Can you trust the numbers?
A model-free assessment of misleading cost disclosures in retail derivatives under PRIIPs regulation

David Shkel*

January 15, 2024

*University of Hagen, Universitätsstraße 41, 58084 Hagen, Germany, david.shkel@fernuni-hagen.de.

Can you trust the numbers?
A model-free assessment of misleading cost disclosures in retail derivatives under PRIIPs regulation

Abstract

Structured retail derivatives are tailor-made products designed to meet the specific needs of private investors. Given the vast variety of products available in European markets, coupled with their complexity and potential difficulty in understanding, regulators have implemented measures to enhance transparency. One such measure is the mandatory disclosure of costs associated with the purchase of these products under the Packaged Retail and Insurance-Based Investment Products (PRIIPs) regulation, which came into effect in the European Union in 2018.

Previous research indicates that, on average across portfolios, disclosed costs for investment products are accurate for many issuers. However, due to uncertainties in cost estimation, it remains unclear whether these costs are consistently and appropriately disclosed. To remove this uncertainty and determine whether the costs are accurately reported on an individual product basis, we have conducted an analysis using synthetic zero coupon bonds, which consist of the combination of two different retail derivatives.

Our findings reveal that a majority of issuers significantly understate costs, with only two out of eight issuers adequately disclosing costs for their entire portfolio. For some other issuers, cost disclosure might be appropriate for some small sub-portfolios, but overall the disclosed costs are too low. This discrepancy constitutes a clear violation of applicable regulatory requirements and runs counter to the overarching goal of achieving greater transparency.

1 Introduction

Structured retail products, also known as retail derivatives or certificates, are securitized derivatives designed for private investors. They offer retail investors the opportunity to trade derivatives, especially in small lot sizes, and allow them to hold a wide range of desired (exotic) payoff profiles. In Europe, these products are typically offered by banks and can be traded directly with the banks or through exchanges.

However, the ability to trade derivatives as private investors comes with a cost. These costs are incorporated into the market prices of structured products, usually set by the issuing banks, which act as market makers.[1] Unlike other investment alternatives, such as mutual funds, the associated costs have not been disclosed in the past.

The first regulatory action requiring issuers to disclose costs was the Packaged Retail and Insurance-Based Investment Products (PRIIPs) regulation, which came into force in the European Union in 2018. Under this regulation, issuers are obligated to disclose the costs associated with the purchase of retail derivatives. The goal of introducing the PRIIPs regulation and other regulatory measures, such as the Markets in Financial Instruments Directive (MiFID II), was to make it easier for private investors to understand complex products and provide them with all the necessary information to make an informed investment decision. This includes the disclosure of costs, achieved through the introduction of a standardized key information document (KID).

For private investors, estimating the costs included in market prices is challenging and, depending on the complexity of the products, almost impossible. Before the introduction of the PRIIPs regulation, issuers had the ability to conceal these costs. Previously, only certain self-imposed requirements from derivatives associations were in effect. However, these rules left enough room for interpretation, enabling issuers to still disguise the costs (e.g., Baule et al. (2023)).

The analysis of costs has been the subject of numerous studies. In the early stages of retail derivatives markets, authors found high issuer margins of several percentage points

[1] These costs are also referred to as issuer margins. We will use these terms interchangeably.

across products and markets (e.g. Wilkens et al. (2003) for discount certificates, Baule and Tallau (2011) for bonus certificates, Wallmeier and Diethelm (2009) for multi-asset products, Egan (2019) for the US market, Wilkens and Stoimenov (2007) for the German market, Burth et al. (2001) for the Swiss market, or Eom et al. (2016) for the Korean market). Over time, margins for a given product category generally decline (see, for example, Baule et al. (2023)). Several factors affecting the height of the margins were also identified. These factors include, but are not limited to, the life cycle of the product (e.g. Stoimenov and Wilkens (2005)), expected order flow (e.g. Baule (2011)), competition (e.g. Schertler (2016)), and model risk (e.g. Baule and Shkel (2021)).

Since costs must be disclosed, a natural question arises: do these disclosed values correspond to the actual costs? If so, further research on issuers' pricing policies can be conducted with less computational effort and higher accuracy, as costs no longer need to be estimated. Baule et al. (2023) find evidence that, on average, many issuers disclose reasonable costs across their portfolios. Nevertheless, doubts persist about the reasonableness of disclosed costs for some issuers. Residuals between disclosed costs and estimated costs are relatively large compared to average margins for these issuers. This observation does not necessarily imply fraudulent cost disclosure by issuers; these differences could be artifacts of some unavoidable problems during the cost estimation process.

The goal of this paper is to minimize uncertainty and produce the most accurate cost estimates as a basis for analyzing cost disclosures. The challenges in replicating product prices and estimating margins include the synchronicity of required inputs to valuation, the choice of a pricing model, the calibration procedure, and the treatment of default risk. By reducing uncertainties associated with cost calculation through a model-free and data-light approach, we analyze disclosed costs of retail derivatives. We find that some banks disclose reasonable costs, while others report very low values compared to actual costs.[2]

The approach combines two products to obtain a combination with a simple payoff profile, namely a zero coupon bond. These products are easy to price, and most of the pricing uncertainties mentioned earlier are no longer relevant.

[2]Data-light means that the number of necessary input factors required to estimate the costs is minimized.

he remainder of the paper is organized as follows: Section 2 presents structured financial products, the mechanisms in European markets for structured retail products, and the challenges associated with the replication of such products. Section 3 presents the analyzed data set and the research methodology. The results are discussed in Section 4, and Section 5 concludes.

2 Structured Financial Products

As customized retail derivatives, structured financial products are easy-to-trade, flexible instruments useful for implementing a variety of investment strategies. They empower private investors to engage in derivative trading without needing to invest comparatively high amounts, as is typically the case on futures exchanges. Issuers of retail derivatives are obligated to act as market makers, providing bid and ask prices continuously to ensure liquidity. Short selling of retail derivatives is not possible.

Market prices consist of three components: (i) a default-free model price, (ii) an adjustment for issuer default risk, and (iii) an issuer margin. Considering issuer default risk is crucial because retail derivatives are legally vulnerable bonds. Issuer margins encompass all costs, including structuring and overhead costs, as well as a profit margin.

Issuers use the fair price to hedge the risks associated with retail derivatives, enabling them to meet investors' demands at maturity. With perfect hedging, issuers can earn the margin. However, they might not earn the entire margin because investors are free to sell the products back to the issuer at any time. To earn a positive amount, issuers reduce the margin during the life of the product.

Margins should not fall to zero or become negative before maturity, as new investors can buy the product at any time, leaving issuers with no opportunity to earn a margin unless they further reduce them. Consequently, the margin $m(t)$ at any time t should be a positive, decreasing function of the time to maturity $T - t$.[3] If the product is bought at

[3]Deviations from this principle are possible, especially if issuers expect high buying or selling volumes (Baule (2011)). An optimal pricing policy was derived in Baller et al. (2016).

time t and sold at time $\tau < T$, the issuer earns a margin of $m(t) - m(\tau) \geq 0$. If investors were to hold the product to maturity, the earned margin would be $m(t) > 0$.

