Structured Products Report

Knowledge
Innovation
Independence

Arfima Financial Solutions

Contents

1 Introduction

Structured products are financial instruments issued by banks in which their final payments are generally linked to the performance of a single asset or a basket of them. There exits an extensive variety of structured products since they are specified combining different payouts and risk profiles by the issuer. Payout structures vary from simplest ones to very complex structures and they are usually constructed by the usage of all types of derivatives.

Nowadays, structured products are drawing more and more attention since they are suitable for all types of investors (defensive, conservative or dynamic). However, it is important for investors to understand the risk-reward of each product in order to match the desire investment profile. This report introduces a standard set of structured products explaining their main features.

The European Structured Investment Products Association (EUSIPA) establishes standards for a uniform structured products categorization. Under the agreed standards, structured products are classified into two main families: **I) Investment Products**; and **II) Leverage Products**. Investment Products encompass three types of products: ***a) Capital Protection Products***; ***b) Yield Enhancement Products***; and, ***c) Participation Products***. On the hand, Leverage Products are divided in: ***a) Leverage without Knock-Out Products***; ***b) Leverage with Knock-Out Products***; and, ***c) Constant Leverage Products***. Figure 1 outlines the risk-reward profile for each product category.

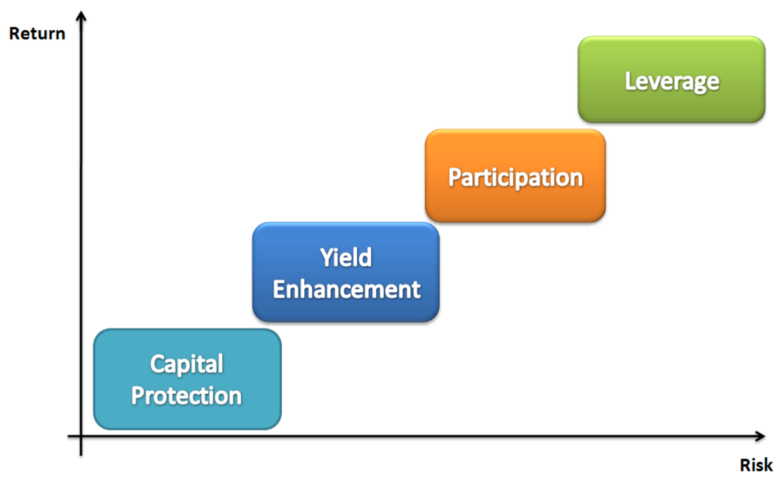
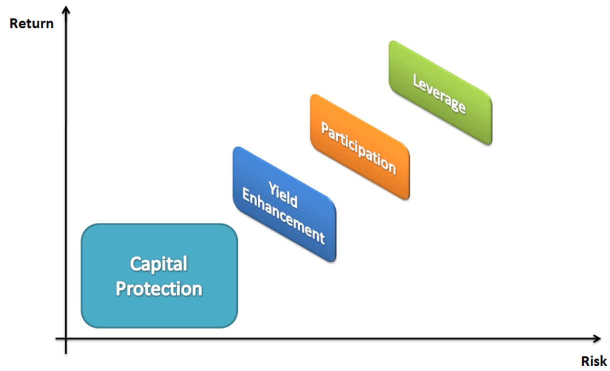


Figure 1: Risk-reward profile.

2 Capital Protection Products (CPP)

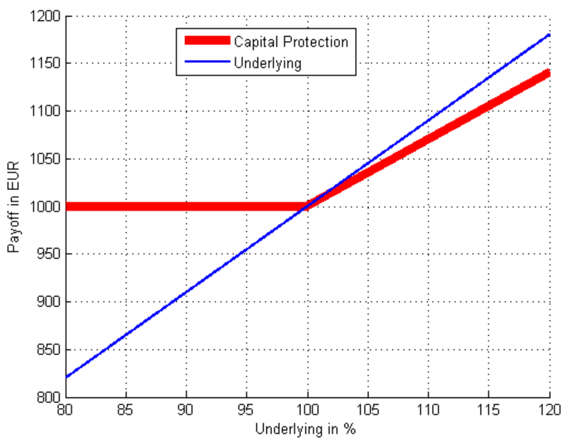
The Capital Protection Products offer a full or partial protection of the capital invested (the notional of the product) and allow the investor to participate in the performance of a selected underlying security. The level of capital protection is determined by the maximum amount of the invested capital the investor can lose. The defined capital protection is guaranteed only at maturity. It is standard practice to set the capital protection level at 100%, but it can be higher or lower. As a rule, a lower level of capital protection means a higher participation rate in the underlying performance.

These products can be structured to perform in rising or falling markets and should be in accordance with market expectations over the product lifetime. If you have a firm opinion about the price development of the underlying security, you can additionally optimize the participation rate by ading a cap on possible gains (capital protection product with a cap).



This type of products have the lowest risk profile and allow the investor not to be exposed to price setbacks.

2.1 Uncapped Bull Capital Protection



Definition. The Uncapped Bull Capital Protection offers a full or partial capital protection of the notional invested at maturity. The level of protection (in percentage) can be tailored to match the investor's risk aversion. It allows the investor to take profit from the unlimited underlying's upside performance. This type of product is suitable for conservative investors who want to profit from a bullish view on the underlying but are looking for a full or partial protection of their capital.

Advantages. The capital is protected and the investor is certain to get back the notional times the protection level at maturity. This type of product allows the investor to participate in the underlying's upside performance while offsetting the risk on the downside.

Risk. Since the capital is fully or partially protected, the participation rate in the underlying performance is generally lower compared to a direct investment in the underlying and if the redemption price is equal to the protection level, the investor does not receive any return on his investment. In addition, since the capital is protected only at maturity, the price of the product can be lower than the protection level during the lifetime of the product. Finally, as all structured products, it is subject to the issuer's credit risk.

Pricing. The price is determined by the sum of a zero-coupon bond plus a long call option on the selected underlying. The number of call options depends on both the notional of the product and the participation rate.

Final Payoff. See Exhibit 2.1 for the final payoff of a representative example.

Exhibit 2.1: Uncapped Bull Capital Protection.

Notional (N)	1,000 EUR
Capital protection level	100%
Strike (K)	3000 points (100% of the initial value)
Participation rate	70%

Table 1: Uncapped Bull Capital Protection.

- **If the underlying value at expiry, S_T, is above the strike ($S_T > K$):** the investor receives a return depending on the underlying's performance weighted by the participation rate,

$$\text{Payoff} = N \times \left[\text{Protection level} + \text{Participation rate} \times \frac{S_T - K}{K}\right].$$

Let $S_T = 5000$ points,

$$\text{Payoff} = 1000 \times \left[100\% + 70\% \times \frac{5000 - 3000}{3000}\right] = 1,466.67 \text{ EUR}.$$

- **If the underlying value is below or equal to the strike ($S_T \leq K$):** the investor receives the notional adjusted by the protection level,

$$\text{Payoff} = N \times \text{Protection level}.$$

Let $S_T = 2500$ points,

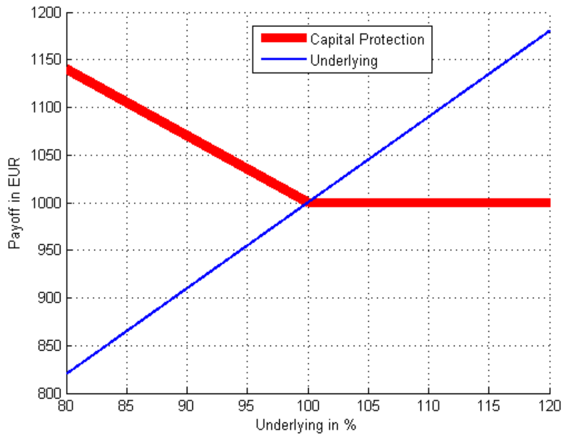
$$\text{Payoff} = 1000 \times 100\% = 1,000 \text{ EUR}. \blacktriangleleft$$

2.2 Uncapped Bear Capital Protection

Definition. The Uncapped Bear Capital Protection offers a full or partial capital protection of the notional invested at maturity. The level of protection (in percentage) can be tailored to match the investor's risk aversion. It allows the investor to take profit from the unlimited underlying's downside performance. This type of product is suitable for conservative investors who want to profit from a bearish view on the underlying but are looking for a full or partial protection of their capital.

Advantages. The capital is protected and the investor is certain to get back the notional times the protection level at maturity. This type of product allows the investor to participate in the underlying's downside performance while offsetting the risk on the upside.

