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ORIGINAL RESEARCH

Outperformance Certificates: analysis, pricing, interpretation, and performance

Rodrigo Hernández · Wayne Y. Lee · Pu Liu · Tian-Shyr Dai

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Abstract In this paper we introduce a new financial product named Outperformance Certificates. We study the €43 billion sample by examining 1,507 issues of the certificates outstanding in August 2005 issued by banks in Europe. We present formulas to price the certificates and empirically examine the profits in the primary market for issuing the certificates. We find that issuance of the certificates is profitable for the issuers in our sample. Issuers sell the certificate at prices 3–5 % above the fair value based upon the components of the underlying assets. We also find that the dividend yields and ex-dividend dates play an important role in the profitability of the certificates. The underlying securities tend to have high dividend yield and large market capitalization. We also find the certificates tend to mature *soon* after the ex-dividend dates of the underlying assets.

Keywords Option pricing · Structured products · Financial innovation · Outperformance Certificates

JEL Classification G13 · G24

1 Introduction

Financial innovations, especially the creations of new financial products through the combination of fixed income securities, stocks, and derivative securities (known as structured

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products), have accelerated in the past two decades. The increase of financial innovation can be attributed to the rapid development of computer technology and financial engineering techniques such as financial pricing models (Miller 1992). Consequently, these financial innovations perform several important functions: (1) they reduce the transaction costs by combining several separate financial products into one single product; (2) they complete the market by offering the payoffs not available in the market; and (3) they provide tax and regulative arbitrage opportunities, to name just a few (Ross 1976; Tufano 1995).

Innovative investment banks that create the new financial products may be compensated for their innovation in two ways: They may earn positive *monopolistic* profits in the *primary* market when the newly created products are issued (Baubonis et al. 1993; Benet, et al. 2006; Burth et al. 2001; Chance and Broughton 1988; Chen and Kensinger 1990; Chen and Sears 1990; Finnerty 1993; Hernandez et al. 2008, 2010a, b, c),[1] and they may also earn profits as *market makers* in the *secondary* market, especially in private placements, and through larger market shares and lower marketing costs than *imitators* in *competitive secondary* markets (Grünbichler and Wohlwend 2005; Marsden and Poskittl 2004; Stoimenov and Wilkens 2005; Tufano 1989; Wilkens and Roder 2003; Wilkens et al. 2003; Wilkens and Stoimenov 2007; Szymanowska et al. 2007).

In this paper, we offer a new financial product known as "*Outperformance Certificates*" to examine whether innovators of structured products earn a profit in the primary market. The results in our paper reveal that indeed innovators of *Outperformance Certificates* can sell the certificate at prices 3–5 % above the *fair value* based upon the *components* of the underlying assets. Our results provide additional evidence that inventors of newly structured products are rewarded for their creative and innovative ability.

Outperformance Certificates (also known by the commercial names of *Sprint Certificates, Accelerator Certificates,* or *Speeders,* but in this paper, they will be referred to as *certificates*) are one of the equity-linked "structured products" issued by major banks in Europe. The rate of return on the investment in the certificates is contingent upon the performance of a *pre-specified underlying equity* or *equity index* over a *pre-specified period* known as *term to maturity*. If the price of the underlying asset goes up during the term to maturity, the investors of the certificates will receive a return equal to a *pre-specified multiple* (known as *participation rate*)[2] times the return on the underlying asset. If the price of the underlying asset goes down during the *term*, the investors of the certificates will receive the *same* return as the underlying asset. In calculating the return on the underlying asset, the certificate issuers will use only the change in the *asset price*, the *cash dividend* paid during the period is not included. In other words, investors in the Outperformance Certificates do not receive cash dividends even if the underlying assets do pay dividends during its term to maturity.[3] The returns on the certificates may or may not be subject to a maximum limit. If the returns on the certificates are subject to a maximum limit, they are referred to as *capped* certificates; otherwise, they are known as *uncapped* certificates. Appendixes 1 and 2 are examples of a capped and an uncapped certificate.

[1] For detailed reports on how technical expertise, investment in information technology infrastructure, and especially the quantitative capabilities of product developers play an important role in the success in the development of new products and in deterring potential imitators to replicate the products, see Simmons (2006), and Mollenkamp and Fleming (2006).

[2] The *participation rate* is always greater than 100 %—that is why the instruments are termed as "*Outperformance*" Certificates.

[3] It turns out the cash dividends play a very important role in certificate issuers' profits. As we will show the underlying assets tend to have higher dividend yields than other stocks in the industry, and a major portion of certificate issuers' profits come from the dividend payment.

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The banks that issued these *certificates* are usually well-recognized large banks in Europe or European branches of major U.S. banks including ABN AMRO, Barclays, Citigroup, Deutsche Bank, DZBANK, Goldman Sachs, HSBC Trinkaus, Société Générale, UBS, WGZ-Bank, and Zürcher Kantonalbank.[4]

We have organized the rest of the paper into seven sections: In Sect. 2, we introduce the design of the certificates. In Sect. 3 we present the pricing model of the certificates. In Sect. 4, we price 1,237 issues of certificates that have complete data. We find that on average issuers earn a profit of 3–5 % in the € 43.1 billion sample. The results show that innovators of the new securities can still earn a profit even though they cannot patent the new product. We further analyze the sources of the profits and find that dividends play a very important role in the issuers' profit. We find that the dividend yields of the underlying securities tend to be higher than the stocks in the same industry and the certificates tend to mature soon after the ex-dividend dates of the underlying assets. These results are reported in Sect. 5. We present the realized gains for the certificates that expired on or before August 21, 2009 in Sect. 6. We conclude the paper in Sect. 7.

2 Description of the product

The rate of return of a certificate is contingent upon the price performance of its underlying asset over its term to maturity, T. The *beginning date* for calculating the gain or loss of the underlying asset is known as the *fixing date* (or *pricing date*) and the *ending date* of the period is known as the *expiration date*. The price of the underlying asset on the *fixing date* is referred to as the *reference price* (or *exercise price,* or *strike price*), and the price of the underlying asset on the *expiration date* is referred to as the *valuation price.*[5]

If we denote I_0 as the *reference price*, I_T as the *valuation price*, I_C the underlying asset price *cap level* imposed by certificate issuers in calculating the maximum *redemption value*, γ as the *participation rate,* then for an initial investment in one certificate, the total value that an investor will receive on the *expiration date* per unit of underlying asset (known as the *redemption value* or *settlement amount*), V_T, is presented in Table 1.

Alternatively, the relationship between the rate of return on a certificate and the rate of return on the underlying asset based upon the change in the underlying asset price (without taking into account dividends) with a participation rate of 200 % and a capped return of 30 % on the *capped* certificate is represented in Fig. 1.

3 Pricing the Outperformance Certificate

The outcome of an initial investment in one uncapped Outperformance Certificate with an *exercise price* of I_0, a *participation rate* of γ, and a term to maturity T is exactly the same outcome of holding the following portfolio of instruments: (1) one underlying asset; (2) a short position in zero coupon bonds. The face values of the bonds are the cash dividends to

[4] For banks offering other structured products, see Szymanowska et al. (2007) for the Dutch market, Wilkens et al. (2003) for the German market, and Burth et al. (2001), and Grünbichler and Wohlwend (2005) for the Swiss market.