The calculation of costs under the PRIIPs regulation is outlined in Delegated Regulation (EU) 2017/653, along with Annex VI. Total costs comprise entry costs and exit costs. Entry costs are defined as the difference between the market price (either the issue price or the secondary market price) and the fair value of the product. Annex VI explicitly states that credit risk must be taken into account. Similarly, exit costs are the difference between the fair value and the market price. This difference is negative if the market price includes a positive issuer margin, especially if the product is sold back to the issuer before maturity. At maturity, the investor receives the specified payout. Therefore, reported exit costs should be zero if the recommended holding period is equal to maturity, or they should be negative, at least in most cases, if the recommended holding period is less than maturity.

The total costs and their components must be expressed in euros, included in an investment amount of 10,000 euros. Based on market prices at a given time, only entry costs can be estimated. Thus, this study compares disclosed entry costs and costs implied by market prices. According to Article 15 of the PRIIPs regulation, "PRIIP manufacturers shall review the information contained in the key information document every time there is a change that significantly affects or is likely to significantly affect the information contained in the key information document and, at least, every 12 months following the date of the initial publication of the key information document." Consequently, cost disclosure should always approximately state the true costs regardless of the date of the KID.

Although costs play a crucial role in decision-making for private investors (cf. Baule and Münchhalfen (2022)), they were not required to be disclosed before the introduction of the PRIIPs regulation in 2018. Prior to this date, there were only some self-imposed requirements from derivatives associations to disclose fair prices (cf. Baule et al. (2023)).

As for the voluntary self-regulation preceding the PRIIPs regulation, there are mixed results regarding the adequacy of the disclosed values. While Bauer et al. (2020) concluded that costs were correctly disclosed, Baule et al. (2023) demonstrated, based on a

larger dataset, that the disclosed costs were too low. Issuers took advantage of the vague definition of disclosure requirements to report biased costs.

In the context of the current regulatory framework (PRIIPs), Baule et al. (2023) found evidence that, on average, most issuers report reasonable costs. However, uncertainties persist, and some issuers may still report biased values.

In the literature, issuer margins (and correspondingly costs for private investors) are typically calculated as the difference between the market price (ask price, if available) and the theoretical value of the product, including adjustments for issuer default risk. By using the same approach to calculate fair value, considering default risk, and employing the same data and methods as the issuers, costs can be accurately estimated. As there are some uncertainties, the costs cannot be expected to be perfectly reproduced. However, minimizing the number of uncertainties increases the informative value of the estimated costs.

The greatest uncertainty in our analysis stems from the type of products examined. For simple products like discount certificates, which are essentially covered calls (a long position in a stock and a short call written on this stock), there is no need to select a pricing model, especially if the certificate uses an underlying with a liquid options market. In such cases, the discount certificate can be precisely replicated by holding a long position in the underlying and a short position in the option contract, provided it is available. Alternatively, the Black and Scholes (1973) model, along with observable implied volatilities, can be used to calculate the required option price for replication.

However, when analyzing more complex products, such as those including path-dependent options, one must contend with model risk. Exotic options, usually not traded liquidly on exchanges, preclude the calibration of a simple pricing model to interpolate between observable prices. Instead, a more sophisticated pricing model must be chosen, introducing some uncertainty about the fair value (see Baule and Shkel (2021)).

Another uncertainty that can be easily eliminated is dividends. One could use options to estimate dividends, rely on dividend forecasts, or simply choose an underlying that does not pay dividends at all.

The risk-free interest rate required for valuation also needs to be estimated. As there is no unanimous opinion about the correct value of the risk-free interest rate, it remains a factor of uncertainty. Approaches used in the literature to estimate the risk-free rate include the use of an interest rate model such as the Svensson (1994) model calibrated to government bonds (e.g., Schertler (2016) or Entrop et al. (2016)) or the use of observable quantities such as LIBOR or OIS values (e.g., Henderson and Pearson (2011) or Vokata (2021)). Given that different methods lead to comparable interest rate estimates and the sensitivity of (equity) option prices to changes in the interest rate is manageable, the uncertainty in this aspect should be low compared to the actual costs.

The challenge of choosing a model and determining the right input parameters also extends to adjustments for default risk. Many papers employ the Hull and White (1995) model (e.g., Entrop et al. (2016) or Schertler (2021)), while earlier papers, especially, did not consider default risk at all (e.g., Burth et al. (2001)). These two approaches represent the extreme cases for considering default risk and are popular because they do not require many input parameters.

A more sophisticated method for accounting for default risk is the use of a structural model (e.g., Baule et al. (2008)). Typically, one needs a credit spread and, depending on the model, a correlation between the issuer's firm value and the option's underlying as input parameters. The use of CDS spreads is common. Since the introduction of the Bank Recovery and Resolution Directive in the European Union, certificates are senior to standard senior unsecured bonds, causing the use of CDS spreads to slightly overestimate default risk. However, as adequate spreads are available for only a fraction of issuers and a few maturities, it remains common to use CDS spreads.

There is evidence in the literature suggesting that banks did not adequately account for default risk before the collapse of Lehman Brothers (see Arnold et al. (2021)).

The products are typically offered in euros. Consequently, some currency conversions are necessary if the underlying of the product is not quoted in euros. In the case of a quanto product, where the exchange rate is fixed, no conversion is required. Otherwise, (forward) exchange rates are necessary to calculate product prices. Given that exchange rates are observable, a liquid futures market on exchange rates is in place, and exchange

rates usually do not experience heavy fluctuations during a trading day, the uncertainty introduced by these quantities is comparatively low.

The final uncertainty in cost calculation pertains to the synchronicity of the required input values. Ideally, the market price of the retail derivative, the price of the underlying, the option data (prices and/or implied volatilities), and even other values such as the risk-free interest rate, CDS spreads, and dividend estimates should share the exact same time stamp. Without this synchronization, the calculated costs may be distorted. This becomes even more critical with more volatile input parameters.

While interest rates, CDS spreads, and dividend forecasts typically change little over the course of a trading day, other values can fluctuate considerably. In particular, the market price of the product under investigation and the price of its underlying should be synchronized. If option prices are used, they should also be synchronized with these two variables. However, this problem can be mitigated by using implied volatilities, as these usually fluctuate less within a day than option prices.

This study is based on four different types of retail derivatives: (i) discount certificates, (ii) put warrants, (iii) discounted calls (also called bull spreads), and (iv) discounted puts (also called bear spreads). All products follow the European exercise type, meaning that a payoff to the private investor can only occur at maturity. A discount certificate is essentially a covered call, representing a combination of a long position in the underlying and a short position in a call written on this underlying. The payoff of a discount certificate DC is given by:

$$DC = \min\{S_T; Cap\} \tag{1}$$

where S_T is the price of the underlying at maturity and Cap the strike of the short call option that limits the payoff. A put warrant is a bank issued put option. The payoff P is given by:

$$P = \max\{Cap - S_T; 0\} \tag{2}$$

where Cap is the strike. A discounted call (bull spread) is a combination of a long call with strike K_1 and a short call with strike $K_2 > K_1$. The payoff $Bull$ is given by:

$$Bull = \begin{cases} 0 & ; \ S_T < K_1, \\ S_T - K_1 & ; \ K_1 \leq S_T \leq K_2, \\ K_2 - K_1 & ; \ S_T > K_2. \end{cases} \tag{3}$$

Similarly, a discounted put (bear spread) is a combination of a long put with strike K_2 and a short put with strike $K_1 < K_2$. The payoff $Bear$ is given by:

$$Bear = \begin{cases} K_2 - K_1 & ; \ S_T < K_1, \\ K_2 - S_T & ; \ K_1 \leq S_T \leq K_2, \\ 0 & ; \ S_T > K_2. \end{cases} \tag{4}$$

3 Methodology and Data

Model risk emerges as the uncertainty with the most substantial impact on option prices and, consequently, on estimated costs, as demonstrated by Baule and Shkel (2021). The magnitude of model risk can be comparable to estimated margins. Therefore, the analysis in this study is conducted using simpler products that include only plain vanilla options.

