bank, Dresdner Bank, DZ Bank, HSBC, and UBS), both the tax effect and the maturity effect are significant at least at the 1% level. Furthermore, for BHF-Bank and Citibank, we find evidence for the maturity effect (also at least at the 1% level), although we could not confirm the micro-level order flow hypothesis for these issuers. This finding is easily explained with statistical arguments: First, the micro-level variable *SALE* is perturbed by the uncertainty of the next trade type as discussed in the previous section—issuers cannot forecast the direction of the next trade, but only anticipate the probability of it being a sale or a rebuy. Second, only a small minority of trades may take place within the last 0.3 years prior to maturity which are responsible for the maturity effect. So the anticipation of the maturity effect vanishes in the micro-level order flow regression because of these statistical arguments.

The size of the two effects is up to 0.62% (tax effect) and 0.43% (maturity effect), which is considerably larger than the aggregated order flow effect, as measured by the variable *SALE* in regression (18). These values shed additional light on the pricing intention of the issuers. As discussed, the regression coefficient of order flow, ranging from 0.03% to 0.21%, is a lower threshold of the intended margin surplus (or deduction), which the size of the tax and maturity effects reveals.

[INSERT TABLE 7 ABOUT HERE]

5.4.2 Life Cycle Measured by Relative Age

The results of regression (21) provide further evidence for the validity of the order flow hypothesis for most of the issuers. As a robustness check, in this section we measure the *age* of a certificate by its relative age,

$$AGE_{i,t} = \frac{t - t_i^*}{T_i - t_i^*}, \tag{22}$$

instead of the absolute remaining time to maturity, $LIFE_{i,t}$. We modify regression (21):

$$\begin{aligned} MARGIN_{i,t} &= \alpha + \beta_2 AGE_{i,t} + \beta_3^T TAX_{i,t} + \beta_3^M MAT_{i,t} + \beta_4 COMP_{i,t} \\ &\quad + \lambda_1 MONEY_{i,t} + \lambda_2 TIME_t + \lambda_3 CREDIT_{i,t} + \epsilon_{i,t}. \end{aligned} \tag{23}$$

The economic background of this regression is that some issuers might base their pricing on the relative age of their certificates, despite the absolute remaining time to maturity being more relevant according to the above analysis.

Table 8 shows the results. The output further supports the findings with regard to the tax and maturity effects for most of the issuers. Only for Dresdner Bank are we unable to confirm any of the effects, and for UBS, the maturity effect is no longer significant. An additional regression with the micro-level variable *SALE* (not reported in detail) also shows no significance. Thus these two issuers obviously base their pricing on the relative age of the certificate, with an additional anticipation of the tax effect in the case of UBS.

For Commerzbank, Deutsche Bank, DZ Bank, and HSBC Trinkaus, both effects are statistically significant with both approaches of measuring a certificate's *age* (by the variables *LIFE* and *AGE*). For BHF-Bank and Citibank, the maturity effect, and for UBS, the tax effect can be confirmed with both approaches.

[INSERT TABLE 8 ABOUT HERE]

5.4.3 Final Remarks

Table 9 provides an overview of our findings, concerning the anticipation of order flow at the micro level, and the separation into tax and maturity effect. Cases with statistical evidence in both regression (with regard to the age of the certificate, measured absolutely and relatively) are marked '+'. When there is no significance with at least one approach, the case is marked '−'. Four issuers, namely Commerzbank, Deutsche Bank, DZ Bank, and HSBC Trinkaus, doubtlessly anticipate both effects. BHF-Bank and Citibank clearly anticipate the maturity effect, and UBS anticipates the tax effect. For the remaining issuers an anticipation of order flow cannot be proven without doubt.

[INSERT TABLE 9 ABOUT HERE]

Knowing that issuers take advantage of investors' intention to buy certificates with little more than 1 year remaining time to maturity in order to save taxes, it is interesting to compare the investors' tax benefits with the issuers' additional profit. Obviously, investors are willing to pay a premium for certificates with a tax advantage. However, issuers cannot expect to extract the whole rent of the tax advantage due to competition among each other and to other investments.[27] To get an idea of the relation, we sum up the total tax advantage of all certificate buys within our sample period with a remaining time to maturity of more than 1 year. This value amounts to 13.3 million Euros.[28] In comparison, the additional margin for issuers due to the tax effect amounts to 0.9 million Euros.[29] Hence, issuers can extract only about 7% of the tax advantage.

[27]If the overpricing would become too obvious, investors could buy single stocks, mutual funds, etc. instead of certificates.

[28]This figure is based on the assumptions that all certificates are held until maturity, and that all investors are subject to German taxation. As some certificates might be sold back prematurely without tax advantage, or purchased by international investors, it is an upper bound for the actual value.

[29]This value refers to issuer sales 1 year or more before maturity. For all trades, the additional margin due to anticipating order flow amounts to 1.6 million Euros.