[5] For most cases in the sample the *exercise prices* and the *valuation prices* are the *closing* prices on the *fixing date* and the *expiration date* respectively. In a few cases, the *opening* prices or the *average* prices during the previous three trading days are used as *strike* prices or *valuation* prices.

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Table 1 Payoff at Expiration

Certificate	$I_T < I_0$	$I_0 < I_T < I_C$	$I_C < I_T$
Uncapped	I_T	$I_T + (\gamma - 1)(I_T - I_0)$	$I_T + (\gamma - 1)(I_T - I_0)$
Capped	I_T	$I_T + (\gamma - 1)(I_T - I_0)$	$I_T + (\gamma - 1)(I_T - I_0) - \gamma(I_T - I_C)$

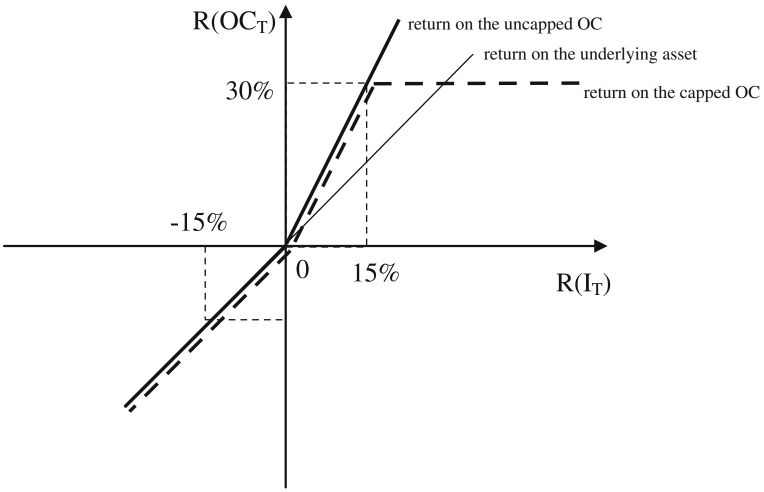

Fig. 1 The rate of return of uncapped and capped Outperformance Certificates, $R(OC_T)$ as a function of the rate of the return on the underlying asset, $R(I_T)$, with a participation rate of 200 %

Table 2 Payoffs at expiration for the portfolios identical to the certificates

Security	Current Value	$I_T < I_0$	$I_0 < I_T < I_C$	$I_C < I_T$
Underlying asset	I_0	I_T	I_T	I_T
Long calls	$(\gamma - 1)\ C_1$	0	$(\gamma - 1)(I_T - I_0)$	$(\gamma - 1)(I_T - I_0)$
Uncapped certificate	$I_0 + (\gamma - 1)\ C_1$	I_T	$I_T + (\gamma - 1)(I_T - I_0)$	$I_T + (\gamma - 1)(I_T - I_0)$
Underlying asset	I_0	I_T	I_T	I_T
Long calls	$(\gamma - 1)\ C_1$	0	$(\gamma - 1)(I_T - I_0)$	$(\gamma - 1)(I_T - I_0)$
Short calls	γC_2	0	0	$-\gamma(I_T - I_C)$
Capped certificate	$I_0 + (\gamma - 1)\ C_1 - \gamma C_2$	I_T	$I_T + (\gamma - 1)\ (I_T - I_0)$	$I_T + (\gamma - 1)(I_T - I_0) - \gamma(I_T - I_C)$

be paid by the underlying asset, and the maturity dates are the ex-dividend dates of cash dividends; 3) $(\gamma - 1)$ call options on the underlying asset. The exercise price of the options is I_0, and the term to expiration of the options is T, the same as the term to maturity of the certificate. Let the call price be $c_1(I_0, T, X, q, r, \sigma)$ a function of underlying asset *reference price*, I_0, time to maturity, T, the exercise price, X, the dividend yield of the underlying asset, q, the risk-free rate, r, and σ is the standard deviation of the underlying asset returns.

Since the payoff of an uncapped certificate is the same as the combined payoffs of the three positions and as suggested in the "*building-block*" approach by Cheung and Chung

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(1996),[6] we can calculate the fair value of the certificate based upon the value of the three positions. The payoffs from the portfolio are shown in Table 2. Therefore, the total cost, TC, for each uncapped certificate is

$$TC = I_0 - PV_D + (\gamma - 1)\ c_1(I_0, T, X, q, r, \sigma) \tag{1}$$

where PV_D is the present value of the cash dividends to be paid by the underlying asset during the term to maturity of the certificate.

In order to replicate the outcome of a capped certificate we need to add one additional position to the replicating portfolio: (4) a short position of γ call options on the underlying asset with an exercise price of I_C and a term to expiration of T. Let the call price be $c_2(I_0, T, X, q, r, \sigma)$. Since the payoff of a capped certificate is the same as the combined payoffs of the above four positions, we can calculate the fair value of the certificate based upon the value of the four positions. Therefore, the total cost, TC, for each capped Outperformance Certificate is represented by the following equation:

$$TC = I_0 - PV_D + (\gamma - 1)\ c_1(I_0, T, X, q, r, \sigma) - \gamma c_2(I_0, T, I_C, q, r, \sigma) \tag{2}$$

If we denote P as the issue price of the certificate, any selling price above the fair value is the gain to the certificate issuer. And the profit function for the issuer of certificates is:

$$\prod = P - TC \tag{3}$$

4 The profitability of Outperformance Certificates

In this section, we examine the profits for issuing Outperformance Certificates. We calculate the profit for each issue of certificate that has all the necessary data for the three different pricing models. We find that issuing certificates is *profitable* for both *types* of certificates based upon all three pricing models.

4.1 Data description

The sample is comprised of 1,507 issues of certificates that were outstanding in August of 2005 issued between July 2003 and August 2005. We developed our sample from the final term sheets published on web pages of each bank.[7] In Table 3, we present the descriptive statistics for both the *uncapped* and the *capped* certificate samples. For *uncapped* certificates, the *median* size is €20.7 million with 500,000 certificates in each issue. The *median* term to maturity is 709 days with a median participation rate of 152 %. The total value issued is €14.9 billion on 596 issues. For *capped* certificates, the *median* size is € 19.5 million with 500,000 certificates in each issue. The *median* term to maturity is 492 days with a median participation rate of 200 %. The total value issued is €28.2 billion on 911 issues. The *combined* value of capped and uncapped certificates is about €43.1 billion on 1,507 issues. It is worth noting that the median participation rate for *capped* certificates of 200 % is *higher* than the median participation rate for *uncapped* certificates of 152 %. That is because *capped* certificates have a ceiling on the returns; therefore, issuers are more willing to *increase* the participation rate to compensate for capped returns.

[6] Cheung and Chung (1996) suggest a complex financial instrument's market value is to be "synthetically" approximated as the sum of its building blocks.

[7] The banks' websites are available from the authors upon request.