Risk. Since the capital is fully or partially protected, the participation rate in the underlying performance is generally lower compared to a direct investment in the underlying and if the redemption price is equal to the protection level, the investor does not receive any return on his investment. In addition, since the capital is protected only at maturity, the price of the product can be lower than the protection level during the lifetime of the product. Finally, as all structured products, it is subject to the issuer's credit risk.



Pricing. The price is determined by the sum of a zero-coupon bond plus a long put option on the selected underlying. The number of put options depends on both the notional of the product and the participation rate.

Final Payoff. See Exhibit 2.2 for the final payoff of a representative example.

Exhibit 2.2: Uncapped Bear Capital Protection

Notional (N)	1000 EUR
Capital protection level	100%
Strike (K)	3000 points (100% of the initial value)
Participation rate	70%

Table 2: Uncapped Bear Capital Protection.

- **If the underlying value at expiry, S_T, is below the strike ($S_T < K$):** the investor receives a return depending on the underlying's performance weighted by the participation rate,

$$\text{Payoff} = N \times \left[\text{Protection level} + \text{Participation} \times \frac{K - S_T}{K}\right].$$

Let $S_T = 2000$ points,

$$\text{Payoff} = 1000 \times \left[100\% + 70\% \times \frac{3000 - 2000}{3000}\right] = 1,233.33 \text{ EUR}.$$

- **If the underlying value is above or equal to the strike($S_T \geq K$):** the investor receives the notional adjusted by the protection level,

$$\text{Payoff} = N \times \text{Protection level}.$$

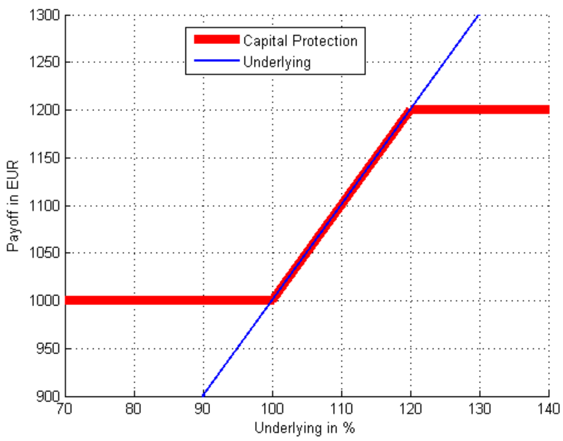
Let $S_T = 4000$ points,

$$\text{Payoff} = 1000 \times 100\% = 1,000 \text{ EUR}. ◀$$

2.3 Bull Capital Protection with Cap

Definition. The Bull Capital Protection with Cap offers a full or partial capital protection of the notional invested at maturity. The level of protection (in percentage) can be tailored to match the investor's risk aversion. It allows the investor to take profit from the underlying's upside performance until a predefined cap level (the product's return is at its maximum). This type of product is suitable for conservative investors who want to profit from a limited bullish view on the underlying but are looking for a full or partial protection of their capital.

Advantages. The capital is protected and the investor is certain to get back the notional times the protection level at maturity. This type of product allows the investor to participate in the underlying's upside performance (until the cap level) while offsetting the risk on the downside. Compared to the Uncapped Bull Capital Protection, it generally offers a higher participation rate between the strike and the cap levels or/and a higher level of protection.



Risk. Since the capital is fully or partially protected, the participation rate in the underlying performance is generally lower compared to a direct investment in the underlying and if the redemption price is equal to the protection level, the investor does not receive any return on his investment. Compared to the Uncapped Bull Capital Protection, the participation in the underlying's upside performance is not unlimited but subject to the cap level. In addition, since the capital is protected only at maturity, the price of the product can be lower than the protection level during the lifetime of the product. Finally, as all structured products, it is subject to the issuer's credit risk.

Pricing. The price is determined by the sum of a zero-coupon bond plus a long call spread option on the selected underlying. The number of call spread options depends on both the notional of the product and the participation rate.

Final Payoff. See Exhibit 2.3 for the final payoff of a representative example.

Exhibit 2.3: Bull Capital Protection with Cap.

Notional (N)	1000 EUR
Capital protection level	100%
Strike (K)	3000 points(100% of the initial value)
Cap level (C)	3600 points (120% of the initial value)
Participation rate	100%

Table 3: Bull Capital Protection with Cap.

Final Payoff:

$$\text{Payoff} = N \times \Big[\text{Protection level} \quad + \\ \text{Min}\Big[\text{Maximum Performance}; \text{Max}\Big[\text{Participation} \times \frac{S_T - K}{K}; 0\Big]\Big]\Big].$$

- **If the underlying value at expiry, S_T, is above the strike and below the cap ($K < S_T < C$):** the investor receives a return depending on the underlying's performance weighted by the participation rate,

$$\text{Payoff} = N \times \left[\text{Protection level} + \text{Participation} \times \left[\frac{S_T - K}{K}\right]\right].$$

Let $S_T = 3375$ points,

$$\text{Payoff} = 1000 \times \left[100\% + 100\% \times \frac{3375 - 3000}{3000}\right] = 1,125 \text{ EUR}.$$

- **If the underlying value is above or equal to the cap ($S_T \geq C$):** the investor receives the maximal return,

$$\text{Payoff} = N \times \Big[\text{Protection level} + \text{Maximum Performance}\Big].$$

Let $S_T = 4000$ points,

$$\text{Payoff} = 1000 \times \left[100\% + 20\%\right]. = 1,200 \text{ EUR.}$$

- **If the underlying value is below or equal to the strike ($S_T \leq K$):** the investor receives the notional adjusted by the protection level,

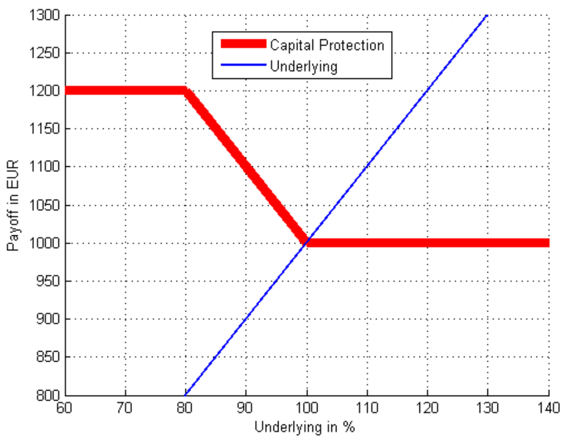
$$\text{Payoff} = N \times \text{Protection level.}$$

Let $S_T = 2500$ points,

$$\text{Payoff} = 1000 \times 100\% = 1,000 \text{ EUR.} \blacktriangleleft$$

2.4 Bear Capital Protection with Cap

Definition. The Bear Capital Protection with Cap offers a full or partial capital protection of the notional invested at maturity. The level of protection (in percentage) can be tailored to match the investor's risk aversion. It allows the investor to take profit from the underlying's downside performance until a predefined cap level (the product's return is at its maximum). This type of product is suitable for conservative investors who want to profit from a limited bearish view on the underlying but are looking for a full or partial protection of their capital.



Advantages. The capital is protected and the investor is certain to get back the notional times the protection level at maturity. This type of product allows the investor to participate in the underlying's downside performance (until the cap level) while offsetting the risk on the upside. Compared to the Uncapped Bear Capital Protection,it generally offers a higher participation rate between the strike and the cap levels or/and a higher level of protection.

Risk. Since the capital is fully or partially protected, the participation rate in the underlying performance is generally lower compared to a direct investment in the underlying and if the redemption price is equal to the protection level, the investor does not receive any return on his investment. Compared to the Uncapped Bear Capital Protection, the participation in the underlying's downside performance is not unlimited but subject to the cap level. In addition, since the capital is protected only at maturity, the price of the product can be lower than the protection level during the lifetime of the product. Finally, as all structured products, it is subject to the issuer's credit risk.

Pricing. The price is determined by the sum of a zero-coupon bond plus a long put spread option on the selected underlying. The number of put spread options depends on both the notional of the product and the participation rate.

Final Payoff. See Exhibit 2.4 for the final payoff of a representative example.

Exhibit 2.4: Bear Capital Protection with Cap.

Notional (N)	1000 EUR
Capital protection level	100%
Strike (K)	3000 points(100% of the initial value)
Cap level (C)	2400 points(80% of the initial value)
Participation rate	100%

Table 4: Bear Capital Protection with Cap.