6 Conclusion

The existing literature has repeatedly shown that the margins of structured financial retail products are a decreasing function of the product's relative age. This behavior could be attributed to order flow, but due to a general lack of data, the connection between order flow and product age has never been proved. Based on a unique data set of exchange trades and issuer quotes for discount certificates on the German DAX, we have established this link; in addition, we have analyzed the influence of life cycle and order flow separately.

First, we investigated the order flow of discount certificates with respect to their age. While the relative age showed no definite picture, we found a clear pattern in the investors' certificate-buying behavior with respect to the remaining absolute time to maturity of the certificates. For tax reasons (according to the tax regime of the investigation period), investors strongly preferred certificates with more than 1 year time to maturity, because potential gains would be tax-free after the speculative holding period of 1 year. Accordingly, certificate sales increased dramatically close to 1 year prior to maturity. Issuer rebuys, on the other hand, slowly increased over the certificate's lifetime—either relative or absolute—reaching their maximum close to maturity, where rebuys dominated sales.

Based on these patterns, we tested the life cycle and order flow hypotheses separately. We regressed the observed margins against both the product age and order flow, measured by an indicator variable. As expected, we confirmed the life cycle hypothesis. Furthermore, we found evidence that about half of the issuers also anticipated the order flow and quoted higher prices when they expected sales to dominate and lower prices when they expected rebuys to dominate.

Additionally, we investigated the influence of competition on the margins, testing the hypothesis that certificates for which a larger number of substitutes from different issuers exist trade at a lower margin than unique products. We found this hypothesis to hold for 5 issuers.

Taking a closer look at order flow, we examined whether the anticipation of order flow is attributable to both the tax effect, i.e., the positive order flow more than 1 year prior to maturity, and the maturity effect, i.e., the negative order flow close to maturity. Controlling for the life cycle, measured by (i) the relative age and (ii) the absolute remaining time to maturity in separate regressions, we found evidence that both effects were anticipated—some issuers anticipated the tax effect, some the maturity effect, and some both.

The size of the order flow effect ranges between 3 and 23 base points among the issuers. While these values may appear small, given that the average size of the margin in our sample is a mere 0.42%, the order flow effect contributes considerably to issuers' profits. Considering the overall increasing market volume and decreasing relative margins, the effect becomes more pronounced. In total, the order flow effect accounts for 1.6 million Euros additional profit for the market subsegment of discount certificates on the DAX.

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	Cert.	Trades			Volume	
Issuer		Buy	Sell	?	Buy	Sell
ABN Amro	101	132	1045	8	8.0	38.3
BHF-Bank	99	86	434	18	5.1	18.3
BNP Paribas	481	604	5922	153	38.6	272.5
Citibank	219	866	1367	17	83.1	139.4
Commerzbank	1137	3283	18869	143	326.2	766.1
Deutsche Bank	997	4262	16631	162	279.8	644.0
Dresdner Bank	444	1500	4310	163	55.3	173.8
DZ Bank	114	408	1500	1541	14.6	35.6
HSBC Trinkaus	127	195	1020	28	12.2	47.6
Sal. Oppenheim	187	316	1439	9	24.1	53.9
UBS	545	1606	11574	588	147.9	518.8
Total	4451	13258	64111	2830	994.8	2708.3

Table 1. *Data overview. The first column lists the number of outstanding discount certificates on the DAX within the investigation period per issuer. The second to fourth columns list the number of exchange trades, where "buy" denotes an issuer's rebuy, "sell" an issuer's sale and "?" a trade which could not be classified. The last two columns list the total trading volume in million Euros over all trades, split by issuer buy and sell trades.*

Issuer	trades	margin	spread	time	annual
ABN Amro	1377	0.39%	0.10%	1.06	0.37%
		(0.20%)	(0.07%)	(0.33)	
BHF-Bank	520	0.47%	0.07%	1.26	0.37%
		(0.32%)	(0.06%)	(0.35)	
BNP Paribas	6526	0.44%	0.07%	1.21	0.36%
		(0.22%)	(0.04%)	(0.43)	
Citibank	2233	0.34%	0.02%	0.82	0.41%
		(0.26%)	(0.02%)	(0.47)	
Commerzbank	22152	0.35%	0.02%	1.23	0.28%
		(0.21%)	(0.02%)	(0.61)	
Deutsche Bank	20893	0.40%	0.02%	1.06	0.38%
		(0.34%)	(0.02%)	(0.57)	
Dresdner Bank	5810	0.64%	0.03%	1.04	0.62%
		(0.42%)	(0.04%)	(0.44)	
DZ Bank	1908	1.06%	0.03%	1.08	0.98%
		(0.56%)	(0.06%)	(0.32)	
HSBC Trinkaus	1215	0.50%	0.08%	1.17	0.43%
		(0.26%)	(0.08%)	(0.66)	
Sal. Oppenheim	1755	0.40%	0.21%	1.18	0.34%
		(0.31%)	(0.42%)	(0.45)	
UBS	13180	0.39%	0.07%	1.22	0.32%
		(0.30%)	(0.05%)	(0.57)	
Total	77369	0.42%	0.05%	1.14	0.37%
		(0.33%)	(0.08%)	(0.55)	