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Table 3 Descriptive statistics for the *uncapped* and the *capped* Outperformance Certificate samples

Type	Statistic	Issue size (€ Mill.)[a,g]	Issue size (# of certificates)[b]	Maturity (# of days)	Performance factor	Cap level[c]	Max. redemption level[d]	Issue price[e]	
Uncapped	Mean	25.20	694,730	853	1.59	n.a.	n.a.	100.29	
	Median	20.70	500,000	709	1.52	n.a.	n.a.	100.00	
	Min	0.81	20,000	85	1.08	n.a.	n.a.	92.27	
	Max	211.00	5,000,000	2,563	3.10	n.a.	n.a.	114.42	
	Total amount issued[f]								14,944
	Total number of issues								596
Capped	Mean	31.02	1,058,041	508	2.03	15.13	30.61	99.78	
	Median	19.50	500,000	492	2.00	14.29	28.58	100.00	
	Min	0.92	4,600	146	2.00	3.42	6.84	91.05	
	Max	677.40	200,000,000	1,819	4.00	50.00	100.00	112.05	
	Total amount issued[f]								28,263
	Total number of issues								911

[a] In million Euros

[b] In number of certificates

[c] As a percent above the exercise price

[d] As a percent above the exercise price

[e] As a percentage of the reference price for 584 issues that have the issue price

[f] In million Euros

[g] Three of the 596 issues do not have information about issue amount

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Although not reported, we break down the statistics for the certificates market by the *country* in which the issuing banks are located and by the issuers. Germany dominates the market with 73 % of the issues and 80 % of the value. When we break down the certificate market statistics by issuers, the issuers of the certificates are all major banks in Europe such as BNP Paribas of France (with 288 issues for €8.29 billion), Deutsche Bank of Germany (with 154 issues for €6.94 billion), UBS of Switzerland (with 151 issues for €6.00 billion), DZ Bank of Germany (with 94 issues for €5.19 billion), UBS of Switzerland (with 115 issues for €4.92 billion), Sal. Oppenheim of Germany (with 136 issues for €4.13 billion), BHF bank of Germany (with 88 issues for €1.97 billion), and Vontobel of Germany (with 53 issues for €1.91 billion).

In order to calculate the profit, we need the following data for each certificate: (1) the price of the certificate, P, (2) the *reference price* of the underlying asset, I_0, (3) the cash dividends to be paid by the underlying assets and the ex-dividend dates, (4) the risk-free rate of interest, r, (5) the exercise price of the options component in the certificate, X, (6) the volatility of the underlying asset, σ, (7) the term of maturity of the certificate which is also the term to expiration of the option, T, (8) the *participation rate*, γ, and (9) the cap level, I_C, for a capped certificate.

The prices for the certificate, P, are obtained from the final term sheets published on the web pages of each bank. We further double-check the prices and other variables from the Bloomberg Information System and several websites to ensure the accuracy of the data.[8] The prices of underlying assets are obtained from Bloomberg; dividend data are taken from IBES on Bloomberg; and the risk-free rates of interest are the yields of government bonds of which the terms to maturity match those of the certificates.[9] The exercise prices (X) of the options, the terms to maturity of the certificates (T), the participation rate (γ), and the cap levels (I_C) for capped certificates are all taken from the final term sheets. The volatilities (σ) of the underlying assets are the implied volatility obtained from Bloomberg based upon the *call* options of the underlying asset.[10,11]

4.2 Methodology

Note that the underlying asset may pay discrete dividends during the life of Outperformance Certificates. The present value of these discrete dividendsPV_D is equal to $\sum_{i=1}^{n} D_i e^{-rt_i}$, where $D_i$is paid at ith ex-dividend date t_i. These discrete dividends play an important role in measuring the profit for issuing the certificates and should be properly dealt with. Frishling (2002) lists three popular models as follows:[12]

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8 These websites include OnVista (Germany http://www.onvista.de/), the Yahoo (Germany http://de.yahoo.com/), ZertifikateWeb (Germany http://www.zertifikateweb.de/), TradeJet (http://www.tradejet.ch), Berlim-Bremen Boerse Stock Exchange (http://www.berlinerboerse.de), Stuttgart Boerse Stock Exchange (http://www.boerse-stuttgart.de/), and Swiss Stock Exchange (http://www.swx.com).

9 When we cannot find a government bond that matches the term of maturity for a particular certificate, we use the linear interpolation of the yields from two government bonds that have the closest maturity dates surrounding that of the certificate.

10 The implied volatility calculated by the Bloomberg System is the weighted average of the implied volatilities for the three call options that have the closest at-the-money strike prices. The weights assigned to each implied volatility are linearly proportional to the "degree of near-the-moneyness" (i.e. the difference between the underlying asset price and the strike price) with the options which are closer-to-the-money receive more weight.

11 For alternative formulas to compute implied standard deviations, see Ang et al. (2009).

12 For alternative models, see Chen et al. (2009) and Lee et al. (2004).

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Model 1 Roll (1977) suggests that the stock price is divided into two parts: the net-of-dividend stock price (i.e., $I_0 - PV_D$) and PV_D. The former part is assumed to follow a lognormal diffusion process; whereas the latter part is assumed to grow at the risk-free rate. Vanilla options can be computed by applying the Black–Scholes formula with the stock price replaced by the net-of-dividend stock price.

Model 2 Musiela and Rutkowski (1997), following Heath and Jarrow (1988), suggest that the cum-dividend stock price process, defined as the stock price plus the forward values of all paid dividends, follows a lognormal diffusion process. Thus, vanilla options can be computed by applying the Black–Scholes' formula and by adding the forward values of the dividends prior to maturity to the strike price.

Model 3 The stock price declines by the same amount of dividend paid on the ex-dividend date and it follows lognormal price process between two ex-dividend dates. Approximating pricing formulas for vanilla options are obtained in Bos and Vandermark (2002) and Dai and Lyuu (2008).

Frishling (2002) shows that the above three models may generate very different option prices. While Model 3 generates more reasonable option prices, Model 1 (Model 2) tends to undervalue (overvalues) the option prices. To explain this phenomenon, Bos and Vandermark (2002) show that both Model 1 and Model 2 violate a perfectly reasonable continuity requirement. A dividend paid just before maturity should be equivalent to an increase in the exercise price by the dividend amount. Model 1 subtracts the present value of future dividends from the stock price as input to the Black–Scholes formula, but this is not equivalent to adding the dividend amount to the exercise price. Likewise, a dividend paid just after the option's initiation date should be equivalent to a decrease in the stock price. Model 2 adds the forward values of dividends to the stock price as input to the Black–Scholes formula, which causes the same problem. This phenomenon can be observed by comparing the pricing results of these three models against the ex-dividend date as illustrated in Fig. 2.

4.3 Empirical results of the profitability analysis

Therefore, the profit for each issue of the certificates can be calculated by Eq. (3). We calculated the profit for each *uncapped* and *capped* certificate that has complete data (580 issues of uncapped certificates and 657 issues of capped certificates, with a total of 1,237 issues).