However, even in this case, significant uncertainty persists due to the necessity for synchronicity among prices. To address this challenge, we consider the combination of two structured products and compare the estimated costs of portfolios of these two products with the aggregate of the disclosed costs.

The two combinations under consideration are the sum of a discounted call and a discounted put and the sum of a discount certificate and a put warrant. The combination of a discounted call and a discounted put, both written on the same underlying with identical strikes K_1 and K_2 and the same time to maturity, results in a vulnerable zero bond with a notional amount of $K_2 - K_1$.[4] This follows directly from adding the payoffs 3 and 4 or from applying the put-call parity.

[4]The payoff is typically scaled by a predefined factor to facilitate trading in small lot sizes for private investors. For brevity in notation, we omit this additional multiplier in the formulas.

The second combination, consisting of a discount certificate and a put warrant, both written on the same underlying with the same time to maturity and both having the strike Cap, also results in a vulnerable zero bond. Adding the two payoffs 1 and 2 yields a zero bond whith a nominal amount equal to Cap.

By employing these constructions, we eliminate any dependence on the underlying of the products. Consequently, there is no longer any uncertainty regarding the underlying. This implies that no option pricing model needs to be applied, and no data is required on the underlying or the options written on it. As a result, virtually all synchronicity problems are eliminated. Only the two prices of the discounted call and the discounted put, or the discount certificate and the put warrant, along with the interest rate, the CDS rate, and eventually an exchange rate, need to have the same time stamps. Although synchronicity with the interest rate, the CDS rate, and the exchange rate is not critical, as a small deviation does not significantly impact the estimated values.

The fair price P_F of the synthetic zero bonds, i.e., the combination of the products, can be calculated by simply discounting the notional value N using an appropriate discount factor. This factor is based on the sum of the risk-free rate r and the CDS spread CDS, and the time to maturity T.[5] This results in a price of:

$$P_F = e^{-(r+CDS)\cdot T} \cdot N. \tag{5}$$

The costs c are simply the difference between the market price of the combined product P_M, which is the sum of the two products that form the synthetic zero bond, and the fair price, normalized by the fair price:

$$c = \frac{P_M - P_F}{P_F}. \tag{6}$$

The reported costs c_d^A according to the PRIIPs regulation are stated in the KIDs as an amount in euros, which is already included in a total investment volume of 10,000 euros. These absolute costs are then converted into percentage costs as $c_d = \frac{c_d^A}{10{,}000 - c_d^A}$.

The disclosed costs are compared with the costs estimated from market data. The costs disclosed for the synthetic zero bonds are the weighted sum of the disclosed costs of the two

[5]If required, currency conversion is applied. For brevity in notation, we omit its inclusion in the formulas.

combined retail derivatives, weighted by their respective prices. A plot of disclosed costs against calculated costs should yield a straight line starting at the origin and having a slope of one if the costs are appropriately disclosed. However, due to remaining uncertainties, one would not expect a perfect line.

The prices of the retail derivatives were obtained from the Frankfurt stock exchange, corresponding to the closing prices on five different trading days from the year 2023.[6] These closing prices all share the same time stamps, and data on all tradable products were downloaded. Information on the products, including maturity, strikes, and disclosed costs, was extracted from the KIDs, available for most issuers on their websites.[7]

To determine the risk-free interest rate, the Svensson (1994) model calibrated to German government bonds was employed. The model parameters are provided daily by the Bundesbank, the German central bank. Finally, the five-year CDS spreads (the most liquid spreads), the current exchange rate, and the future exchange rates were determined using Refinitiv workspace.

The final data set of synthetic zero bonds is presented in Table 1. The dataset for the combination of bull spreads and bear spreads includes five well-known banks. Other banks for which retail derivatives data was available do not offer bull spreads and bear spreads.[8] The average time to maturity varies between three and seven months. The notional amount, calculated as the difference in strikes multiplied by a certain ratio to control the product price, is highest for BNP (8.4 euros).[9]

UBS, on the other hand, has products with the smallest notional amount, reflecting its focus on offerings related to single stocks and no equity index products, which usually

[6]Only the results for December 7th, 2023, are reported, since the results are similar for all trading days under study. Plots and regression results for the other trading days are given in the appendix.

[7]The KIDs as PDF files were downloaded, and the information was extracted using scripts. This approach does not work for all issuers due to certain restrictions. Data for eleven out of fourteen issuers was obtainable.

[8]An exception is HSBC; however, only five synthetic zero bonds were constructable, so we excluded HSBC from this analysis.

[9]The payoff is multiplied by the ratio to adjust market prices, making products based on indexes more affordable for private investors.

have a larger notional amount. The remaining issuers offer a mix of mainly equity index products and single stock products, with some other underlyings like commodities and exchange rates being rarely represented. The dataset does not include quanto products, but a significant fraction of the underlyings are not quoted in euros. The average notional for these issuers is about five euros.

Portfolio size varies widely across issuers. BNP and UBS have the largest portfolios with over 2,000 synthetic zero bonds, while DZ Bank offers only roughly 300 synthetic zero bonds.

The combinations of discount certificates and put warrants can be constructed for six issuers. These combinations have an average remaining time to maturity of 0.56 years. Citigroup has the portfolio with the shortest time to maturity, averaging only 0.25 years, while BNP and HSBC have the highest values with 0.65 and 0.67 years, respectively.

The average nominal value, corresponding to the cap of the discount certificate (and the strike of the put warrant) times the ratio, is 119 euros. The values for different issuers vary widely, with DZ Bank having an average value of only 97 euros, while the value for Citigroup is nearly double this amount at 185 euros.

Portfolio sizes also vary widely. Citigroup offers only 37 combinations, DZ Bank, HSBC, and JP Morgan have a portfolio size in the low hundreds, and finally, BNP and Société Générale have the largest portfolios with 2,760 and 1,898 combinations.

[INSERT TABLE 1 ABOUT HERE.]

4 Results

Table 2 presents a comparison of the disclosed costs and the estimated costs for the synthetic zero bonds. It is evident that the synthetic zero bonds using discount certificates are associated with significantly lower costs. This result is expected, considering that investment products like discount certificates typically entail a long position in the underlying, making them more expensive than leverage products such as bull or bear spreads,

which only involve option positions. To attain an acceptable margin in absolute terms, the relative margins for leveraged products need to be higher.

For combinations of bull and bear spreads, the estimated costs are higher than the disclosed costs for all issuers. The relative difference between these two values is highest for DZ Bank, with the estimated costs being more than 1.5 times the disclosed costs.

A valid comparison of costs between issuers would only be possible if the time to maturity is identical for every issuer. One way to address the different times to maturity would be to compare annualized costs by dividing the costs by the remaining time to maturity in years for every product. However, since this is just an approximation of the annual costs and a comparison between issuers' costs is not relevant for this study, we refrain from doing so.