Table 2. *Average margins and spreads. The first column "trades" lists the total number of trades (buy and sell trades) per issuer. The second column "margin" lists the average margin defined in Equation (8), based on the mid quote of each trade, averaged over both buy and sell trades. The third column "spread" lists the average bid-ask spread at the times of the trades relative to the mid quote. The fourth column "time" lists the average time to maturity at the trade dates, measured in years. The last column "annual" lists the annualized average margin. To avoid the large noise when annualizing single margins close to maturity, we did not average over annualized margins, but annualized the average margin, so the column "annual" is simply the quotient "margin" divided by "time". For the margin, the bid-ask spread, and the time to maturity, standard deviations are reported in brackets.*

Sales				Rebuys			
Coefficient	Estimate	Stddev	t value	Coefficient	Estimate	Stddev	t value
LIFE	+573	671	0.85	*LIFE*	−1089	224	4.85***
MONEY	+2233	4158	0.54	*MONEY*	+2416	1514	1.60
$MONEY^2$	−7058	16325	0.43	$MONEY^2$	+24610	9253	2.66**
RATE	+487	708	0.69	*RATE*	−30	223	0.13
VOL	−106	26	4.12***	*VOL*	+20	10	1.98*
REBUYS	+0.103	0.013	7.85***	*SALES*	+0.023	0.003	7.60***
r^2	0.00262			r^2	0.00319		

Table 3. *Results of volumes regressions (12) and (13) for issuer sales and issuer rebuys. The lines refer to the coefficients absolute remaining time to maturity, moneyness, moneyness squared, risk-free interest rate, market volatility, and rebuys and sales volume, respectively. Coefficient estimates, standard deviations adjusted for heteroskedasticity according to White (1980), and t values are reported. Significance at the 10% level is denoted by *, at the 1% level by **, and at the 0.1% level by ***. The final line lists the regression adjusted* r^2*s.*

Issuer	n	const.	*LIFE*	*FLOW* $\cdot 10^{-3}$	*COMP*	*MONEY*	*TIME*	*CREDIT*	r^2
ABN Amro	815	+0.44%**	+0.33%***	−0.056	−0.42%**	−0.38%***	+0.14%***	+0.00	0.496
		(0.14%)	(0.03%)	(0.034)	(0.15%)	(0.05%)	(0.04%)	(0.05)	
BHF-Bank	425	−0.37%*	+0.25%***	−0.022	+0.14%	−0.01%	−0.05%	+1.06***	0.446
		(0.20%)	(0.05%)	(0.089)	(0.19%)	(0.03%)	(0.06%)	(0.11)	
BNP Paribas	3426	−0.19%***	+0.24%***	+0.001	+0.08%*	−0.05%***	+0.05%	+0.53***	0.699
		(0.04%)	(0.03%)	(0.023)	(0.04%)	(0.01%)	(0.03%)	(0.04)	
Citibank	1337	−0.25%*	+0.47%***	+0.023	−0.08%	+0.16%**	+0.30%***	+0.16*	0.723
		(0.12%)	(0.03%)	(0.020)	(0.12%)	(0.05%)	(0.04%)	(0.06)	
Commerzbank	13591	+0.01%	+0.13%***	+0.046**	−0.03%	−0.15%***	+0.08%***	+0.52***	0.569
		(0.02%)	(0.02%)	(0.016)	(0.03%)	(0.02%)	(0.02%)	(0.04)	
Deutsche Bank	13150	−0.05%*	+0.25%***	+0.065**	−0.08%**	−0.12%***	+0.09%**	+0.50***	0.324
		(0.03%)	(0.02%)	(0.022)	(0.03%)	(0.02%)	(0.03%)	(0.04)	
Dresdner Bank	3394	−0.15%	+0.42%***	+0.112**	+0.25%*	−0.19%**	−0.34%*	+0.77***	0.294
		(0.14%)	(0.04%)	(0.041)	(0.14%)	(0.06%)	(0.17%)	(0.16)	
DZ Bank	1204	+0.81%***	+0.87%***	+0.213**	−0.89%***	−0.70%***	+0.95%***	−1.05***	0.652
		(0.19%)	(0.11%)	(0.080)	(0.09%)	(0.12%)	(0.14%)	(0.21)	
HSBC Trinkaus	813	+0.33%**	+0.23%***	+0.128***	−0.42%***	−0.11%***	+0.02%	+0.49***	0.653
		(0.13%)	(0.02%)	(0.031)	(0.13%)	(0.03%)	(0.05%)	(0.06)	
Sal. Oppenheim	1116	+0.62%	+0.23%***	−0.080	−0.74%	−0.20%***	+0.12%*	+0.46***	0.510
		(0.50%)	(0.03%)	(0.057)	(0.53%)	(0.03%)	(0.06%)	(0.07)	
UBS	6872	+0.03%	+0.22%***	+0.081***	−0.10%*	−0.11%***	+0.07%*	+0.54***	0.401
		(0.07%)	(0.02%)	(0.022)	(0.06%)	(0.02%)	(0.04%)	(0.06)	