It is evident from Eq. (1) that higher dividend yield for underlying assets will reduce the total cost, TC (and therefore increase the profit $\prod$) for issuing certificates in two ways: a higher dividend yield will lead to a *higher* value of PV_D and it will also lead to a *lower* value of the option C. We will show in Sect. 6 of the paper that in choosing the underlying assets, certificate issuers tend to choose the underlying assets with high dividend yields in the industry.

The profitability is measured by the profit ($\prod$) as a percentage of the total issuing cost (TC):

$$\text{Profitability} = (\text{P} - \text{TC})/\text{TC} \tag{4}$$

The results in Table 4 show that average profit for all the 580 issues of *uncapped* certificates in the sample is between 2.72 and 3.32 % above the issuing cost and the average profit for the 657 issues of *capped* certificates is between 4.29 and 4.55 %. With a total sample value of €14.9 billion for the *uncapped* certificates and a total sample value of €28.3 billion for the *capped* certificates, the profitability measures translate into a profit of

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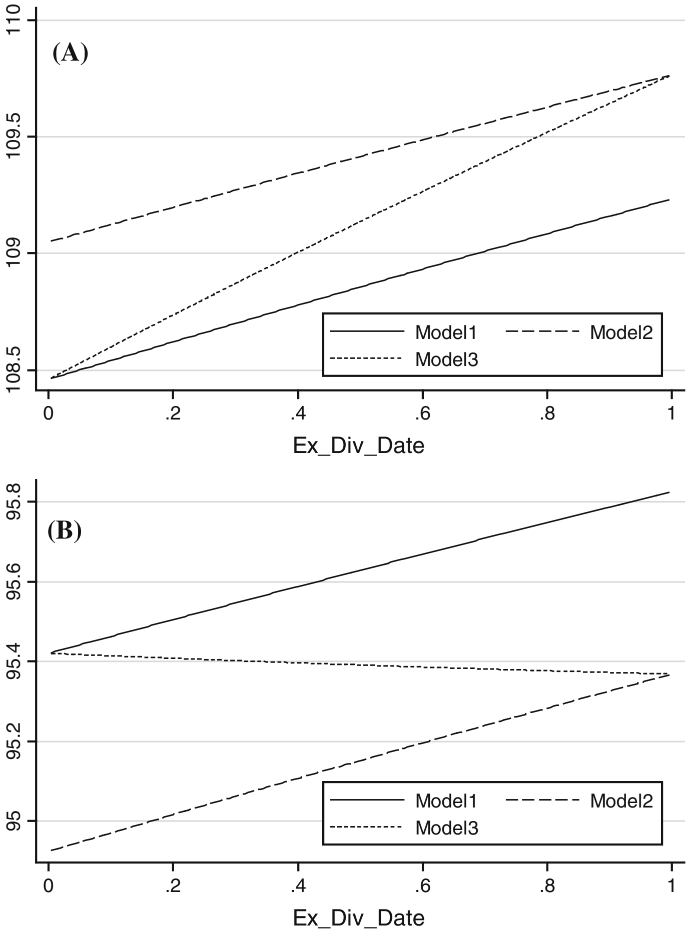

Fig. 2 Theoretical prices of the certificates as a function of the *ex-dividend date*. Model 1, Model 2, and Model 3 denote the option prices generated by Model 1, Model 2, and Model 3 respectively. The *uncapped* certificate example (**a**) is based on: underlying asset price = $100, term to maturity = 1 year, risk free rate = 10 %, volatility = 30 %, participation rate = 200 %, dividend = $5. The *capped* certificate example (**b**) is based on the same numerical settings of the uncapped example plus a cap at $120 (i.e. maximum redemption amount $140)

€405-€495 million approximately for the *uncapped* certificates and a profit of €1.2-€1.3 billion approximately for the *capped* certificates for a total profit of €1.2-€1.8 billion for the entire Outperformance Certificate sample.[13] The empirical distributions of the profits for *uncapped* and *capped* certificates based upon Model 1 are illustrated in Fig. 3.

[13] The sample of certificates finally priced in the study is smaller than the original sample of securities because not all data needed for pricing was available. In this process, 16 uncapped certificates were dropped and no particular pattern is observed. For capped certificates, 254 cases were dropped and most of them (245 cases) are from the BNP Bank. We do not know the exact impact of those cases on the results; however, we know that BNP Bank, on average, made a profit of 0.66 % on the uncapped certificates. Bearing this in mind, we can estimate that the profitability of capped certificates could be around the same values as the uncapped certificates, 3.3 %.

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Table 4 Profitability in the primary market

Type	Statistic	Model 1	Model 2	Model 3	
Uncapped	Mean	3.31	2.72	2.99	
	p value	<0.001	<0.001	<0.001	
	Min	−11.60	−11.60	−11.60	
	Max	23.51	21.48	22.08	
	n				580
Capped					
	Mean	4.29	4.55	4.43	
	p value	<0.001	<0.001	<0.001	
	Min	−13.00	−13.00	−13.00	
	Max	21.14	22.31	21.96	
	n				657
Total					
	Mean	3.83	3.69	3.75	
	p value	<0.001	<0.001	<0.001	
	Min	−13.00	−13.00	−13.00	
	Max	23.51	22.31	22.08	
	n				1,237

Profitability measured by the profit ($\prod$) as a percentage of the total issuing cost for the Outperformance Certificates by certificate type. Model 1, Model 2, and Model 3 denote the option prices generated by Model 1, Model 2, and Model 3 respectively. The p value tests the probability that the profitability is equal to zero

The results indicate that the profit of issuing the certificates is *positive* and statistically significant, making the issuance of the certificates a profitable business for the issuing firms. Although not reported in this paper, when we break down the profit by countries in which the certificates are issued, by issuers, by term to maturities, and by industries the underlying assets are in, the profit for issuing the certificates can consistently be observed. The results are in line with previous studies discussed in Sect. 1 where issuing prices are compared with theoretical fair values. In addition, the prices are particularly similar to the results in the study of Hernandez, Brusa, and Liu (2008) in which they analyzed the Bonus Certificates market. Bonus Certificates and Outperformance Certificates are similar in several respects. First, in terms of positive potentials, the return patterns for both products are exactly the same. Secondly, when the returns on these two products are positive, the returns on these products are greater than 100 % of the returns on the underlying securities. Thirdly, when the returns are positive, the returns may be capped or uncapped. With respect to the downside potential, Outperformance Certificates offer no protection while Bonus Certificates offer a downside protection, conditional on whether the price of the underlying asset drops below the pre-specified *knock-in* level or not. Hernandez, Brusa, and Liu (2008) show that Bonus Certificates are more popular than Outperformance Certificates with a market value of €123 billion in comparison to the total market value €43 billion for Outperformance Certificates. In addition, they also show that Bonus Certificates are overpriced by 2.60 and 3.08 % for uncapped and capped certificates respectively. Our results appear to confirm the life cycle hypothesis for structured products (Wilkens et al. 2003, Stoimenov and Wilkens 2005; Entrop et al. 2009; Fig. 2).