Additionally, the graphical representation of the costs would be challenging to interpret since the range of annualized costs is significantly smaller compared to the non-standardized costs. Thus, the argumentation would be based on small fractions of percentage points for the synthetic zero bonds containing discount certificates, making it hard to follow.[10]

[INSERT TABLE 2 ABOUT HERE.]

The estimated costs are higher than the reported costs for all issuers but BNP for the combination of discount certificates and put warrants. Both values are almost identical for BNP, and the corresponding standard deviations are also almost equal, which is a first sign that BNP discloses costs correctly. The differences between disclosed and estimated costs are relatively small in percentage points, but the relative differences can be high. The most striking difference is visible for Société Générale, with disclosed costs averaging 0.13%, while the estimated average costs are 1.13%.

These observations indicate that costs are either correctly reported or under-reported. This is further analyzed using graphical representations and regressions.

[10]The results for annualized costs are available on request from the author.

The charts depicting disclosed costs versus estimated costs for the combinations of bull spreads and bear spreads are shown in Figure 1. The dispersion in the plots for BNP, DZ Bank, and UBS is relatively small, with all points closely aligning with the blue regression lines. However, a higher variation is noticeable for Citigroup and UniCredit.

[INSERT FIGURE 1 ABOUT HERE.]

For BNP and UBS, the slopes of the regression lines (blue lines) are hardly distinguishable from the red lines, indicating a near-perfect alignment between disclosed and estimated costs. Only a small fraction of the observations deviates from the lines. In general, it could be stated that these two issuers disclose costs adequately. The coefficients for the blue regression lines and the adjusted R^2 values are given in Table 3.

[INSERT TABLE 3 ABOUT HERE.]

The regression for the portfolio of DZ Bank results in a line with a slope clearly smaller than one. The majority of points lie clearly below the red line. This suggests that the disclosed costs are too low, indicating a potential bias in the values disclosed by DZ Bank.

The results for Citigroup and UniCredit are not as clear. The blue regression lines reveal relatively small slopes, but a significant fraction of the data points align acceptably with the red lines representing perfect compliance between disclosed and estimated costs. Concerning the portfolio of UniCredit, the majority of data points fall below the red line, which could be indicative of too low disclosed costs. To obtain a clearer picture, the products were analyzed on a single underlying basis.

In Figure 2, the plots for the most popular underlying for every issuer are provided. For all issuers but UBS, the most popular underlying is the DAX. UBS offers only single stock products, with Salesforce being the most popular underlying. The plots for BNP, UBS, and DZ Bank confirm the results stated above. While DZ Bank discloses too small values, BNP and UBS disclose the true costs. For UniCredit, the impression from the first plot is affirmed. The disclosed costs are too small. Even though the slope of the blue regression line is clearly larger than in the case of DZ Bank, it is evident that the majority of data

points lie below the red line. Thus, it has to be stated that UniCredit discloses costs that are too small as well.

Lastly, the plot for Citigroup differs from the plots for all other issuers. The slope of the regression line is smaller than one, but the majority of data points cluster around the red line of perfect disclosure quite adequately. However, what is quite striking is the stacking of points for fixed estimated costs. For given estimated costs, the disclosed values vary widely. These costs mainly belong to products with identical times to maturity. This implies that the disclosed costs vary with the strikes of the bull spreads and bear spreads. Even though a high fraction of the data points lies around the red line, this indicates some falsely reported costs since identical market prices (i.e. identical estimated costs) should be accompanied by identical costs. This fact is clearly violated, meaning that Citigroup discloses incorrect values, although they are more likely too high than too low. An additional analysis revealed that the disclosed costs for synthetic zero bonds formed of bull spreads and bear spreads with either the highest or the lowest strikes are the highest. Products with mid-range strikes are equipped with lower disclosed costs.

The results for the most popular underlying are generally confirmed by the remaining underlyings for all issuers.[11]

[INSERT FIGURE 2 ABOUT HERE.]

The plots for the combinations of discount certificates and put warrants for all six issuers are provided in Figure 3, and the corresponding coefficients for the blue regression lines are presented in Table 4. Similar to the analysis for synthetic zero bonds discussed earlier, the clearest results are observed for BNP. The regression of disclosed costs on estimated costs produces a blue line that closely aligns with the red line, representing perfect correspondence between disclosed and estimated costs. The slope of this line is 0.92, and the intercept is close to zero. Only a few minor deviations are noticeable. Some groups of points, forming nearly perfect lines with slopes close to one, deviate from the majority of points. These groups mostly correspond to products written on the same underlying

[11] Plots for every underlying are available on request from the author.

with the same time to maturity of over one year. The displacement from the red line can be explained by a different discount factor, which has the same impact on all synthetic zero bonds with the same maturity and does not affect the slope of the line. Since the time to maturity is relatively high for these products, the impact of a different discount factor becomes visible. Therefore, one can conclude that BNP discloses costs correctly. A similar pattern is visible in Figure 4, which shows the combinations for the most popular underlying from the issuers' portfolios.

[INSERT FIGURE 3 ABOUT HERE.]

[INSERT TABLE 4 ABOUT HERE.]

The plots for the remaining issuers exhibit clear differences from the red lines. However, they share a common feature in that at least a small fraction of the points is adequately approximated by the red lines, indicating that cost disclosures for certain parts of the portfolios align with estimated costs. The plots for Citigroup, HSBC, and JP Morgan show some similarities. The DAX is the only underlying for which combinations are possible for JP Morgan. Notably, there are outliers in the lower right corner, and these three values are removed in the plot in Figure 4. For all three issuers, it is evident that only a small fraction of the portfolio lies on the red line. The majority of values are clearly below the red line and exhibit limited variability. Hence, the disclosed costs appear to be generally too low. These observations are further supported by the plots for each issuer's most popular underlying.[12]

[INSERT FIGURE 4 ABOUT HERE.]

The DZ Bank portfolio is divided into three groups. One group is close to the red line, another comprises products with almost zero disclosed costs, and the last one consists of products with disclosed costs slightly over one percent. However, the estimated costs of the last two groups vary widely, leading to the majority of costs being disclosed too low.

[12]Note that the regression for HSBC in Figure 4 was conducted without the outliers in the upper left and lower right corners. Otherwise, the regression line would be almost flat.

Finally, the cost disclosures for Société Générale can be divided into two groups. The majority of synthetic zero bonds have estimated costs of under two percent, while a fraction of the combinations reveals costs of over eight percent. However, even for the lower-cost products, the disclosed costs are too low compared to the estimated values. This is evident in the plot of the most popular underlying in Figure 4. The majority of the synthetic zero bonds have disclosed costs between zero and 0.1%, while the estimated costs lie between zero and 0.6%. Thus, the disclosed costs are obviously too low compared to the estimated values.

In summary, it is evident that not all issuers disclose costs in the same way. While two issuers (BNP and UBS) clearly disclose costs correctly, the majority of issuers disclose costs that are too low. Citigroup plays a unique role among issuers. The cost disclosure for the combination of discount certificates and put warrants is too low, aligning with most issuers. Meanwhile, the costs disclosed for the combination of bull spreads and bear spreads reveal a distinctive pattern. With a fixed value for the estimated costs, the disclosed costs vary with the strikes of the products and are noticeably higher than the estimated costs for a significant fraction of the portfolio. The low cost disclosures cannot be explained by different discount factors, as in the case of BNP, since the sub-portfolios with fixed times to maturity do not show displaced lines with a slope of one.