Final Payoff:

$$\text{Payoff} = N \times \Bigg[\text{Protection level} \quad + \\ \text{Min}\Bigg[\text{Maximum Performance}; \text{Max}\bigg[\text{Participation} \times \frac{K - S_T}{K}; 0\bigg]\Bigg]\Bigg].$$

- **If the underlying value at expiry, S_T, is below the strike and above the cap ($C < S_T < K$) at expiry:** the investor receives a return depending on the underlying's performance weighted by the participation rate,

  $$\text{Payoff} = N \times \Bigg[\text{Protection level} + \text{Participation} \times \bigg[\frac{K - S_T}{K}\bigg]\Bigg].$$

  Let $S_T = 2625$ points,

  $$\text{Payoff} = 1000 \times \bigg[100\% + 100\% \times \frac{3000 - 2625}{3000}\bigg] = 1,125 \text{ EUR}.$$

- **If the underlying value is below or equal to the cap ($S_T \leq C$):** the investor receives the maximal return,

  $$\text{Payoff} = N \times \Big[\text{Protection level} + \text{Maximum Performance}\Big].$$

  Let $S_T = 2300$ points,

  $$\text{Payoff} = 1000 \times 120\% = 1,200 \text{ EUR}.$$

- **If the underlying value is above or equal to the strike ($S_T \geq K$):** the investor receives the notional adjusted by the protection level,

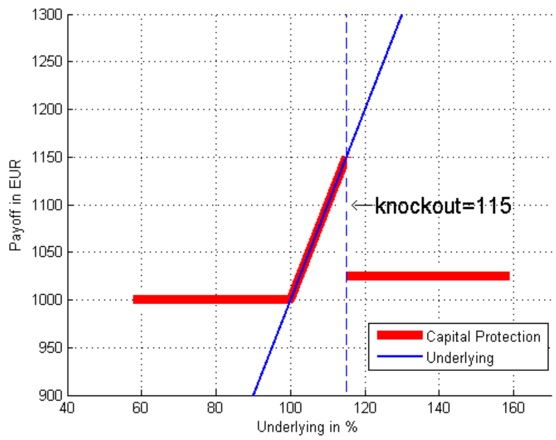
$$\text{Payoff} = N \times \text{Protection}.$$

Let $S_T = 3500$ points,

$$\text{Payoff} = 1000 \times 100\% = 1,000 \text{ EUR}. \blacktriangleleft$$

2.5 Bull Capital Protection with Knock-Out

Definition. The Bull Capital Protection with Knock-Out offers a full or partial capital protection of the notional invested at maturity. The level of protection (in percentage) can be tailored to match the investor's risk aversion. It allows the investor to take profit from the underlying's upside performance until a predefined barrier level is reached (Knock-out). If the Knock-out is reached (Knock-Out event) during the lifetime of the product (American barrier) or at expiry only (European barrier) the product loses its participation to the underlying's performance and the investor receives the notional adjusted by the capital protection level at maturity. It is very common however that an additional coupon (or rebate) is paid at maturity in case a knock-out event occurs to compensate this loss of exposition. This type of product is suitable for conservative investors who want to profit from a moderately bullish view on the underlying but are looking for a full or partial protection of their capital.



Advantages. The capital is protected and the investor is certain to get back the notional times the protection level plus a potential coupon (if a knock-out event occurs) at maturity. This type of product allows the investor to participate in the underlying's upside performance until the knock-out level while offsetting the risk on the downside. Compared to the Uncapped Bull Capital Protection, it generally offers a higher participation rate between the strike and the knock-out levels or/and a higher level of protection plus a potential coupon.

Risk. The participation rate in the underlying performance is lost if a knock-out event occurs and if the underlying price is below the strike and no knock-out event occurs, the investor receives only the protection level times the notional at maturity.

Compared to the Uncapped Bull Capital Protection, the participation in the underlying's upside performance is not unlimited but subject to the knock-out level. In addition, since the capital is protected only at maturity, the price of the product can be lower than the protection level during the lifetime of the product. Finally, as all structured products, it is subject to the issuer's credit risk.

Pricing. ***a) European structures:*** the price is determined by the sum of a zero-coupon bond plus a long call spread option plus a short digital call option on the selected underlying. ***b) American structures:*** the price is determined by the sum of a zero-coupon bond plus a long American knock-out call plus a long American digital call on the selected underlying.

The number of options depends on the notional of the product, the participation rate and the potential coupon rate (rebate).

Final Payoff. See Exhibit 2.5 for the final payoff of a representative example.

Exhibit 2.5: Bull Capital Protection with Knock-Out.

Notional (N)	1000 EUR
Capital protection level	100%
Strike (K)	3000 points(100% of the initial value)
Knock Out level ($EuropeanKO$)	3600 points(120% of the initial value)
Coupon (C)	5%
Participation rate	100%

Table 5: Bull Capital Protection with Knock-Out.

- **If the underlying value at expiry, S_T, is above the strike ($S_T > K$) and no knock-out event occurred:** the investor receives a return depending on the underlying's performance weighted by the participation rate,

$$\text{Payoff} = N \times \left[\text{Protection level} + \text{Participation} \times \frac{S_T - K}{K}\right].$$

Let $S_T = 3375$ points,

$$\text{Payoff} = 1000 \times \left[100\% + 100\% \times \frac{3375 - 3000}{3000}\right] = 1,125 \text{ EUR}.$$

- **If the underlying value is equal or below the strike at expiry ($S_T \leq K$) and no knock-out event occurred:** the investor receives the notional adjusted by the protection level.

Let $S_T = 2500$ points,

$$\text{Payoff} = 1000 \times 100\% = 1.000 \text{ EUR}.$$

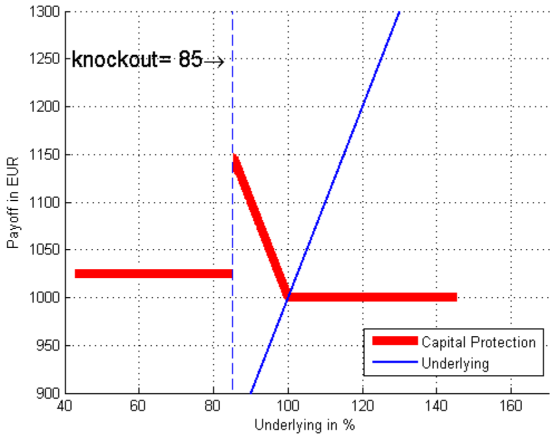
- **If a knock-out event occurred:** the investor receives the notional adjusted by the protection level plus the coupon (rebate),

$$\text{Payoff} = N \times \Big[\text{Protection level} + C\Big],$$
$$\text{Payoff} = 1000 \times \Big[100\% + 5\%\Big] = 1.050 \text{ EUR.} \blacktriangleleft$$

2.6 Bear Capital Protection with Knock-Out

Definition. The Bear Capital Protection with Knock-Out offers a full or partial capital protection of the notional invested at maturity. The level of protection (in percentage) can be tailored to match the investor's risk aversion. It allows the investor to take profit from the underlying's downside performance until a predefined barrier level is reached (Knock-out). If the Knock-out is reached (Knock-Out event) during the lifetime of the product (American barrier) or at expiry only (European barrier) the product loses its participation to the underlying's performance and the investor receives the notional adjusted by the capital protection level at maturity. It is very common however that an additional coupon (or rebate) is paid at maturity in case a knock-out event occurs to compensate this loss of exposition. This type of product is suitable for conservative investors who want to profit from a moderately bearish view on the underlying but are looking for a full or partial protection of their capital.

Advantages. The capital is protected and the investor is certain to get back the notional times the protection level plus a potential coupon (if a knock-out event occurs) at maturity. This type of product allows the investor to participate in the underlying's downside performance until the knock-out level while offsetting the risk on the upside. Compared to the Uncapped Bear Capital Protection, it generally offers a higher participation rate between the strike and the knock-out levels or/and a higher level of protection plus a potential coupon.



Risk. The participation rate in the underlying performance is lost if a knock-out event occurs and if the underlying price is above the strike and no knock-out event occurs, the investor receives only the protection level times the notional at maturity. Compared to the Uncapped Bear Capital Protection, the participation in the underlying's downside performance is not unlimited but subject to the knock-out level. In addition, since the capital is protected only at maturity, the price of the product can be lower than the protection level during the lifetime of the product. Finally, as all structured products, it is subject to the issuer's credit risk.

Pricing. ***a) European structures:*** the price is determined by the sum of a zero-coupon bond plus a long put spread option on the selected underlying plus a short digital put option. ***b) American structures:*** the price is determined by the sum of a zero-coupon bond plus a long American knock-out put plus a long American digital put on the selected underlying.

The number of options depends on the notional of the product, the participation rate and the potential coupon rate (rebate).

Final Payoff. See Exhibit 2.6 for the final payoff of a representative example.

Exhibit 2.6: Bear Capital Protection with Knock-Out

Notional (N)	1000 EUR
Capital protection level	100%
Strike (K)	3000 points(100%)
Knock Out level ($EuropeanKO$)	2400 points(80%)
Coupon (C)	5%
Participation rate	100%

Table 6: Bear Capital Protection with Knock-Out.