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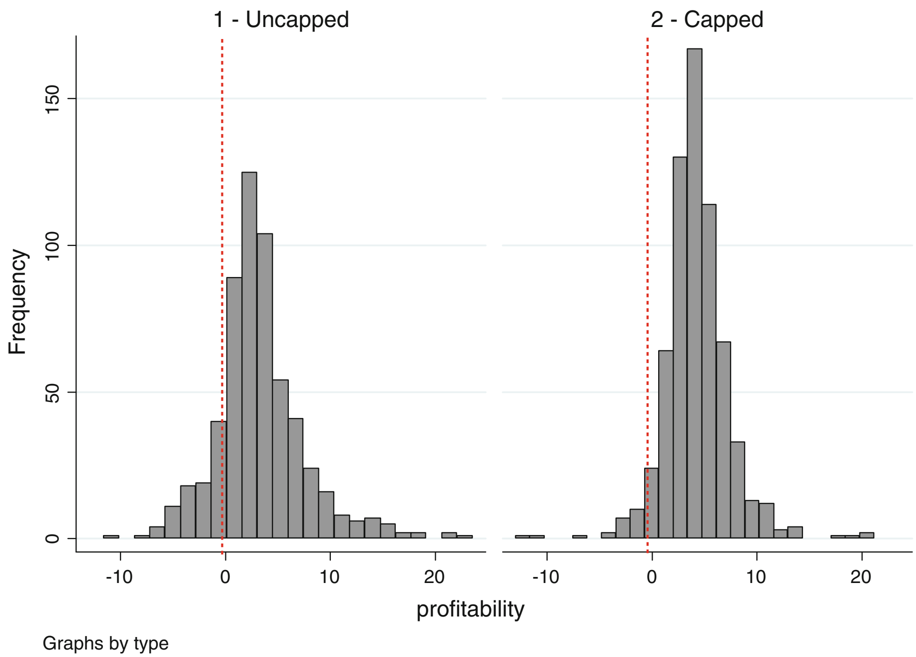

Fig. 3 Distributions of the profits in the primary market based on Model 1 by certificate type

However, there are some caveats that apply to these results. New instruments, particularly over-the-counter ones, do not have deep markets and illiquidity can be a source of premium (Amihud 2002; Longstaff et al. 2005; Chen et al. 2007). Illiquidity can also lead to limitations on trades which are needed to unwind abnormal profits or to hedge using options with same terms to maturity or with the same exercise prices of the certificate (Cochrane 2002; Ofek and Richardson 2003; Hong et al. 2006). The profits calculated at issuance are gross profits before any design or marketing cost. Even though the certificates are unsecured obligations, we assumed the counterparty default risk is negligible since the issuers are high quality banks. Finally, the pricing of the certificates is based upon the fair value of combined positions that have the same payoff as the payoff of the certificates. The replicating portfolio includes one or more options that do not exactly match exchange traded or OTC traded options in terms of maturity dates or exercise prices. By pricing the options with theoretical prices and not using exchange traded or OTC traded option prices we may overestimate the profits of the issuers.[14]

In order to measure how the profit of the Outperformance Certificates are affected by the characteristics of the certificates and the issuers, we also run an ordinary least square regression analysis for issuers' profit as a function of thirteen variables related to the characteristics of the bonds and the issuers. The thirteen variables are (1) the volatility of

[14] An alternative approach suggested in the literature is to consider transaction costs. Leland (1985) derives a modified version of the Black–Scholes formula to account for transaction costs and Boyle and Vorst (1992) price the options based upon a discrete time tree model when there are proportional transaction costs. The analyses based upon these models, however, require the availability of transaction costs which we cannot obtain for the bond issues.

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the underlying asset in percentage (Volatility); (2) the dividend yield of the underlying asset in percentage (Dividend Yield); (3) the term to maturity of the bond in years (Time to Maturity); (4) the strike price of the option component in the bond as a percentage of the reference price of the underlying asset (Strike); (5) the participation rate in percentage (Participation Rate); (6) a dummy for *capped* Outperformance Certificates (Capped); (7) the market capitalization of the underlying asset in € millions (MC of Underlying); (8) the issue size in € millions (Issue Size); (9) the total number of exchanges where the bond is listed (Listings); (10) the issuer's market share in the outperformance certificate market in percentage (Market Share); (11) the issuer's return on assets in percentage (ROA); (12) the issuer's market capitalization in € millions (MC of Issuer); and (13) a dummy variable for cases where the underlying asset is in the same country as the issuer (Home Bias). Variables 1–6, traditional inputs of option pricing formulas, are used as control variables and variables 7–13 as instruments to test the influence of specific factors on the mispricing of the bonds. The value of each variable used in the regressions is adjusted for the mean in the sample.

The results of regression analysis, presented in Table 5, show that the profit of the bond is *positively* associated with the volatility and the dividend yield of the underlying assets, the term to maturity of the certificates, the strike price of the option component in the certificate, the market capitalization of the underlying asset, the issue size of the certificate, and when the certificate is capped. Since these certificates perform like call options, greater volatility of the underlying assets provides an incentive for investors to purchase the certificates; therefore creates greater demand for the certificates and the greater the demand in turn creates greater profit opportunities for the issuers. The term to maturity of the certificate and the dividend yield of the underlying asset are positively related to the issuers' profit, as expected, because investors in the certificates do not receive the dividends paid by the underlying assets. The reason for dividend yield to be positively correlated to the issuers' profit will be further explained in the next section (Sect. 5) and the longer the term to maturity, the greater the dividends will be paid out, which is similar to a situation of higher dividend yield. Since the value of a call option is a decreasing function of the strike price, we anticipate the profit of issuers', who takes short positions in calls, to be positively correlated to strike prices. The results show that issuing capped certificates tends to be more profitable than uncapped certificates because in capped certificates investors' gains are restricted by the cap. Finally, the possible relationship between issuers' profit and issue size may be explained by the banks' economies of scale. Unfortunately, further analysis of issuer-specific factors on the pricing behavior would be desired, but it would require information not publicly available (e.g. profits from issuance of other over-the-counter products, hedging costs, etc.).