The motivation for issuers to potentially disclose too low costs could be linked to the desire to make their products more appealing to private investors, who are known to be sensitive to product costs (e.g., Baule and Münchhalfen (2022)). Indeed, the rationale of issuers potentially disclosing too low costs to make their products more attractive does not seem to explain the observed pattern exhibited by Citigroup, where costs are disclosed too high for parts of the portfolio. In this scenario, there is no apparent justification for disclosing values that are too high.

Even if these results do not conclusively prove that the majority of issuers with deviations from true disclosures intentionally act fraudulently, they raise at least some questions about compliance with the PRIIPs regulation. It might be the case that issuers interpret the PRIIPs regulation differently, leading to higher fair prices and thus lower costs for their products. During the era of self-regulation before PRIIPs became effective in 2018,

issuers were allowed to include hedging costs in their fair value calculations. They used this possibility to distort their disclosures (e.g., Baule et al. (2023)) by calculating higher fair values. If issuers still use such an approach to calculate fair values and, thereby, derive costs, it could explain the partly too-low disclosed costs observed in this study.

The remaining uncertainty about the valuation, introduced by interest rates, CDS rates, and exchange rates, is unable to explain the deviations. The sensitivity of bond prices to these quantities is quite small. Additionally, these values affect all synthetic zero bonds, and any variation would roughly result in a parallel shift of the regression lines. While the intercept might be affected, the slope would not change noticeably.

A more reasonable explanation of the results are Article 15 "Review" and Article 16 "Revision" of the PRIIPs regulation. According to these articles, the information contained in the KIDs must always be up-to-date. If some information changes in a way that significantly affects or is likely to significantly affect the information contained in the key information document, the information should be reviewed, as per Article 15. If this review concludes that changes are necessary, these changes in the documents must be made immediately under Article 16. The interpretation of these rules can depend on the issuer. Issuers could always argue that the cost information did not change significantly. For the synthetic zero bonds containing discount certificates, issuers could argue that the change in relative costs is insignificant. Regarding the second combination based on bull and bear spreads, one could argue that the absolute costs did not change significantly. However, neither argumentation truly holds. If a significant fraction of the disclosed costs is drastically lower than the estimated costs (regardless of whether the costs are stated in absolute or relative terms), one cannot argue that the informational change is insignificant.

Therefore, there is no valid justification for the issuers' understatement of costs.

5 Conclusion

Structured financial products are customized retail derivatives for private investors. Private investors are generally not as sophisticated as institutional investors. Therefore, private investors need to be protected and informed to ensure that they can base their

decisions on a solid foundation. In addition to a comprehensible product description, information on the potential risks and returns, as well as the costs associated with the investment, is particularly important. Research shows that the product features determining the risk and return potential, as well as the costs, are of great importance for the investment decisions of private investors (see Baule and Münchhalfen (2022)). All of this information must be disclosed by issuers under the PRIIPs regulation, which came into force in 2018.

The analysis of the costs of structured financial products has been explored in a significant body of literature. However, these studies often rely on replicating the products and estimating costs as the difference between market prices and model prices. This approach introduces certain uncertainties. Due to challenges related to the synchronicity of input parameters, the choice of pricing model, and the estimation of unobservable input parameters, costs cannot be precisely determined. As these uncertainties do not lead to a systematic price error, the results of these studies apply to the cross-section of products. Detailed analyzes on a per-product basis are hindered. If the disclosed costs were reliable, it would yield two important implications. Firstly, it would substantially alleviate the computational burden associated with cost estimation. Secondly, it would enable in-depth studies of costs for individual products.

It appears that cost disclosures for most issuers and products are biased. BNP and UBS are the exceptions, as they disclose appropriate costs for their entire portfolios. Some other issuers report reasonable costs for small portions of their portfolios. However, the majority of the reported values are significantly lower than the actual costs estimated in this study.

From a consumer protection and regulatory standpoint, the findings of this study are alarming. The existing regulatory framework in the European Union is designed to enhance transparency, instill trust in private investors, and empower them to make well-informed decisions. Mandatory disclosure of costs plays a crucial role in achieving the overarching objective of high transparency. Private investors often consider costs in their decision-making process when this information is available. However, since not every issuer accurately discloses the true costs, there is a violation of regulatory rules in the European

Union. Consequently, investors are unable to make informed decisions based on the available product information. In this context, the cost disclosures fail to contribute to the intended goal of transparency.

Given that these findings are consistent across various trading days, different underlyings, and various product combinations, regulatory intervention is warranted against such biased disclosures. A potential measure that could be implemented involves requiring issuers to disclose their pricing approach to the regulator. This approach would enable the regulator to monitor the composition of market prices of market prices and evaluate whether costs are being disclosed reliably. Considering the complexity of financial products and their pricing, there's no need to make such information public. Banks could keep their internal practices confidential from competitors, while simultaneously improving the reliability of cost disclosures.

Alternatively, adjustments to the rules outlined in Article 15 and Article 16 of the PRIIPs regulation could be considered. The regulator might set a threshold for changes in costs that would prompt a revision. This approach would provide private investors with information on the true costs within a small specified uncertainty, determined by the threshold specified in the regulation.

References

Arnold, M., D. Schuette, and A. Wagner (2021). Neglected Risk in Financial Innovation: Evidence from Structured Product Counterparty Exposure. *European Financial Management 27*, 287–325.

Baller, S., O. Entrop, M. McKenzie, and M. Wilkens (2016). Market makers' optimal price-setting policy for exchange-traded certificates. *Journal of Banking & Finance 71*, 206–226.

Bauer, J., H. Fink, and E. Stoller (2020). Are issuer margins fairly stated? Evidence from the issuer estimate value for retail structured products. *Forecasting 2*, 387–409.

Baule, R. (2011). The order flow of discount certificates and issuer pricing behavior. *Journal of Banking & Finance 35*, 3120–3133.

Baule, R., O. Entrop, and M. Wilkens (2008). Credit risk and bank margins in structured financial products: Evidence from the German secondary market for discount certificates. *Journal of Futures Markets 28*, 376–397.

Baule, R. and P. Münchhalfen (2022). What is your desire? Retail investor preferences in structured products. *Review of Behavioral Finance 14*, 197–222.

Baule, R., P. Münchhalfen, D. Shkel, and C. Tallau (2023). Fair-washing in the market for structured retail products? Voluntary self-regulation versus government regulation. *Journal of Banking & Finance 148*, 106749.

Baule, R. and D. Shkel (2021). Model risk and model choice in the case of barrier options and bonus certificates. *Journal of Banking & Finance 133*, 106307.

Baule, R. and C. Tallau (2011). The pricing of path-dependent structured financial retail products: The case of bonus certificates. *Journal of Derivatives 18*(4), 54–71.

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

Burth, S., T. Kraus, and H. Wohlwend (2001). The pricing of structured products in the Swiss market. *Journal of Derivatives 9*(2), 30–40.

Egan, M. (2019). Brokers versus retail investors: Conflicting interests and dominated products. *Journal of Finance 74*, 1217–1260.

Entrop, O., G. Fischer, M. McKenzie, M. Wilkens, and C. Winkler (2016). How does pricing affect investors' product choice? Evidence from the market for discount certificates. *Journal of Banking & Finance 68*, 195–215.