- **If the underlying value at expiry, S_T, is below the strike ($S_T < K$) and no knock-out event occurred:** the investor receives a return depending on the underlying's performance weighted by the participation rate,

  $$\text{Payoff} = N \times \left[\text{Protection level} + \text{Participation} \times \frac{K - S_T}{K}\right].$$

  Let $S_T = 2625$ points,

  $$\text{Payoff} = 1000 \times \left[100\% + 100\% \times \frac{3000 - 2625}{3000}\right] = 1,125\text{EUR}.$$

- **If the underlying value is equal or above the strike at expiry ($S_T \geq K$) and no knock-out event occurred:** the investor receives the notional adjusted by the protection level.

  Let $S_T = 3500$ points,

  $$\text{Payoff} = 1000 \times 100\% = 1,000 \text{ EUR}.$$

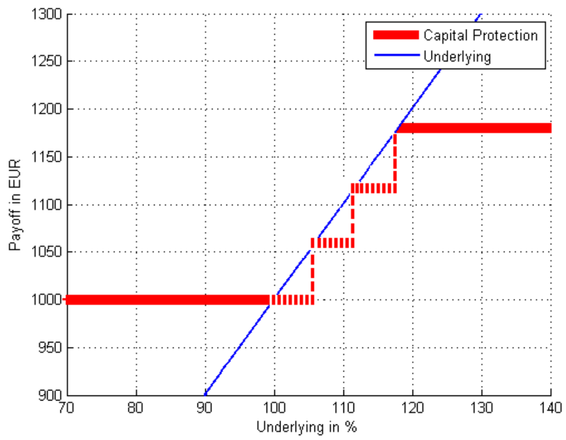
- **If a knock-out event occurred:** the investor receives the notional adjusted by the protection level plus the coupon (rebate).

  $$\text{Payoff} = N \times (\text{Protection level} + C),$$

  $$\text{Payoff} = 1000 \times (100\% + 5\%) = 1,050 \text{ EUR}. ◀$$

2.7 Capital Protection with Coupon (Binary)

Definition. The Capital Protection with Coupon offers a full or partial capital protection of the notional invested at maturity. The level of protection (in percentage) can be tailored to match the investor's risk aversion. It allows the investor to receive coupon payments depending on the price of a selected underlying at predefined dates. This type of product is suitable for conservative investors who want to profit from a moderately bullish view on the underlying but are looking for a full or partial protection of their capital.



Advantages. The capital is protected and the investor is certain to get back the notional times the protection level at maturity plus potential coupons.

Risk. If the price of the underlying does not satisfy the conditions determined at the specified dates, the investor will receive only the protection level times the notional at maturity, i.e he does not receive any return on his investment. In addition, since the capital is protected only at maturity, the price of the product can be lower than the protection level during the lifetime of the product. Finally, as all structured products, it is subject to the issuer's credit risk.

Pricing. The price is determined by the sum of a zero-coupon bond plus a strip of digital options on the selected underlying.

Final Payoff. See Exhibit 2.7 for the final payoff of a representative example.

Exhibit 2.7: Capital Protection with Coupon

Notional (N)	1000 EUR
Capital protection level	100%
Strike (K)	3000 points (100% of the initial value)
Coupon (C)	6%

Table 7: Capital Protection with Coupon.

Observation Date	Condition Level	Coupon
1	3100 points	4%
2	3200 points	6%
3	3300 points	8%

Table 8: Observation Dates.

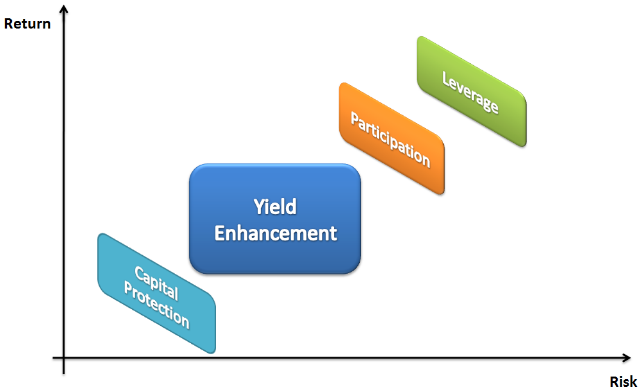
- **On each Observation Dates t : If the underlying S_t is equal or above the corresponding Condition Level:** the investor receives the corresponding coupon,

$$\text{Payoff} = N \times \left[C_t \right].$$

- **If the underlying S_t did not satisfied the Condition Level on any Observation Dates t:** the investor receives the notional adjusted by the protection level,

$$\text{Payoff} = 1000 \times 100\% = 1,000 \text{ EUR.} \blacktriangleleft$$

3 Yield Enhancement Products (YEP)



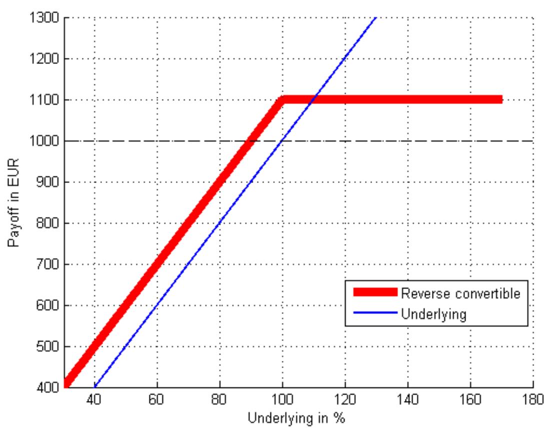
The Yield Enhancement Products do not offer a protection of the initial capital invested. The main objective is to pick up a higher yield than a money market investment with a risk tailored to match investor's risk appetite. They offer a coupon (return) linked to the underlying's performance but they will perform poorer than the Participation Products in case of a strong performance of the underlying. On the downside, they hold a risk of loss and are therefore mostly suitable for stable market conditions.

The Yield Enhancement Products can be designed with various features to match both the investor market's expectation and risk profile. They are mainly suitable for conservative investors who have a stable market view on the underlying and are looking for an attractive yield with a tailored risk.

3.1 Reverse Convertible

Definition. The objective of the Reverse Convertible is to get a fixed coupon (return) at maturity that is higher than the current money market rate. However, since the Reverse Convertible includes the sale of an option, the investor has an unlimited exposition to the underlying's downside performance. This type of product is therefore suitable for conservative investors who have a stable or moderately bullish market view on the underlying and are looking for an attractive yield with a tailored risk.

Advantages. The investor receives an attractive return on his investment in any case. The investment period is generally below 12 months and this type of products allow the investor to optimize the return on his investment on relatively short time periods. Finally, the Reverse Convertible gives the investor the opportunity to benefit from the underlying's implied volatility.



Risk. The return will be lower than a direct investment in the underlying in case of a strong upside performance. In addition, if the underlying performs badly, the loss can be unlimited since the downside exposition is similar to a direct investment in the underlying. Finally, as all structured products, it is subject to the issuer's credit risk.

Pricing. The price is determined by the sum of a zero-coupon bond plus a short put.

Final Payoff. See Exhibit 3.1 for the final payoff of a representative example.

Exhibit 3.1: Reverse Convertible

Notional (N)	1000€
Initial Value	3000 points
Strike (K)	2700 points (90% of the initial value)
Coupon (C)	6%

Table 9: Reverse Convertible.

- **If the underlying value at expiry, S_T, is above or equal to the strike ($S_T \geq K$):** the investor receives the notional plus the coupon,

$$\text{Payoff} = N \times (1 + C).$$

Let $S_T = 3200$ points,

$$\text{Payoff} = 1000 \times (1 + 6\%) = 1,060 \text{ EUR}.$$

- **If the underlying value is below the strike ($S_T < K$):** the investor receives the notional plus the coupon plus the negative performance of the underlying,

$$\text{Payoff} = N \times \left[1 + C + \frac{S_T - K}{K}\right].$$

Let $S_T = 2300$ points,

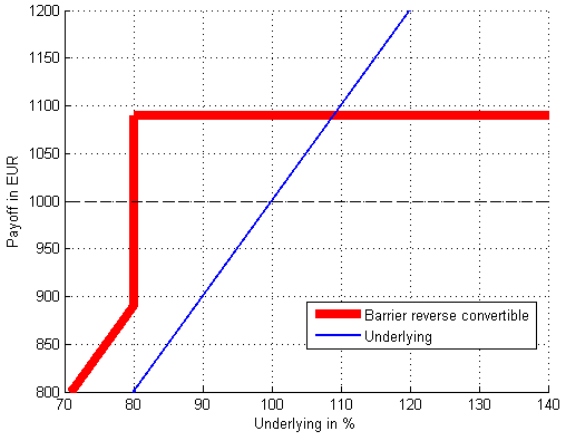
$$\text{Payoff} = 1000 \times \left[1 + 6\% + \frac{2300 - 2700}{2700}\right] = 911.90 \text{ EUR}. \blacktriangleleft$$

3.2 Barrier Reverse Convertible

Definition. The objective of the Barrier Reverse Convertible is to get a fixed coupon (return) at maturity that is higher than the current money market rate. Since the Reverse Convertible includes the sale of an option, the investor has an unlimited exposition to the underlying's downside performance. However, contrary to the Reverse Convertible, if the underlying price is below the strike at expiry but the barrier has not been reached during the lifetime of the product (American barrier) or at expiry (European barrier) the investor receives back the notional invested (conditional capital protection). This type of product is therefore suitable for conservative investors who have a stable or moderately bullish market view on the underlying and are looking for an attractive yield with a tailored risk.