5 Explanations for the profitability of the certificates

In this section, we provide explanations for the success of the certificates. Given that investors in certificates do *not* receive the dividends paid by underlying assets, interestingly three related questions arise in terms of the dividend payment of the underlying assets:

First, it is interesting to know whether the issuance of certificates can still be profitable if the issuers *had* promised paying the dividends of the underlying assets to the certificate investors; In other words, what role does the absence (or the presence) of dividend payment play in the profitability of the certificate issues? The results of our analyses suggest that if

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Table 5 This table presents the results of the OLS regression analysis for the issuer's profit as a function of (1) the volatility of the underlying asset in percentage (volatility), (2) the dividend yield of the underlying asset in percentage (dividend yield), (3) the term to maturity of the bond in years (time to maturity), (4) the strike price of the option component in the bond as a percentage of the reference price of the underlying asset (strike), (5) the performance factor in percentage (performance factor), (6) a dummy for *capped* Outperformance Certificates (capped), (7) the market capitalization of the underlying asset in € millions (MC of underlying), (8) the issue size in € millions (issue size), (9) the total number of exchanges where the bond is listed (listings), (10) the issuer's market share in the outperformance certificate market in percentage (market share), (11) the issuer's return on assets in percentage (ROA), (12) the issuer's market capitalization in € millions (MC of issuer), and (13) a dummy variable for cases where the underlying asset is in the same country as the issuer (Home Bias)

Variable	Model								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	1.5747	1.2352	1.5622	1.8012	1.5568	1.5418	1.7885	1.7199	2.2574
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Volatility[a]	0.0752	0.1194	0.0812	0.0760	0.0781	0.0563	0.0546	0.0739	0.1117
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Dividend yield[a]	0.9971	1.0741	1.0068	0.9970	0.9932	0.8997	0.8108	0.9871	0.7554
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Term to maturity[a]	1.0553	0.9315	0.9757	1.0705	1.0299	1.0438	0.9770	1.0543	0.7503
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.063)
Strike[a]	0.1916	0.1841	0.1950	0.1922	0.1915	0.1913	0.2324	0.1918	0.2479
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Performance factor[a]	0.0015	−0.0024	0.0008	0.0013	0.0020	0.0036	0.0077	0.0013	0.0064
	(0.705)	(0.541)	(0.840)	(0.750)	(0.614)	(0.386)	(0.099)	(0.734)	(0.173)
Capped	4.1298	4.7256	4.2042	4.2141	4.1639	4.0654	3.6070	4.1973	3.3393
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001
MC of underlying[a]		4.13E−06							6.00E−06
		(0.166)							(0.117)
Issue size[a]			0.0070						0.0141
			(0.007)						(<0.001)
Listings				−0.1066					−0.1507
				(0.424)					(0.566)

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Table 5 continued

Variable	Model								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Market share[a]					−0.0284				−0.0572
					(0.240)				(0.098)
ROA[a]						−0.3312			−0.5318
						(0.187)			(0.149)
MC of issuer[a]							1.53E−06		3.04E−06
							(0.596)		(0.374)
Home bias								−0.2569	−0.1320
								(0.167)	(0.063)
Number of obs.	1,237	1,234	1,234	1,237	1,237	1,085	840	1,237	643
Adjusted R^2	0.2337	0.2355	0.2355	0.2335	0.2339	0.2265	0.2247	0.2342	0.2485

p values are listed in parentheses

[a] Mean adjusted values

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certificate issuers had promised to pay dividends of the underlying assets, the profit will be significantly reduced and even completely wiped out.

The importance of the absence of dividend payment in the profitability of certificate issuance leads to the second interesting question: do certificate issuers have an incentive to use the level of dividend yield as a selection criterion for underlying assets? In other words, do certificate issuers have a tendency to select stocks with *high* dividend yield as the underlying assets? Since the certificate issuers only pay the investors based upon the *price appreciation* of the underlying assets but not based upon *dividends*, do certificate issuers have an incentive to select securities that pay *high* dividend so that issuers of certificates can capture the benefits of the price drop of the underlying asset over the life time of the certificates? The results of our analyses suggest yes and the underlying securities tend to have *higher* dividend yields than the average dividend yield for all the stocks in the same *industry* at the *country* level as well for the *region* (i.e. Western Europe).

Since the dividend yield plays such an important role in the profitability of certificate issuance and since certificate issuers tend to select *high* dividend yield stocks as the underlying securities, we further ask the question: do certificate issuers have an incentive to *time* the *maturity date* of the certificates by making certificate mature *soon* after the *ex-dividend date* on which the underlying asset price tends to drop? We also find evidence supporting this conjecture. Now we present evidence for each of the above three questions.

From Eqs. (3) and (1), the profit function of an uncapped certificate is:

$$\Pi = \mathrm{P} - [\mathrm{I}_0 - \mathrm{PV_D} + (\gamma - 1)\mathrm{c}_1(\mathrm{I}_0, \mathrm{T}, \mathrm{X}, \mathrm{q}, \mathrm{r}, \sigma)] \tag{5}$$

If the certificate issuers have to pay dividends to investors and the certificate is selling at par (i.e. $P = \mathrm{I}_0$), then the new profit function for the uncapped certificate becomes Equation (6) below, which is always negative:

$$\begin{aligned} \Pi' &= \Pi - \mathrm{PV_D} \\ &= -(\gamma - 1)\,\mathrm{c}_1(\mathrm{I}_0, \mathrm{T}, \mathrm{X}, \mathrm{q}, \mathrm{r}, \sigma) \end{aligned} \tag{6}$$

If an uncapped certificate issuer had promised to pay dividends of the underlying assets to investors, and the certificate is selling at *par* (or *discount*), then the issuer would suffer losses in issuing the certificate. Therefore, in order to make a profit the issuer must sell the certificate at a premium (even in this case, the profit would have been significantly reduced due to the dividend payment to the certificate investors). Since most issuers choose to sell the certificates at or close to *par*,[15] the profit of the certificates is mainly contributed by not making dividend payment to investors.

Similarly, we know that the profit function for a capped certificate is:

$$\Pi = \mathrm{P} - [\mathrm{I}_0 - \mathrm{PV_D} + (\gamma - 1)\,\mathrm{c}_1(\mathrm{I}_0, \mathrm{T}, \mathrm{X}, \mathrm{q}, \mathrm{r}, \sigma^2) - \gamma\,\mathrm{c}_2(\mathrm{I}_0, \mathrm{T}, \mathrm{X}, \mathrm{q}, \mathrm{r}, \sigma^2)] \tag{7}$$

If the certificate issuers have to pay dividends to investors and the certificate is selling at par (i.e. $P = \mathrm{I}_0$), then the new profit function for the capped certificate becomes:

$$\begin{aligned} \Pi' &= \Pi - \mathrm{PV_D} \\ &= -(\gamma - 1)\,c_1(\mathrm{I}_0, \mathrm{T}, \mathrm{X}, \mathrm{q}, \mathrm{r}, \sigma^2) + \gamma\,\mathrm{c}_2(\mathrm{I}_0, \mathrm{T}, \mathrm{X}, \mathrm{q}, \mathrm{r}, \sigma^2) \end{aligned} \tag{8}$$

[15] As shown in Table 1, both the median and the mean of the selling price of the certificate, P, as a percentage of the underlying asset price on the issue date, I_0, are equal to or very close to 1.00.