Table 4. *Results of the order flow regression (17). Column "n" lists the number of observations, i.e., trades, per issuer, after randomly selecting one trade per day in cases where more than one trade per day and certificate occurred. The following columns list the estimated coefficients of the regression, namely the constant, the absolute remaining time to maturity, the order flow measured by signed log volume, the degree of competition, the moneyness, the calendar time, and the credit spread. Robust Newey-West standard deviations are reported in brackets. Significance at the 10% level is denoted by *, at the 1% level by **, and at the 0.1% level by ***. The final column lists the regression adjusted* r^2*s.*

Issuer	n	const.	*LIFE*	*SALE*	*COMP*	*MONEY*	*TIME*	*CREDIT*	r^2
ABN Amro	815	+0.45%***	+0.34%***	−0.05%	−0.42%**	−0.38%***	+0.14%***	+0.02	0.498
		(0.13%)	(0.03%)	(0.03%)	(0.15%)	(0.05%)	(0.04%)	(0.06)	
BHF-Bank	425	−0.32%*	+0.26%***	−0.05%	+0.12%	−0.01%	−0.04%	+1.05***	0.450
		(0.18%)	(0.05%)	(0.06%)	(0.18%)	(0.03%)	(0.06%)	(0.11)	
BNP Paribas	3426	−0.19%***	+0.24%***	+0.00%	+0.08%*	−0.05%***	+0.05%	+0.53***	0.699
		(0.04%)	(0.03%)	(0.02%)	(0.03%)	(0.01%)	(0.03%)	(0.03)	
Citibank	1337	−0.25%*	+0.47%***	+0.01%	−0.08%	+0.16%**	+0.29%***	+0.16**	0.723
		(0.12%)	(0.03%)	(0.01%)	(0.12%)	(0.05%)	(0.04%)	(0.06)	
Commerzbank	13591	−0.01%	+0.13%***	+0.03%***	−0.03%	−0.15%***	+0.08%***	+0.52***	0.571
		(0.02%)	(0.02%)	(0.01%)	(0.03%)	(0.02%)	(0.02%)	(0.04)	
Deutsche Bank	13150	−0.07%*	+0.25%***	+0.04%**	−0.08%**	−0.12%***	+0.09%**	+0.50***	0.323
		(0.03%)	(0.02%)	(0.02%)	(0.03%)	(0.02%)	(0.03%)	(0.04)	
Dresdner Bank	3394	−0.19%	+0.38%***	+0.12%***	+0.27%*	−0.18%**	−0.32%*	+0.76***	0.300
		(0.13%)	(0.04%)	(0.03%)	(0.13%)	(0.06%)	(0.16%)	(0.15)	
DZ Bank	1204	+0.72%***	+0.81%***	+0.21%***	−0.90%***	−0.69%***	+0.98%***	−1.05***	0.663
		(0.16%)	(0.11%)	(0.05%)	(0.09%)	(0.10%)	(0.13%)	(0.19)	
HSBC Trinkaus	813	+0.29%*	+0.23%***	+0.08%***	−0.42%***	−0.11%***	+0.02%	+0.48***	0.651
		(0.12%)	(0.02%)	(0.02%)	(0.12%)	(0.03%)	(0.05%)	(0.06)	
Sal. Oppenheim	1116	+0.65%	+0.23%***	−0.05%	−0.74%	−0.20%***	+0.12%*	+0.46***	0.509
		(0.51%)	(0.03%)	(0.05%)	(0.52%)	(0.03%)	(0.06%)	(0.07)	
UBS	6872	+0.00%	+0.21%***	+0.07%***	−0.10%*	−0.11%***	+0.07%*	+0.54***	0.403
		(0.07%)	(0.02%)	(0.02%)	(0.06%)	(0.02%)	(0.04%)	(0.06)	

Table 5. *Results of the order flow regression (18). Column "n" lists the number of observations, i.e., trades, per issuer, after randomly selecting one trade per day in cases where more than one trade per day and certificate occurred. The following columns list the estimated coefficients of the regression, namely the constant, the absolute remaining time to maturity, the order flow measured by a binary variable, the degree of competition, the moneyness, the calendar time, and the credit spread. Robust Newey-West standard deviations are reported in brackets. Significance at the 10% level is denoted by *, at the 1% level by **, and at the 0.1% level by ***. The final column lists the regression adjusted* r^2*s.*