Advantages. The investor receives an attractive return on his investment in any case. The investment period is generally below 12 months and this type of products allow the investor to optimize the return on his investment on relatively short time periods. The Barrier Reverse Convertible offers a conditional capital protection between the strike and the barrier. Finally, it gives the investor the opportunity to benefit from the underlying implied volatility.

Risk. The return will be lower than a direct investment in the underlying in case of a strong upside performance. In addition, if the underlying performs badly, the loss can be unlimited since the downside exposition is similar to a direct investment in the underlying. Finally, as all structured products, it is subject to the issuer's credit risk.



Pricing. ***a) European structures:*** the price is determined by the sum of a zero-coupon bond plus a short put with a strike level equal to the barrier level plus a short digital put option. ***b) American structures:*** the price is determined by the sum of a zero-coupon bond plus a short American knock-in put on the selected underlying.

Final Payoff. See Exhibit 3.2 for the final payoff of a representative example.

Exhibit 3.2: Barrier Reverse Convertible

Notional (N)	1000€
Initial Value	3000 points
Strike (K)	3000 points (100% of the initial value)
Barrier (KI)	2250 points (75% of the initial value)
Coupon (C)	6%

Table 10: Barrier Reverse Convertible.

- **If the underlying value at expiry, S_T, is equal or above the strike ($S_T \geq K$):** the investor receives the notional plus the coupon,

  $$\text{Payoff} = N \times (1 + C).$$

  Let $S_T = 3100$ points,

  $$\text{Payoff} = 1000 \times (1 + 6\%) = 1,060 \text{ EUR}.$$

- **<u>If the underlying value is below the strike ($S_T < K$) but the barrier has not been reached :</u>** the investor receives the notional plus the coupon,

$$\text{Payoff} = N \times (1 + C).$$

Let $S_T = 2750$ points,

$$\text{Payoff} = 1000 \times (1 + 6\%) = 1,060 \text{ EUR}.$$

- **<u>If the underlying value is below the strike ($S_T < K$) and the barrier has been reached:</u>** the investor receives the notional plus the coupon plus the negative performance of the underlying from the strike level,

$$\text{Payoff} = N \times \left[1 + C + \frac{S_T - K}{K}\right].$$

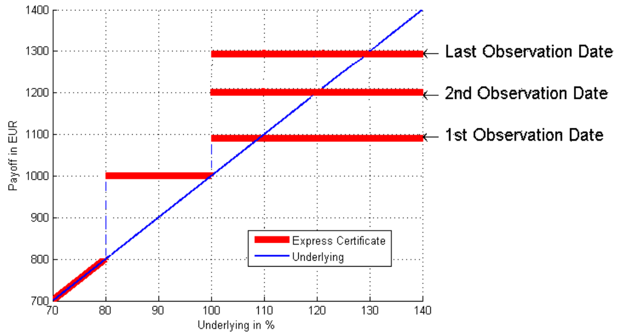
Let $S_T = 2100$ points,

$$\text{Payoff} = 1000 \times \left[1 + 6\% + \frac{2100 - 3000}{3000}\right] = 760 \text{ EUR}. \blacktriangleleft$$

3.3 Express Certificate

Definition. The Express Certificate is similar to the Barrier Reverse Convertible with an early redemption clause. Predefined observation dates are set with specific observation levels. If the underlying is above the observation level on the corresponding observation date, the condition for an early redemption is satisfied and the Express Certificate is redeemed prematurely. If the condition is not satisfied, the product continue to run until the next observation date. If not early redeemed, the product payoff is then similar to a Barrier Reverse Convertible at expiry. The return on the Express Certificate is therefore unknown at the issue date of the product and will depend on the price's development of the underlying that will trigger or not an early redemption. This type of product is therefore suitable for conservative investors who have a stable or moderately bullish market view on the underlying and are looking for an attractive yield with a tailored risk.

Advantages. The product can be early redeemed quickly and the investor will receive an attractive return on his investment. The coupon payment generally increase in time, i.e. the longer the product continue to live, the higher the coupon received. This type of products allow the investor to optimize the return on his investment on relatively short time periods, especially in case of early redemption. The Express Certificate offers a conditional capital protection between the strike and the barrier at expiry.



Risk. The return will be lower than a direct investment in the underlying in case of a strong upside performance. In addition, if the underlying performs badly, the loss can be unlimited since the downside exposition is similar to a direct investment in the underlying. Finally, as all structured products, it is subject to the issuer's credit risk.

Pricing. The price of the Structure ***at expiry*** is determined by the sum of a zero-coupon bond plus a short put with a strike level equal to the barrier level plus a short digital put option. However, since the structure is autocallable, general Martingale Theory is applied to obtain a closed-form formula.

Final Payoff. See Exhibit 3.3 for the final payoff of a representative example.

Exhibit 3.3: Express Certificate

Notional (N)	1000€
Initial Value	3000 points
Strike (K)	3000 points (100% of the initial value)
Barrier (KI)	2250 points (75% of the initial value)
Coupon at expiry (C)	10%

Table 11: Express Certificate.

Observation Date	Condition Level	Coupon
1	3100 points	4%
2	3200 points	6%
3	3300 points	8%

Table 12: Observation Dates.

- **On each Observation Dates t : If the underlying S_t is equal or above the corresponding Condition Level:** the investor receives the notional plus the corresponding coupon and the product is early redeemed,

$$\text{Payoff} = N \times (1 + C_t).$$

If the product has not been early redeemed.

- **If the underlying value at expiry, S_T, is equal or above the strike ($S_T \geq K$):** the investor receives the notional plus the coupon,

$$\text{Payoff} = N \times (1 + C_T).$$

Let $S_T = 3400$ points,

$$\text{Payoff} = 1000 \times (1 + 10\%) = 1,100 \text{ EUR}.$$

- **If the underlying is below the strike ($S_T < K$) but the barrier has not been reached :** the investor receives the notional adjusted by the protection level,

$$\text{Payoff} = N \times \text{Protection level}$$

Let $S_T = 2750$ points,

$$\text{Payoff} = 1000 \times (100\%) = 1,000 \text{ EUR}.$$

- **If the underlying is below the strike ($S_T < K$) and the barrier has been reached:** the investor receives the notional plus the negative performance of the underlying from the strike level,

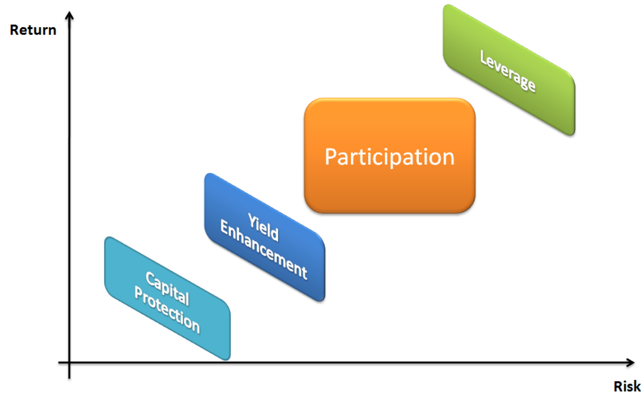
$$\text{Payoff} = N \times \left[1 + \frac{K - S_T}{K}\right].$$

Let $S_T = 2100$ points,

$$\text{Payoff} = 1000 \times \left[1 + \frac{2100 - 3000}{3000}\right] = 700 \text{ EUR}. \blacktriangleleft$$

4 Participation Products (PP)

The Participation Products participate of the underlying's performance both on the upside and the downside. They are generally structured with specific features (cap, barriers,...) that give the opportunity for the investor to match both his market expectation and risk appetite. Return and risk profiles vary with the price development of the underlying security and the specific features. For these products, the risks are generally similar to a direct investment in the underlying.