Eom, Y. H., W. W. Jang, and S. Kim (2016). A Study on Retail Structured Product Market and Financial Regulation in Korea. *Journal of Derivatives and Quantitative Studies 24*, 505–524.

Henderson, B. J. and N. D. Pearson (2011). The dark side of financial innovation: A case study of the pricing of a retail financial product. *Journal of Financial Economics 100*, 227–247.

Hull, J. C. and A. White (1995). The impact of default risk on the prices of options and other derivative securities. *Journal of Banking & Finance 19*, 299–322.

Schertler, A. (2016). Pricing effects when competitors arrive: The case of discount certificates in Germany. *Journal of Banking & Finance 68*, 84–99.

Schertler, A. (2021). Listing of classical options and the pricing of discount certificates. *Journal of Banking & Finance 123*, 106011.

Stoimenov, P. A. and S. Wilkens (2005). Are structured products "fairly" priced? An analysis of the German market for equity-linked instruments. *Journal of Banking & Finance 29*, 2971–2993.

Svensson, L. E. O. (1994). Estimating and interpreting forward interest rates: Sweden 1992–1994. Working Paper, Stockholm University.

Vokata, P. (2021). Engineering lemons. *Journal of Financial Economics 142*, 737–755.

Wallmeier, M. and M. Diethelm (2009). Market pricing of exotic structured products: The case of multi-asset barrier reverse convertibles in Switzerland. *Journal of Derivatives 17*(2), 59–72.

Wilkens, S., C. Erner, and K. Röder (2003). The pricing of structured products in Germany. *Journal of Derivatives 11*(1), 55–69.

Wilkens, S. and P. A. Stoimenov (2007). The pricing of leverage products: An empirical investigation of the German market for "long" and "short" stock index certificates. *Journal of Banking & Finance 31*, 735–750.

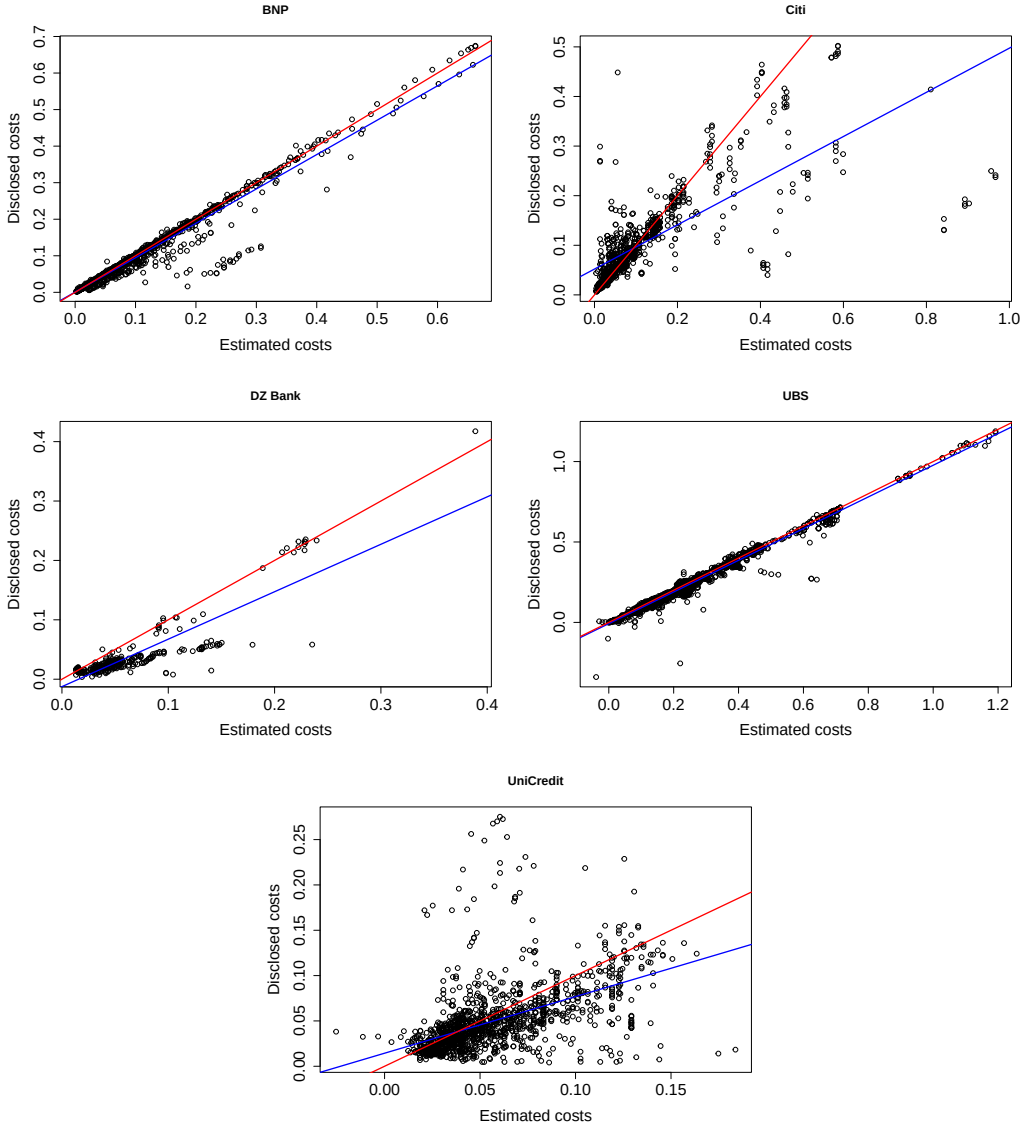

Figure 1. *Scatter plots of disclosed costs against estimated costs for the combination of bull spreads and bear spreads. Blue lines represent regression lines, while red lines indicate a perfect match between disclosed and estimated costs.*