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Table 6 In panel A we compare the dividend yield for all 143 underlying securities with the average dividend yield for all the firms in the same industry at the country level as well as the regional level

	Underlying Asset	Country	Region
Panel A			
Average dividend yield (%)	2.28	1.61	1.64
p value[a]		<0.001	<0.001
Percentile rank[b]		76.1	68.8
p value[c]		<0.001	<0.001
Panel B			
Average market capitalization (€ million)	39,665	12,004	4,122
p value[d]		<0.001	<0.001
Percentile rank[b]		92.8	94.7
p value[c]		<0.001	<0.001

We also calculate the average ranking in dividend yield of underlying assets against all the firms in the same industry at the country level as well as at the regional level. In panel B we compare the market capitalization for all 143 underlying securities with the average market capitalization for all the firms in the same industry at the country level as well as the regional level. We also calculate the average ranking in market capitalization of underlying assets against all the firms in the same industry at the country level as well as at the regional level

[a] The probability that the difference between the underlying asset's dividend yield and the average dividend yield for all the firms in the same industry to be zero

[b] The formula used to compute the percentile ranking is the following: percentile ranking $= \left[\frac{\frac{N-\text{absolute rank}+1}{N}+\frac{N-\text{absolute rank}}{N}}{2}\right]$

[c] The probability that the percentile ranking is indifferent from 50 %

[d] The probability that the difference between the underlying asset's market capitalization and the average market capitalization for all the firms in the same industry to be zero

Although the $\prod'$ may still be positive, depending on the relationship between $\gamma\,(1-\gamma)$, $c_1(I_0, T, X, q, r, \sigma^2)$ and $c_2(I_0, T, X, q, r, \sigma^2)$,[16] the profit $\prod'$ is unambiguously smaller than $\prod$ by the value of PV_D.

Given that the certificate issuers do *not* pay dividends to investors and *not* paying dividends plays an important role in the profitability of the issuers, it is natural to ask the second question: do issuers have an incentive to choose underlying assets that have *higher* dividend yield?

In order to answer this question, we compare the dividend yield of the underlying assets with the average dividend yield of all the stocks in the same industry at country level as well as at the regional level (i.e. Western Europe). We also calculate the percentile ranking in dividend yield for the underlying assets against all the stocks in the same industry at the country level as well as at the regional level. We present the results in Panel A of Table 6. The dividend yield for all the underlying assets (2.28 % on average) is statistically significantly higher than the average dividend yield for the stocks in the same industry at the country level (1.61 % on average) and at the regional level (1.64 % on average). The average percentile ranking of the underlying assets' dividend yield among all the stocks in the same industry is 76 % at the country level and 69 % at the regional level. The results

[16] That is because $(\gamma-1)<\gamma$, but $c_1(I_0, T, X, q, r, \sigma^2) > c_2(I_0, T, X, q, r, \sigma^2)$ due to that the former is a call with an exercise price of X, while the latter is a call with a higher exercise price of I_C.

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indicate that the dividend yields of underlying assets are significantly higher than the average dividend yield for the stocks in the same industry.

Along the same line that certificate issuers select underlying securities to increase the profits, we hypothesize that in order to enhance the marketability of the certificates to potential investors; issuers have a tendency to select securities that are highly recognized by investors. Therefore, we hypothesize that the underlying securities tend to be the stocks of large firms. In addition, stocks of large firms are also more liquid in the equity market and their options are also more widely held. The liquidity of the stocks and options will facilitate the hedging for issuing certificates. Based upon the hypothesis, we empirically examine the firm size of the underlying securities as measured by the market capitalization and the results are reported in Panel B of Table 6. As shown in the panel, the market capitalization for the underlying assets of the certificates (€39.7 billion on average) is significantly higher than the average market capitalization of the firms in the same industry at the country level (€12.0 billion on average) as well as at the regional level (€4.1 billion on average). The average percentile ranking of the market capitalization for the underlying assets among all the stocks in the same industry is 93 % at the country level and 95 % at the regional level. The results confirm our hypotheses.

To answer the question of whether certificate issuers have an incentive to time the *maturity date* of the certificates by making certificate mature *soon* after the *ex-dividend date* so that they can take advantage of the price drop of the underlying asset after the ex-dividend date, we calculated, for each issue of the certificate, the number of days between the maturity date of a certificate and the ex-dividend date of the underlying asset immediately *before* the maturity date, as a percentage of the number of days between two

Table 7 Average number of days between the maturity date of a certificate and the ex-dividend date of the underlying asset immediate before the maturity date, as a percentage of the number of days between two consecutive ex-dividend dates, breaking down by the frequency of the dividend payment per year (i.e. once per year, twice per year, and four times per year)

	Dividend payment frequency			
	1 per year	2 per year	4 per year	Pooled
Uncapped				
n	407	91	18	516
Mean value[a]	0.27	0.36	0.50	0.29
Equality dist. test p value[b]	<0.001	<0.001	0.44	<0.001
Normality test p value[c]	<0.001	<0.001	0.20	<0.001
Capped				
n	460	30	12	502
Mean value[a]	0.44	0.57	0.43	0.45
Equality dist. test p-value[b]	<0.001	0.79	0.20	<0.001
Normality test p-value[c]	<0.001	<0.001	0.78	<0.001

[a] Number of days between the maturity date of a certificate and the ex-dividend date of the underlying asset immediate before the maturity date, as a percentage of the number of days between two consecutive ex-dividend dates

[b] Probability that the average time between the expiration date of the certificate and the previous ex-dividend date of the underlying asset, as a percentage of the time between ex-dividend dates is equal to 0.50

[c] Probability that the distribution of the time between the expiration date of the certificate and the previous ex-dividend date of the underlying asset, as a percentage of the time between ex-dividend dates is normal

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consecutive ex-dividend dates. Our hypothesis is that in the absence of deliberate choice of the certificate's maturity date, the maturity date on average should fall near the middle of two consecutive ex-dividend dates. Therefore, the average number of days between the maturity date of the certificate and the ex-dividend date immediate before the maturity date as a percentage of the number of days between two consecutive ex-dividend dates should be insignificantly different from 0.5. In case the issuers of the certificates purposely design the maturity date in such a way that the certificates mature *soon* after an ex-dividend date, we would expect the measure to be significantly less than 0.5. We present the test results in Table 7.

Since the underlying securities may pay dividends annually, semi-annually, or quarterly (with the majority of stocks paying dividends annually in Europe), we break down the data by the frequency of the dividend payment per year. As shown in Table 7, for both the *uncapped* and the *capped* certificates, the majority of certificates tend to mature soon after an ex-dividend date with the measure being significantly less than 0.5. The results in the table suggest that the certificate issuers tend to time the maturity date of the certificate in such a way that certificates mature soon after the ex-dividend dates.

6 The performance of Outperformance Certificates

We also analyze the expired Outperformance Certificates as of August 21, 2009. The 1,216 issues of expired certificates represent approximately 98 % of the 1,237 issues we priced in Sect. 4 of the paper. In addition to the realized return for each of the expired Outperformance Certificates, we also calculate, for each certificate, the total return (price appreciation plus dividend) on the underlying asset as well as the total return on a benchmark index to which the underlying securities belong over the same period as the term to maturity of the Outperformance Certificates and results are presented in Table 8.