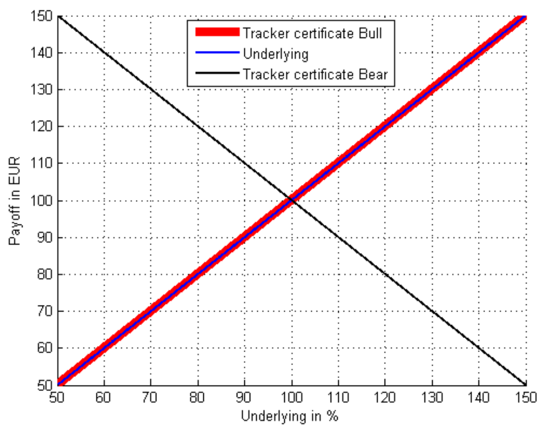
4.1 Tracker Certificate

Definition. The Tracker Certificate provides a synthetic exposure to the underlying performance from the initial level of the underlying. The Bull Tracker Certificates reproduce a synthetic long position in the underlying whereas the Bear Tracker Certificates reproduce a synthetic short position. They are therefore suitable for investors who want to take a directional position on the underlying but can not directly invest in the underlying security.

Advantages. Investors have a straightforward exposition in the underlying security, similar to a direct investment.

Risk. There is no capital protection. If the underlying performs badly, the loss can be unlimited since the exposition is similar to a direct investment in the underlying. Finally, as all structured products, it is subject to the issuer's credit risk.

Pricing. ***a) Bull Tracker Certificate:*** the price is determined by the sum of a zero-coupon bond plus a long call option and a short put option. ***Bear Tracker Certificate:*** the price is determined by the sum of a zero-coupon bond plus a long put option and a short call option.



Final Payoff. See Exhibit 4.1 for the final payoff of a Bull Tracker Certificate representative example.

Exhibit 4.1: Bull Tracker Certificate

Notional	1000€
Strike (K)	3000 points (100% of the initial value)

Table 13: Bull Tracker Certificate.

- **If the underlying value at expiry, S_T, is above or equal to the strike ($S_T \geq K$):** the investor receives the notional plus the positive performance of the underlying,

$$\text{Payoff} = N \times \left[1 + \frac{S_T - K}{K}\right].$$

Let $S_T = 3500$ points ,

$$\text{Payoff} = 1000 \times \left[1 + \frac{3500 - 3000}{3000}\right] = 1,166.67 \text{ EUR}.$$

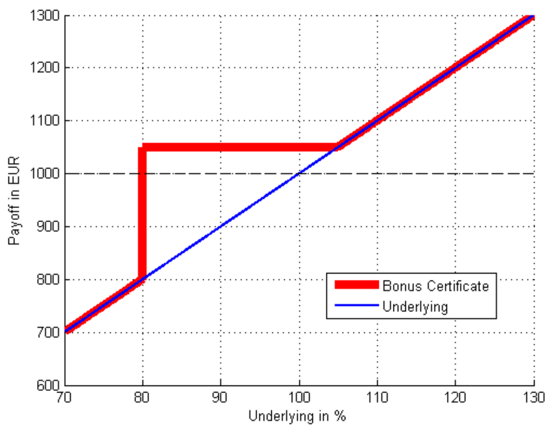
- **If the underlying value is below the strike ($S_T < K$):** the investor receives the notional plus the negative performance of the underlying,

$$\text{Payoff} = N \times \left[1 + \frac{S_T - K}{K}\right].$$

Let $S_T = 2500$ points,

$$\text{Payoff} = 1000 \times \left[1 + \frac{2500 - 3000}{3000}\right] = 833.33 \text{ EUR}. ◀$$

4.2 Bonus Certificate



Definition. The Bonus Certificate is similar to a Tracker certificate since it also provides an exposition to both the upside and downside performance of the underlying. However, if the underlying price is below the strike (initial value) at expiry and the barrier has not been reached during during the lifetime of the product (American barrier) or at expiry (European barrier), the investor receive back the notional invested (conditional capital protection). The Bonus certificate is suitable for investors who want to take a directional position on the underlying with a safety net (until the barrier) in case their market view is wrong.

Advantages. The Bonus Certificate allows the investors to profit from the unlimited underlying's upside performance. In addition, as long as the barrier has not been reached, the capital is protected at maturity (conditional capital protection).

Risk. The capital protection is only conditional. If the underlying performs badly and the barrier is reached, the loss can be unlimited since the exposition will be similar to a direct investment in the underlying from the strike (initial value). Finally, as all structured products, it is subject to the issuer's credit risk.

Pricing. ***a) European structures:*** the price is determined by the sum of a zero-coupon bond plus a long call plus short put with a strike level equal to the barrier level plus a short digital put option on the selected underlying. ***b) American structures:*** the price is determined by the sum of a zero-coupon bond plus a long call plus a short American knock-in put on the selected underlying.

Final Payoff. See Exhibit 4.2 for the final payoff of a representative example.

Exhibit 4.2: Bonus Certificate

Notional (N)	1000€
Strike (K)	3000 points (100% of the initial value)
Barrier (KI)	2250 points (75% of the initial value)
Conditional Protection level	100%

Table 14: Bonus Certificate.

- **If the underlying value at expiry, S_T, is above or equal to the strike ($S_T \geq K$):** the investor receives the notional times the Conditional Protection level plus the positive performance of the underlying,

$$\text{Payoff} = N \times \left[\text{Conditional Protection} + \frac{S_T - K}{K}\right].$$

Let $S_T = 3500$ points,

$$\text{Payoff} = 1000 \times \left[100\% + \frac{3500 - 3000}{3000}\right] = 1,166 \text{ EUR}.$$

- **If the underlying value is below the strike ($S_T < K$) but the barrier has not been reached :** the investor receives the notional times the Conditional Protection level,

$$\text{Payoff} = N \times \text{Conditional Protection}.$$

Let $S_T = 2500$ points,

$$\text{Payoff} = 1000 \times 100\% = 1,000 \text{ EUR}.$$

- **If the underlying is below the strike ($S_T < K$) and the barrier has been**

reached: the investor receives the notional times the Conditional Protection level plus the negative performance of the underlying from the strike level,

$$\text{Payoff} = N \times \left[\text{Conditional Protection} + \frac{S_T - K}{K}\right].$$

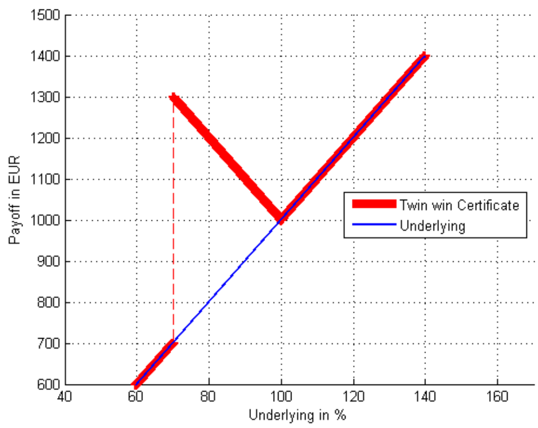
Let $S_T = 2100$ points,

$$\text{Payoff} = 1000 \times \left[100\% + \frac{2100 - 3000}{3000}\right] = 700 \text{ EUR.} \blacktriangleleft$$

4.3 Twin Win Certificate

Definition. The Twin Win Certificate offers the investor to take advantage from both the upside and the downside performance of the underlying until a certain level. If the barrier has not been reached during the lifetime of the product (American barrier) or at expiry (European barrier) the investor will receive the notional invested (conditional capital protection) plus the absolute performance of the underlying. However, if the barrier is reached, the product is similar to a direct investment in the underlying from the strike (initial value). This type of product is suitable for investors who have a directional view on the underlying but still want to benefit from an opposite movement of the underlying (until a certain level).

Advantages. The Twin Win Certificate allows the investors to profit from the unlimited underlying's upside performance but also from the downside performance (in absolute term) until a certain level. In addition, as long as the barrier has not been reached, the capital is protected at maturity (conditional capital protection).



Risk. The capital protection is only conditional. If the underlying performs badly and the barrier is reached, the loss can be unlimited since the exposition will be similar to a direct investment in the underlying from the strike (initial value). Finally, as all structured products, it is subject to the issuer's credit risk.

Pricing. ***a) European structures:*** the price is determined by the sum of a zero-coupon bond plus a long call plus a long put plus a short put with a strike level equal to the barrier level plus a short digital put option. ***b) American structures:*** the price is determined by the sum of a zero-coupon bond plus a long call plus a long American Knock-Out put plus a short American knock-in put on the selected underlying.

Final Payoff. See Exhibit 4.3 for the final payoff of a representative example.