	LIFE	*FLOW*	*SALE*	*COMP*	*MONEY*	*TIME*	*CREDIT*
LIFE	+1						
FLOW	+0.353	+1					
SALE	+0.395	+0.888	+1				
COMP	−0.165	−0.048	−0.048	+1			
MONEY	+0.098	+0.054	+0.024	−0.217	+1		
TIME	−0.110	−0.027	−0.049	+0.101	+0.093	+1	
CREDIT	−0.143	−0.030	−0.051	+0.136	+0.050	+0.845	+1

Table 6. *Average correlations between the regression variables absolute remaining time to maturity, order flow (signed log volume), order flow (binary variable), degree of competition, moneyness, calendar time, and credit spread. Correlations are calculated separately for each issuer and weighted by the number of observations per issuer.*

Issuer	n	const.	*LIFE*	*TAX*	*MAT*	*COMP*	*MONEY*	*TIME*	*CREDIT*	r^2
ABN Amro	815	+0.49%***	+0.31%***	−0.03%	−0.04%	−0.44%**	−0.38%***	+0.15%***	−0.01	0.496
		(0.14%)	(0.06%)	(0.03%)	(0.04%)	(0.15%)	(0.05%)	(0.04%)	(0.07)	
BHF-Bank	425	−0.35%*	+0.13%*	+0.04%	−0.38%**	+0.25%	+0.00%	−0.05%	+1.06***	0.473
		(0.21%)	(0.06%)	(0.09%)	(0.14%)	(0.19%)	(0.02%)	(0.05%)	(0.10)	
BNP Paribas	3426	−0.19%***	+0.24%***	+0.00%	−0.01%	+0.07%*	−0.05%***	+0.05%	+0.53***	0.699
		(0.05%)	(0.03%)	(0.02%)	(0.04%)	(0.03%)	(0.01%)	(0.03%)	(0.03)	
Citibank	1337	−0.04%	+0.37%***	+0.02%	−0.15%***	−0.21%	+0.18%***	+0.27%***	+0.21***	0.745
		(0.14%)	(0.04%)	(0.03%)	(0.03%)	(0.14%)	(0.05%)	(0.05%)	(0.06)	
Commerzbank	13591	+0.06%**	+0.10%***	+0.05%**	−0.12%***	−0.08%**	−0.14%***	+0.07%***	+0.53***	0.588
		(0.02%)	(0.03%)	(0.02%)	(0.02%)	(0.02%)	(0.02%)	(0.02%)	(0.04)	
Deutsche Bank	13150	−0.03%	+0.22%***	+0.04%*	−0.07%***	−0.09%***	−0.11%***	+0.08%**	+0.51***	0.327
		(0.03%)	(0.02%)	(0.02%)	(0.02%)	(0.03%)	(0.02%)	(0.03%)	(0.04)	
Dresdner Bank	3394	−0.05%	+0.23%***	+0.18%***	−0.17%***	+0.25%*	−0.18%**	−0.33%*	+0.74***	0.314
		(0.13%)	(0.06%)	(0.05%)	(0.05%)	(0.12%)	(0.06%)	(0.17%)	(0.16)	
DZ Bank	1204	+1.19%***	+0.17%	+0.61%***	−0.28%*	−1.06%***	−0.69%***	+1.02%***	−1.08***	0.692
		(0.17%)	(0.18%)	(0.10%)	(0.11%)	(0.09%)	(0.08%)	(0.10%)	(0.17)	
HSBC Trinkaus	813	+0.55%***	+0.14%***	+0.12%***	−0.22%***	−0.58%***	−0.15%***	+0.04%	+0.44***	0.721
		(0.11%)	(0.02%)	(0.03%)	(0.04%)	(0.11%)	(0.02%)	(0.04%)	(0.06)	
Sal. Oppenheim	1116	+0.71%	+0.16%***	+0.01%	−0.12%	−0.76%	−0.19%***	+0.13%*	+0.44***	0.515
		(0.54%)	(0.04%)	(0.07%)	(0.09%)	(0.54%)	(0.02%)	(0.07%)	(0.10)	
UBS	6872	+0.06%	+0.18%***	+0.08%***	−0.11%***	−0.12%*	−0.12%***	+0.06%	+0.55***	0.414
		(0.07%)	(0.02%)	(0.02%)	(0.03%)	(0.06%)	(0.02%)	(0.04%)	(0.06)	