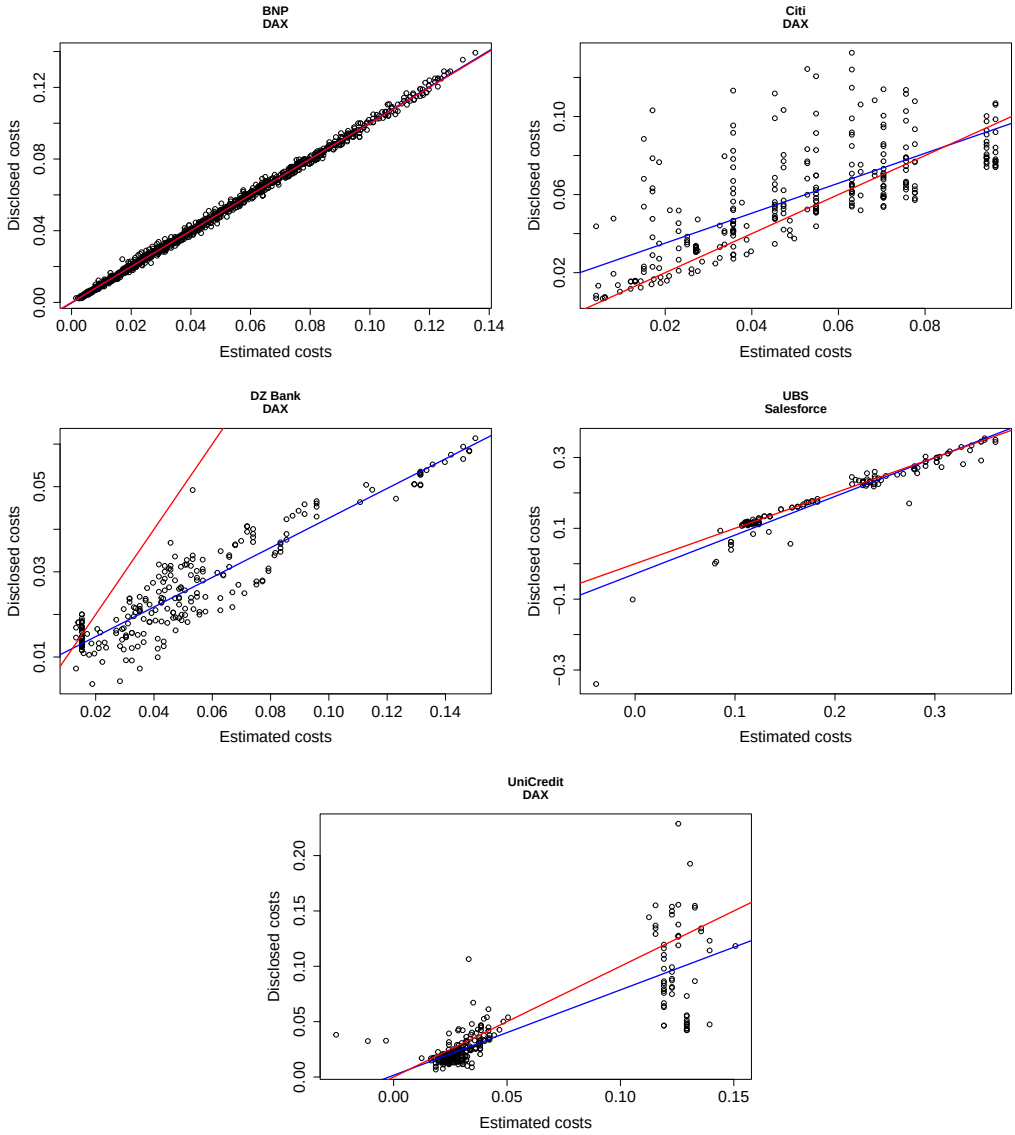

Figure 2. *Scatter plots of disclosed costs against estimated costs for the combination of bull spreads and bear spreads using the most popular underlying from each issuer's portfolio. Blue lines represent regression lines, while red lines indicate a perfect match between disclosed and estimated costs.*

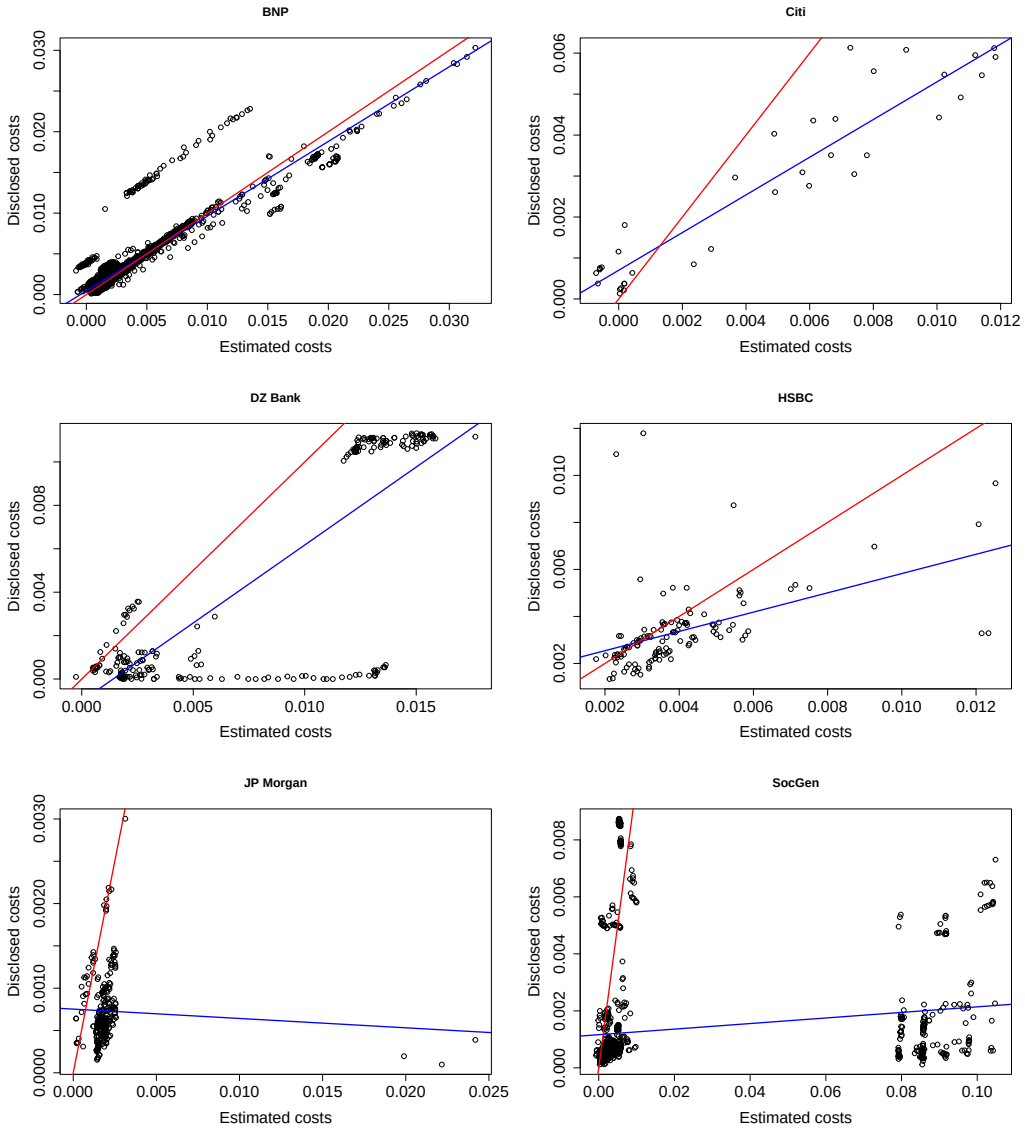

Figure 3. *Scatter plots of disclosed costs against estimated costs for the combination of discount certificates and put warrants. Blue lines represent regression lines, while red lines indicate a perfect match between disclosed and estimated costs.*