Exhibit 4.3: Twin Win Certificate

Notional (N)	1000€
Strike (K)	3000 points (100% of the initial value)
Barrier (KI)	2250 points (75% of the initial value)

Table 15: Twin Win Certificate.

- **If the underlying value at expiry, S_T, is above or equal to the strike ($S_T \geq K$):** the investor receives the notional plus the positive performance of the underlying,

$$\text{Payoff} = N \times \left[1 + \frac{S_T - K}{K}\right].$$

Let $S_T = 3500$ points,

$$\text{Payoff} = 1000 \times \left[1 + \frac{3500 - 3000}{3000}\right] = 1,166 \text{ EUR}.$$

- **If the underlying value is below the strike ($S_T < K$) but the barrier has not been reached:** the investor receives the notional plus the absolute value of the negative performance of the underlying,

$$\text{Payoff} = N \times \left[1 + \frac{K - S_T}{K}\right].$$

Let $S_T = 2500$ points,

$$\text{Payoff} = 1000 \times \left[1 + \frac{3000 - 2500}{3000}\right] = 1,166 \text{ EUR}.$$

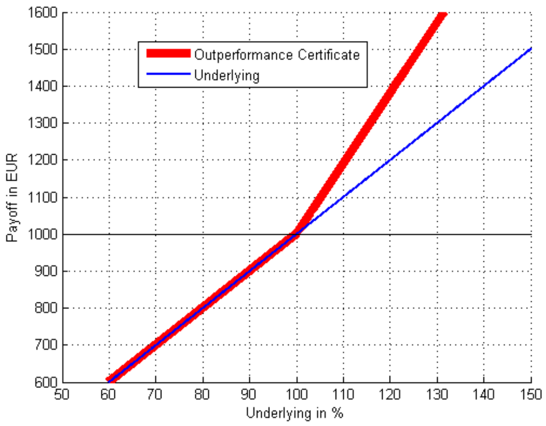
- **If the underlying value is below the strike ($S_T < K$) and the barrier has been reached:** the investor receives the notional plus the negative performance of the underlying from the strike level,

$$\text{Payoff} = N \times \left[1 + \frac{S_T - K}{K}\right].$$

Let $S_T = 2100$ points,

$$\text{Payoff} = 1000 \times \left[1 + \frac{2100 - 3000}{3000}\right] = 700 \text{ EUR.} \blacktriangleleft$$

4.4 OutPerformance Certificate



Definition. The Outperformance certificate is very similar to the Tracker Certificate since it provides a synthetic exposure to the underlying performance from the initial level of the underlying. It offers however a participation rate above 100% on the upside (disproportionately higher rates from price increase). This type of product is suitable for investors who want to take a directional position on the underlying with an higher participation rate to the upside.

Advantages. Investors have a straightforward exposition in the underlying security, similar to a direct investment with a higher participation rate on the upside performance of the underlying.

Risk. There is no capital protection. If the underlying performs badly, the loss can be unlimited since the exposition is similar to a direct investment in the underlying. Finally, as all structured products, it is subject to the issuer's credit risk.

Pricing. The price is determined by the sum of a zero-coupon plus a long call option and a short put option. The number of call options is higher than the number of put options to obtain this disproportionate participation rate.

Final Payoff. See Exhibit 4.4 for the final payoff of a representative example.

Exhibit 4.4: OutPerformance Certificate

Notional	1000€
Strike (K)	3000 points (100% of the initial value)
Participation rate	150% (on the upside)

Table 16: OutPerformance Certificate.

- **If the underlying value at expiry, S_T, is above or equal to the strike ($S_T \geq K$):** the investor receives the notional plus the positive performance of the underlying times the participation rate,

$$\text{Payoff} = N \times \left[1 + \text{Participation} \times \frac{S_T - K}{K}\right].$$

Let $S_T = 3500$ points,

$$\text{Payoff} = 1000 \times \left[1 + 150\% \times \frac{3500 - 3000}{3000}\right] = 1250 \text{ EUR}.$$

- **If the underlying value is below the strike ($S_T < K$):** the investor receives the notional plus the negative performance of the underlying,

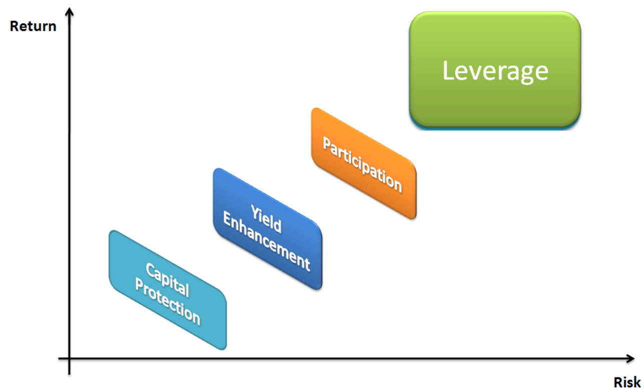
$$\text{Payoff} = N \times \left[1 + \frac{S_T - K}{K}\right].$$

Let $S_T = 2500$ points,

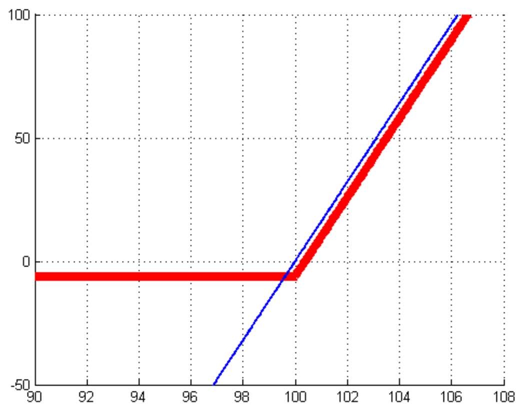
$$\text{Payoff} = 1000 \times \left[1 + \frac{2500 - 3000}{3000}\right] = 833.33 \text{ EUR. } \blacktriangleleft$$

5 Leverage Products (LP)

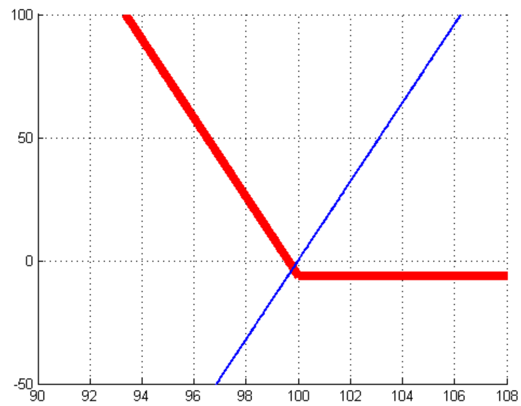
The Leverage Products offers the possibility to increase the leverage of his investment for the investor. This leverage effect allows the investor to achieve outsize gains with lower capital investment. However, the leverage effect also increase the risk of this type of products and the investor can quickly lose his whole investment in case the market expectation is not realized. The Leverage Products have a high risk-return profile and offer active investors the possibility to accelerate their exposition in a selected underlying.



5.1 Call/Put Warrant



Definition. The Call (Put) warrant is a securitized option. It gives the right (but not the obligation) to buy (sell) during a pre-determined period (American option) or at maturity (European option) a predetermined quantity of the underlying at a predetermined price (strike). If the settlement is in cash, the investor will receive at expiry the difference between the underlying value (strike) and the strike (underlying value). The investor has to pay a premium to receive the warrant. This premium represents the notional invested in the product and the whole amount can be lost since the value of the warrant will be zero if the underlying price is below (above) the strike. This type of product is suitable for investors who have a strong bullish (bearish) view on the underlying and are looking to get a leverage on their investment.



Advantages. The Warrant Call (Put) allows the investor to benefit from a leverage effect on the underlying's upside (downside) performance. Since the changes in the warrant's value are much more pronounced compared to the underlying's movements (leverage effect), the investor can sell the warrant on the secondary market higher than its issue price before it expired. Compared to a direct investment in the underlying, it will provide higher return with a smaller investment.

Risk. If his market view is wrong (the option is not exercised), the investor can lose all his investment. Since the changes in the warrant's value are much more pronounced compared to the underlying's movements (leverage effect), the price of the warrant on the secondary market can be much lower than its issue price. Finally, as all structured products, it is also subject to the issuer's credit risk.

Pricing. The price is basically a long call (put) option.

Final Payoff. See Exhibit 5.3 for the final payoff of a representative example.

Exhibit 5.3: Call Warrant

Issue Price (Premium)	5.00 € per warrant
Underlying Value (S_0)	100 EUR
Strike (K)	110 EUR (110% of the underlying value)

Table 17: Call Warrant.