Table 7. *Results of the order flow regression (21), separating tax and maturity effect. The tax effect is measured by a dummy variable which is 1 iff the time to maturity is larger than 1 year. The maturity effect is measured by a dummy variable which is 1 iff the time to maturity is smaller than 0.3 years. Column "n" lists the number of observations, i.e., trades, per issuer, after randomly selecting one trade per day in cases where more than one trade per day and certificate occurred. The following columns list the estimated coefficients of the regression, namely the constant, the absolute remaining lifetime to maturity, the tax effect, the maturity effect, the degree of competition, the moneyness, the calendar time, and the credit spread. Robust Newey-West standard deviations are reported in brackets. Significance at the 10% level is denoted by *, at the 1% level by **, and at the 0.1% level by ***. The final column lists the regression adjusted* r^2*s.*

Issuer	n	const.	*AGE*	*TAX*	*MAT*	*COMP*	*MONEY*	*TIME*	*CREDIT*	r^2
ABN Amro	815	+0.82%***	−0.64%***	−0.04%	−0.01%	−0.27%*	−0.33%***	+0.26%***	−0.02	0.519
		(0.15%)	(0.13%)	(0.04%)	(0.05%)	(0.16%)	(0.05%)	(0.05%)	(0.06)	
BHF-Bank	425	−0.03%	+0.21%	+0.18%*	−0.50%**	−0.16%	−0.04%	+0.04%	+0.96***	0.474
		(0.31%)	(0.16%)	(0.08%)	(0.15%)	(0.40%)	(0.04%)	(0.06%)	(0.12)	
BNP Paribas	3426	+0.06%	−0.06%	+0.12%***	−0.13%***	+0.06%	−0.04%*	+0.02%	+0.50***	0.549
		(0.07%)	(0.04%)	(0.02%)	(0.03%)	(0.08%)	(0.02%)	(0.03%)	(0.04)	
Citibank	1337	+0.32%*	−0.02%	+0.24%***	−0.31%***	−0.33%*	+0.17%*	+0.31%***	+0.10	0.662
		(0.16%)	(0.07%)	(0.03%)	(0.03%)	(0.19%)	(0.07%)	(0.05%)	(0.06)	
Commerzbank	13591	+0.22%***	−0.09%**	+0.10%***	−0.15%***	−0.12%*	−0.12%***	+0.04%*	+0.54***	0.540
		(0.04%)	(0.03%)	(0.01%)	(0.02%)	(0.06%)	(0.01%)	(0.02%)	(0.04)	
Deutsche Bank	13150	+0.16%***	−0.14%**	+0.14%***	−0.14%***	−0.07%	−0.08%**	+0.08%**	+0.50***	0.262
		(0.04%)	(0.05%)	(0.02%)	(0.02%)	(0.05%)	(0.03%)	(0.03%)	(0.04)	
Dresdner Bank	3394	+0.20%*	−1.06%***	+0.03%	+0.07%	+0.61%***	−0.02%	−0.35%*	+0.97***	0.381
		(0.12%)	(0.20%)	(0.05%)	(0.08%)	(0.16%)	(0.05%)	(0.14%)	(0.16)	
DZ Bank	1204	+1.47%***	−0.35%*	+0.59%***	−0.24%**	−1.07%***	−0.69%***	+1.04%***	−1.06***	0.694
		(0.10%)	(0.15%)	(0.07%)	(0.08%)	(0.08%)	(0.08%)	(0.11%)	(0.17)	
HSBC Trinkaus	813	+0.84%***	−0.02%	+0.23%***	−0.28%***	−0.74%***	−0.20%***	+0.07%	+0.36***	0.660
		(0.11%)	(0.05%)	(0.03%)	(0.04%)	(0.11%)	(0.03%)	(0.05%)	(0.06)	
Sal. Oppenheim	1116	+0.80%*	+0.13%	+0.16%***	−0.22%*	−0.82%	−0.21%***	+0.18%*	+0.33***	0.494
		(0.47%)	(0.13%)	(0.04%)	(0.10%)	(0.54%)	(0.04%)	(0.08%)	(0.09)	
UBS	6872	+0.49%***	−0.76%***	+0.05%**	−0.02%	+0.07%	−0.07%***	+0.06%	+0.57***	0.501
		(0.07%)	(0.08%)	(0.02%)	(0.03%)	(0.07%)	(0.02%)	(0.04%)	(0.06)	

Table 8. *Results of the order flow regression (23), separating tax and maturity effect, and using relative instead of absolute lifetimes. The tax effect is measured by a dummy variable which is 1 iff the time to maturity is larger than 1 year. The maturity effect is measured by a dummy variable which is 1 iff the time to maturity is smaller than 0.3 years. Column "n" lists the number of observations, i.e., trades, per issuer, after randomly selecting one trade per day in cases where more than one trade per day and certificate occurred. The following columns list the estimated coefficients of the regression, namely the constant, the relative age, the tax effect, the maturity effect, the degree of competition, the moneyness, the calendar time, and the credit spread. Robust Newey-West standard deviations are reported in brackets. Significance at the 10% level is denoted by *, at the 1% level by **, and at the 0.1% level by ***. The final column lists the regression adjusted* r^2*s.*