Table 8 Realized return for the expired cases as of August 21, 2009 by type

Security type	Annualized total return			
	Statistic	Outperformance Certificates	Underlying securities	Market indices
Uncapped	Mean	24.21	20.77[a]	20.75[b]
	SD	26.87	19.17	9.43
	n			560
Capped	Mean	14.64	23.06[a]	23.37[b]
	SD	13.81	18.96	7.50
	n			656
Total	Mean	19.05	22.01[a]	22.16[b]
	SD	21.40	19.08	8.54
	n			1,216

The statistics include the mean, standard deviation, and number of observations of the annualized total return for the certificates, underlying securities, and the indices comprehensive of the market of the underlying securities

[a] The average difference of the underlying asset's return and the certificate's return is equal to zero and significant at the 0.01 level

[b] The average difference of the index's return and the certificate's return is equal to zero and significant at the 0.01 level

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As shown in Table 8, the realized return on uncapped (capped) Outperformance Certificates tends to be *higher* (*lower)* than the return on underlying assets. The results also indicate that the risk of uncapped (capped) certificates as measured by the standard deviation is also *higher* (*lower)* than the standard deviation of the underlying assets. For instance, for the uncapped certificates, the average realized return is 24.21 %, which is higher than the return on the underlying asset (20.77 %), and the standard deviation for the certificates is 26.87 %, which is also higher than the standard deviation for the underlying assets (19.17 %). On the other hand, for capped certificates, the average realized return is 14.64 %, which is lower than the return on the underlying asset (23.06 %), and the standard deviation for the certificates is 13.81 %, which is also lower than the standard deviation for the underlying assets (18.96 %). The same results are observed when the certificates are compared with the benchmark indices. However, the standard deviations of the indices' returns are lower than the standard deviations of the underlying assets' returns because indices contain large portfolios of stocks; and therefore, the risk (standard deviations) of indices are more diversified than individual underlying assets.

7 Conclusion

In this paper, we analyze a newly structured product known as Outperformance Certificates, and we provide detailed descriptions of the product specifications. In addition, we also study the €43 billion certificate sample by examining 1,507 issues of the certificates issued by major banks in Europe. We further present pricing models for two types of certificates—uncapped and capped certificates—and we empirically examine the profits in the primary market for issuing the two types of certificates. We find that issuance of the certificates is profitable for the issuers in our sample. We further show that the dividend yield plays a very important role in the profitability of issuing the certificates. The dividend yield of the underlying assets tends to be higher than the average dividend yield. We also find that issuers tend to select underlying securities with *large* market capitalization. Issuers also tend to select the *maturity dates* so that the certificates mature *soon* after the *ex-dividend dates* of the underlying securities.

This paper, to the best of our knowledge, is the first to study systematically the Outperformance Certificates in a large scale. The study provides insights into the design, the payoff, the pricing, and the profitability of the newly designed financial products. The methodology and approach used in this paper can be easily extended to the analysis of other structured products.

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Appendix 1: Example of an uncapped performance certificate

The uncapped certificate in Appendix 1 was issued by investment bank UBS using Daimler-Chrysler as the *underlying asset*. The *fixing date* UBS set for the certificate was

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March 24, 2006 and the *issue price* of the certificate (i.e. the stock price on the *fixing date*) was €46.85. The date that an investor must make the payment for the purchase of the certificate (known as the *payment date*) was March 31, 2006. The *expiration date* (i.e. the date on which the closing price of the underlying asset will be used as the *valuation price*) was set on May 11, 2009 and the *performance ratio* for the certificate was set 150 %.

UBS Investment Bank	
UBS Outperformance Certificates on DAIMLERCHRYSLER	
Underlying: Valor: 945657; ISIN: DE0007100000; Reuters: DCXGn.DE; Bloomberg: DCX GY	
Product details	
Underlying	DAIMLERCHRYSLER
Ratio	1:1
Reference price	EUR 46.85
Issue price	EUR 46.85
Strike price (Pb)	EUR 46.85
Participation rate (PR)	150.00 %
Security identification codes	ISIN: CH0024234764
Dates	
Issue date	27.02.2006
Subscription period	27.02–24.03.2006
Fixing date	24.03.2006
Initial payment date	31.03.2006
Last trading day	07.05.2009
Expiration date	11.05.2009
Redemption date	18.05.2009
General information	
Issuer	UBS AG, London Branch
Lead manager	UBS Limited, London
Issue Size	500,000
Structure	Long Underlying + At-the-money Strike Call
Redemption	The Holder of 1 UBS Outperformance Certificate has the right to receive at the Redemption Date the Redemption Amount in Euro which is calculated according to the following formulae: 1) If $\mathrm{Pv} > \mathrm{Pb}$ $\quad \mathrm{R} = [\mathrm{Pb} + (\mathrm{Pv} - \mathrm{Pb}) * \mathrm{PR}] * \mathrm{Ratio}$ 2) If $\mathrm{Pv} \leq \mathrm{Pb}$ $\quad \mathrm{R} = \mathrm{Pv} * \mathrm{Ratio}$ With: R = redemption amount Pv = valuation price Pb = strike price PR = participation rate
Valuation price	Closing price of the underlying on the expiration date
Listing	Frankfurt, Stuttgart (third section)

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Appendix 2: Example of a capped performance certificate

The example of the *capped* certificate in Appendix 2 was issued by UBS using Nokia as the *underlying asset*. The *fixing date* (or *pricing date*) UBS set for the certificate was July 12, 2004 and the *issue price* of the certificate (i.e. the closing stock price on the *pricing date*) was €11.59. The date that an investor must make the payment for the purchase of the certificate (known as the *payment date*) was July 14, 2004. The *expiration date* (i.e. the date on which the closing price of the underlying asset will be used as the *valuation price*) was set on July 14, 2006 with a term to expiration of 2 years. The *performance factor* for the certificate was set 200 %. The *cap level* (the maximum *valuation price* to be used for calculating the *redemption value* (also known as *settlement amount*) of the certificate) was set at €14.80, which would generate a net return of 55.39 %.

UBS Investment Bank

Speeder on NOKIA OYJ

Underlying: Valor: 945657; ISIN: DE0007100000; Reuters: DCXGn.DE; Bloomberg: DCX GY

Product details	
Underlying	NOKIA OYJ
Reference price	EUR 11.59
Issue price	EUR 11.59
Strike price (Pb)	EUR 11.59
Cap level (C)	EUR 14.80
Conversion	1:1
Maximum return	55.3925798 %
Security no.	ISIN: CH0018906567
Dates	
Issue date	28.06.2004
Pricing date	12.07.2004
Payment date	14.07.2004
Last trading day	12.07.2006
Expiration date	14.07.2006
Redemption date	21.07.2006
General information	
Issuer	UBS AG, London Branch
Lead manager	UBS Limited
Issue size	500,000
Redemption	Physical settlement of underlying if underlying at expiration closes lower than strike price
	If the closing price of the Underlying at expiration is higher than or to the strike price but lower than the Cap level, the holder of 1 certificate receives a settlement amount which is calculated as follows:
	$A = [S + 2 * (CP - S)\ ] * R$

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Appendix continued

	where: A = Settlement Amount; S = Strike Price; CP = Closing Price of the Underlying on the Expiration Date; R = Ratio.
	If the underlying Share at Expiration closes higher than or at the Cap Level, the Holder of 1 Certificate receives a settlement amount which is calculated as follows:
	$A = [S + 2 * (C - S)] * R$
	where C = Cap Level
Listing	Frankfurt, Stuttgart (third section)

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