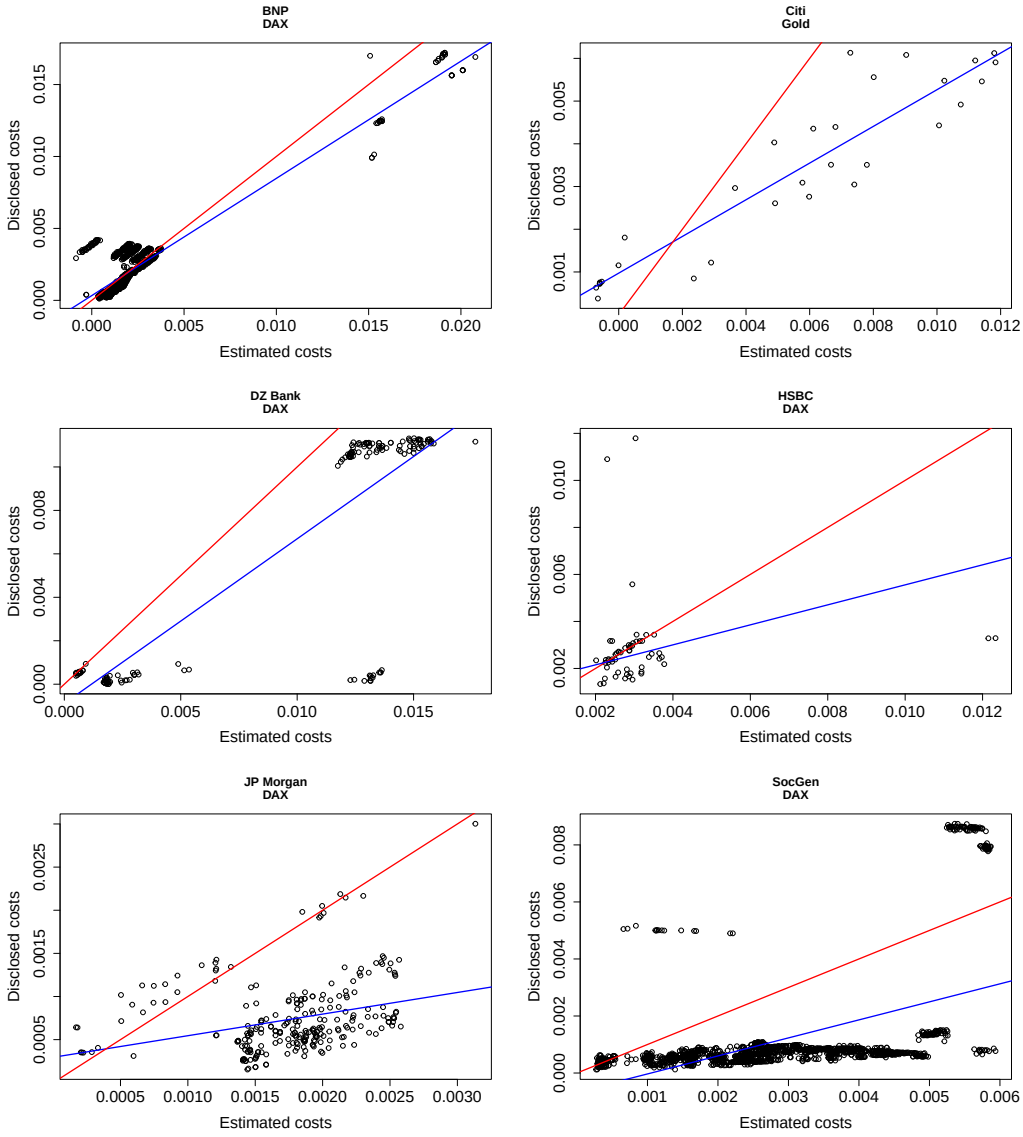

Figure 4. *Scatter plots of disclosed costs against estimated costs for the combination of discount certificates and put warrants using the most popular underlying from each issuer's portfolio. Blue lines represent regression lines, while red lines indicate a perfect match between disclosed and estimated costs.*

Issuer	# Products	TTM	Notional
Panel A: Bull spreads and bear spreads			
BNP	2,270	0.61	8.4
Citigroup	870	0.30	4.0
DZ Bank	291	0.39	5.8
UBS	2,485	0.53	1.7
UniCredit	1,328	0.37	4.7
Total	7,249	0.49	4.8
Panel B: Discount certificates and put warrants			
BNP	2,760	0.65	108
Citigroup	37	0.25	185
DZ Bank	248	0.40	97
HSBC	122	0.67	118
JP Morgan	258	0.35	135
SocGen	1,898	0.49	135
Total	5,323	0.56	119

Table 1. *Descriptive statistics for the synthetic zero bonds, including the number of bonds, average remaining time to maturity (in years), and average nominal amount (in euros). Panel A displays values for combinations of bull spreads and bear spreads, while Panel B shows values for the combination of discount certificates and put warrants.*

Issuer		Mean	SD
Panel A: Bull spreads and bear spreads			
BNP	Discl.	7.0%	8.5%
	Estim.	7.4%	8.8%
Citigroup	Discl.	10.6%	8.9%
	Estim.	12.0%	14.7%
DZ Bank	Discl.	3.9%	4.8%
	Estim.	6.1%	8.1%
UBS	Discl.	23.0%	16.9%
	Estim.	24.1%	17.0%
UniCredit	Discl.	4.9%	3.8%
	Estim.	5.6%	3.2%
Panel B: Discount certificates and put warrants			
BNP	Discl.	0.35%	0.39%
	Estim.	0.34%	0.39%
Citigroup	Discl.	0.27%	0.22%
	Estim.	0.44%	0.45%
DZ Bank	Discl.	0.45%	0.50%
	Estim.	0.76%	0.57%
HSBC	Discl.	0.34%	0.17%
	Estim.	0.40%	0.20%
JP Morgan	Discl.	0.07%	0.04%
	Estim.	0.20%	0.22%
SocGen	Discl.	0.13%	0.18%
	Estim.	1.13%	2.56%

Table 2. *Disclosed and estimated costs for the synthetic zero bonds. For each issuer, the mean and the standard deviation of disclosed costs and estimated costs are provided. Panel A displays values for bull spreads and bear spreads, while Panel B shows values for discount certificates and put warrants.*

Issuer	Slope	Intercept	adj. R^2
Panel A: Bull spreads and bear spreads, all products			
BNP	0.94	0.001	0.95
Citigroup	0.45	0.052	0.54
DZ Bank	0.80	−0.013	0.75
UBS	0.98	−0.008	0.98
UniCredit	0.62	0.014	0.26
Panel B: Bull spreads and bear spreads, top underlying			
BNP	1.01	−0.000	1.00
Citigroup	0.77	0.020	0.51
DZ Bank	0.35	0.008	0.85
UBS	1.09	−0.028	0.89
UniCredit	0.77	0.002	0.68

Table 3. *Results of regressions for disclosed costs against estimated costs for the synthetic zero bonds. The reported information includes slopes, intercepts, and adjusted R^2 for each regression. Panel A includes values for the entire portfolio of bull spreads and bear spreads combinations, while Panel B focuses on the most popular underlying from each issuer's portfolio.*

Issuer	Slope	Intercept	adj. R^2
Panel A: Discount certificates and put warrants, all products			
BNP	0.92	0.0005	0.83
Citigroup	0.46	0.0007	0.87
DZ Bank	0.72	−0.0010	0.66
HSBC	0.41	0.0017	0.22
JP Morgan	−0.01	0.0008	−0.00
SocGen	0.01	0.0012	0.02
Panel B: Discount certificates and put warrants, top underlying			
BNP	0.81	0.0003	0.86
Citigroup	0.43	0.0010	0.86
DZ Bank	0.76	−0.0008	0.70
HSBC	0.43	0.0013	0.05
JP Morgan	0.25	0.0003	0.09
SocGen	0.63	−0.0007	0.25

Table 4. *Results of regressions for disclosed costs against estimated costs for the synthetic zero bonds. The reported information includes slopes, intercepts, and adjusted R^2 for each regression. Panel A includes values for the entire portfolio of discount certificates and put warrants combinations, while Panel B focuses on the most popular underlying from each issuer's portfolio.*