Issuer	Micro Level	Tax	Maturity
ABN Amro	−	−	−
BHF-Bank	−	−	+
BNP Paribas	−	−	−
Citibank	−	−	+
Commerzbank	+	+	+
Deutsche Bank	+	+	+
Dresdner Bank	−	−	−
DZ Bank	+	+	+
HSBC Trinkaus	+	+	+
Sal. Oppenheim	−	−	−
UBS	−	+	−

Table 9. *Summary of the findings. Column 'Micro Level' lists whether issuers anticipate the order flow based on the micro-level indicator variable, 'Tax' if they anticipate the tax effect, and 'Maturity' if they anticipate the maturity effect. '+' denotes clear evidence, i.e., statistical significance for both approaches of measuring the certificates' age (absolute and relative), '−' denotes no evidence or doubts, i.e., no significance with at least one of the approaches.*

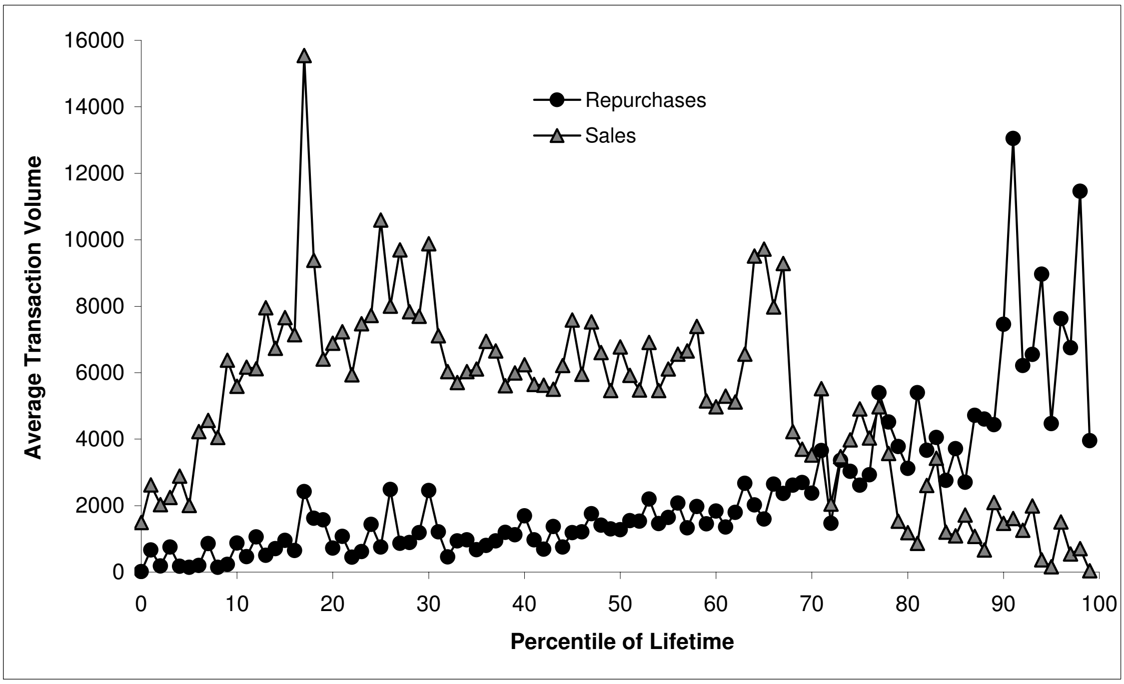

Figure 1. *Sales and rebuys with respect to the life cycle. Each trade is classified by its type and the percentile of the certificate's lifetime when it took place. The triangles (sales) and circles (rebuys) represent the percentiles. The total transaction volume per percentile is divided by the number of certificates which passed this percentile of their life cycle during the investigation period. Hence, the figures are average transaction volumes per certificate and percentile, aggregated over all issuers.*

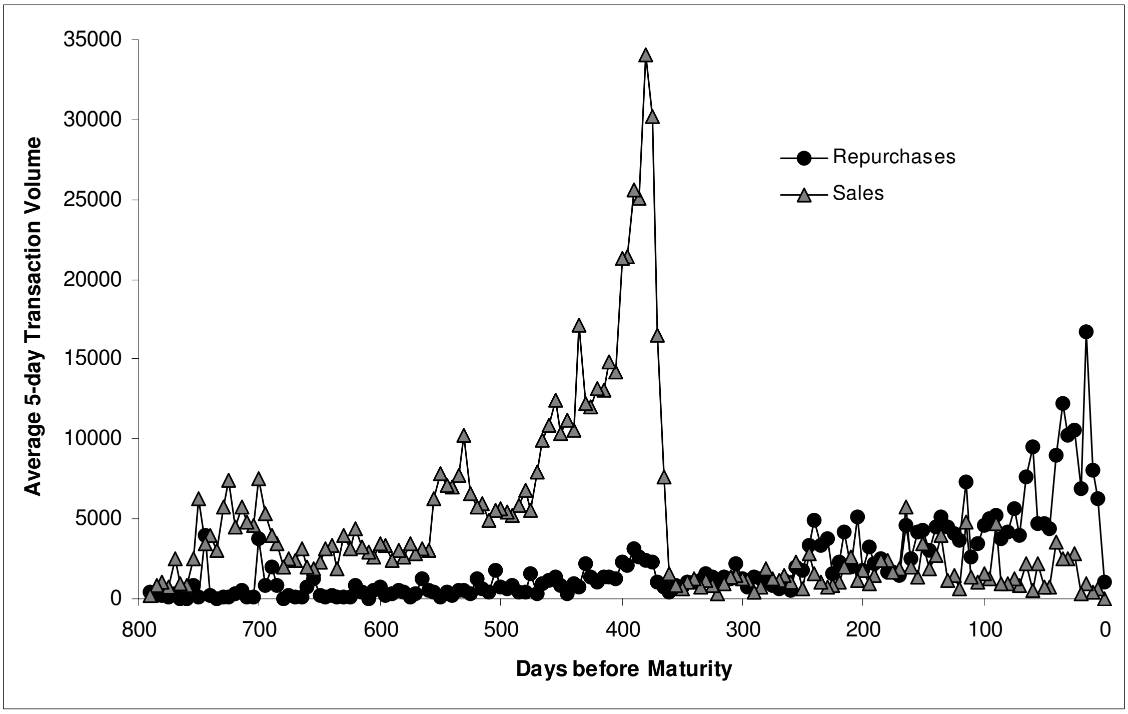

Figure 2. *Sales and rebuys with respect to the remaining time to maturity. Each trade is classified by its type and the certificate's remaining time to maturity when it took place, with a resolution of 5 calendar days. For a better comparison with Figure 1, the remaining time decreases along the x-axis, i.e., maturity is on the right. The triangles (sales) and circles (rebuys) represent the 5-day periods. The total transaction volume per 5-day period is divided by the number of certificates which passed this period of their lifetime during the investigation period. Hence, the figures are average transaction volumes per certificate and 5-day period, aggregated over all issuers.*

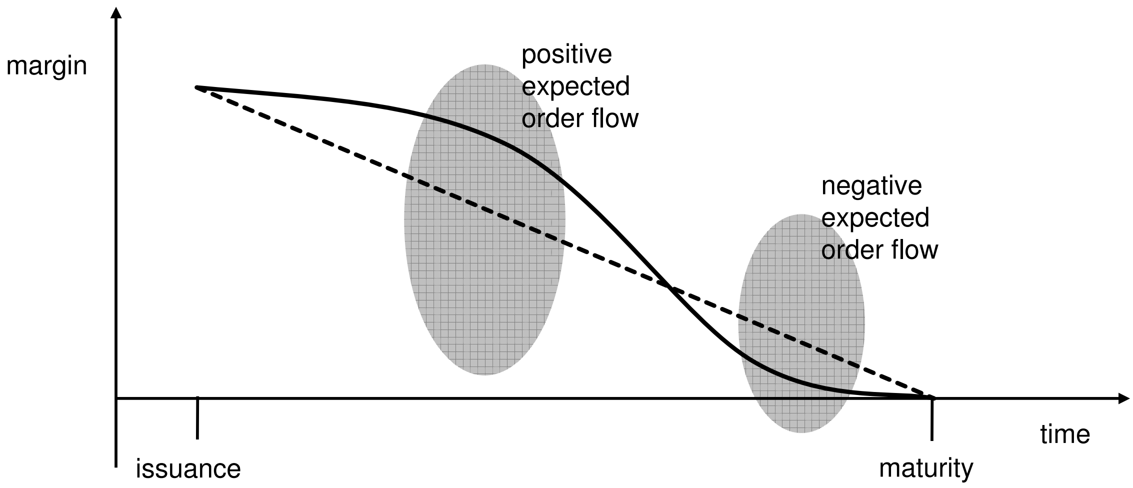

Figure 3. *Life cycle and order flow hypothesis. The life cycle hypothesis assumes a linear decrease of the margin over the lifetime of the certificate (dashed line). However, there are situations (see Figure 2), where the order flow can be expected to be positive (i.e., sales dominate rebuys), and others, where the order flow can be expected to be negative. The order flow hypothesis postulates that issuers anticipate these patterns and charge an additional margin when they expect a positive order flow and charge a margin below the linear function when they expect a negative order flow. A possible smooth non-linear margin function is indicated by the solid line.*