- **If the underlying value at expiry, S_T, is above or equal to the Strike ($S_T \geq K$):** The investor can exercise his right,

$$\text{Payoff per warrant} = S_T - K,$$
$$\text{Performance per warrant} = \frac{\text{Payoff}}{\text{Issue Price}} - 1.$$

  Let $S_T = 130$ EUR,

$$\text{Underlying Performance} = \frac{130 - 100}{100} = 30\%.$$

$$\text{Payoff per warrant} = 130 - 110 = 20 \text{ EUR}$$
$$\text{Performance per warrant} = \frac{20}{5} - 1 = 300\%.$$

- **If the underlying value, S_T, is below the Strike ($S_T < K$):** The warrant is not exercised and the investor loses his investment (the premium). ◄

Exhibit 5.1: Put Warrant

Issue Price (Premium)	5.00 € per warrant
Underlying Value (S_0)	100 EUR
Strike (K)	90 EUR (90% of the underlying value)

Table 18: Put Warrant.

- **If the underlying value at expiry, S_T, is below or equal to the Strike ($S_T \leq K$):** The investor can exercise his right,

$$\text{Payoff per warrant} = K - S_T,$$
$$\text{Performance per warrant} = \frac{\text{Payoff}}{\text{Issue Price}} - 1.$$

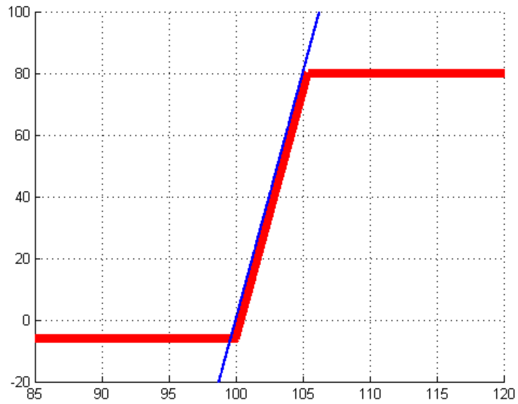
Let $S_T = 70$ EUR ,

$$\text{Underlying Performance} = \frac{100 - 70}{100} = -30\%$$

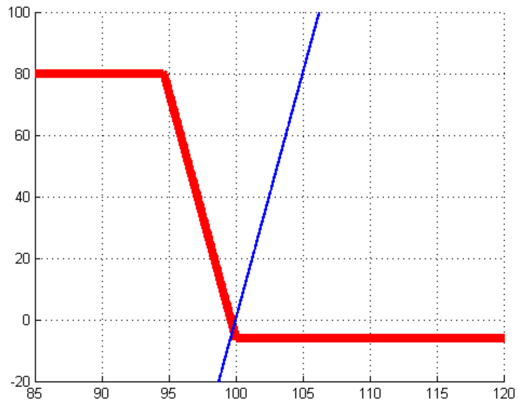
$$\text{Payoff per warrant} = 90 - 70 = 20 \text{ EUR},$$
$$\text{Performance per warrant} = \frac{20}{5} - 1 = 300\%.$$

- **If the underlying value, S_T, is above the Strike ($S_T > K$):** The warrant is not exercised and the investor loses his investment (the premium).◄

5.2 Call/Put Spread Warrants



Definition. The Call (Put) Spread Warrant is actually the sum of two securitized options. It is the combination of a long call (put) and a short call (put) with a higher (lower) strike. It is actually similar to a call (put) warrant with a limited upside potential since the sale of the second option caps the potential performance. The investor will therefore receive at expiry the difference between the underlying value (strike) and the strike (underlying value) limited to the cap level (or second strike). The payoff will be fixed and at his maximum if the underlying is above the (below) the cap level. The investor has to pay a premium to receive the warrant. This premium represents the notional invested in the product and the whole amount can be lost since the value of the warrant will be zero if the underlying price is below (above) the strike. This type of product is suitable for investors who have a limited bullish (bearish) view on the underlying and are looking to get a leverage on their investment.



Advantages. The Warrant Call (Put) Spread allows the investor to benefit from a leverage effect on the underlying's upside (downside) performance, limited to the cap level. It is cheaper than a regular Call (Put) Warrant. Since the changes in the warrant's value are much more pronounced compared to the underlying's movements (leverage effect), the investor can sell the warrant on the secondary market higher than its issue price before it expired.

Risk. The performance is capped compared to a regular Call (Put) Warrant. In addition, if his market view is wrong (the option is not exercised), the investor can lose all his investment. Since the changes in the warrant's value are much more pronounced compared to the underlying's movements (leverage effect), the price of the warrant on the secondary market can be much lower than its issue price. Finally, as all structured products, it is also subject to the issuer's credit risk.

Pricing. The price is basically the combination of a long call (put) option plus a short call (put) option.

Final Payoff. See Exhibit 5.2 for the final payoff of a representative example.

Exhibit 5.2: Call Spread Warrant

Issue Price (Premium)	3.00 € per warrant
Underlying Value (S_0)	100 EUR
Strike ($K1$)	110 EUR (110% of the underlying value)
Cap ($K2$)	125 EUR (125% of the underlying value)

Table 19: Call Spread Warrant.

- **If the underlying value at expiry, S_T, is above or equal to the Cap ($S_T \geq K2$):** The investor receives the maximum performance,

$$\text{Payoff per warrant} = \text{Min}(S_T, K2) - K1,$$

$$\text{Performance per warrant} = \frac{\text{Payoff}}{\text{Issue Price}} - 1.$$

Let $S_T = 130$ EUR,

$$\text{Underlying Performance} = \frac{125 - 100}{100} = 25\%.$$

$$\text{Payoff per warrant} = 125 - 110 = 15 \text{ EUR},$$
$$\text{Performance per warrant} = \frac{15}{3} - 1 = 400\%.$$

- **If the underlying value at expiry, S_T, is above or equal to the Strike and below the Cap ($K1 \leq S_T \leq K2$):** The investor exercise his right,

$$\text{Payoff per warrant} = S_T - K1, \text{Performance per warrant} = \frac{\text{Payoff}}{\text{Issue Price}} - 1.$$

Let $S_T = 117.50$ EUR,

$$\text{Underlying Performance} = \frac{117.50 - 100}{100} = 17.50\%,$$

$$\text{Payoff per warrant} = 117.50 - 110 = 7.50 \text{ EUR},$$
$$\text{Performance per warrant} = \frac{7.50}{3} - 1 = 150\%.$$

- **If the underlying value, S_T, is below the Strike ($S_T < K1$):** The warrant is not exercised and the investor loses his investment (the premium).◀

Exhibit 5.2: Put Spread Warrant

Issue Price (Premium)	3.00 € per warrant
Underlying Value (S_0)	100 EUR
Strike ($K1$)	90 EUR (90%of the underlying value)
Cap ($K2$)	75 EUR (75%of the underlying value)

Table 20: Put Spread Warrant.

- **If the underlying value at expiry, S_T, is below or equal to the Cap ($S_T \leq K2$):** The investor receives the maximum performance,

$$\text{Payoff per warrant} = K1 - \text{Max}(S_T, K2),$$
$$\text{Performance per warrant} = \frac{\text{Payoff}}{\text{Issue Price}} - 1.$$

Let $S_T = 70$ EUR,

$$\text{Underlying Performance} = \frac{70 - 100}{100} = -30\%,$$

$$\text{Payoff per warrant} = 90 - 75 = 15 \text{ EUR},$$
$$\text{Performance per warrant} = \frac{15}{3} - 1 = 400\%.$$

- **If the underlying value at expiry, S_T, is below or equal to the Strike and below the Cap ($K2 \leq S_T \leq K1$):** The investor exercise his right,

$$\text{Payoff per warrant} = K1 - S_T,$$
$$\text{Performance per warrant} = \frac{\text{Payoff}}{\text{Issue Price}} - 1.$$

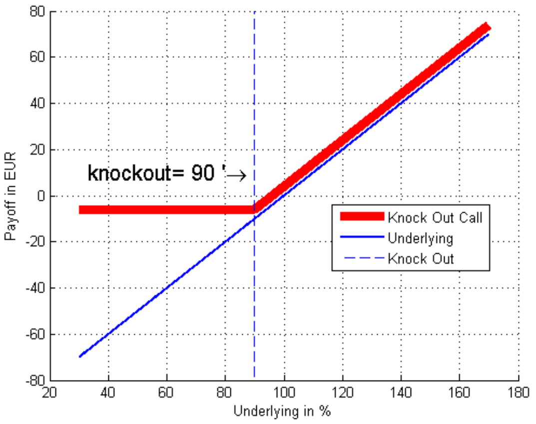
Let $S_T = 82.50$ EUR,

$$\text{Underlying Performance} = \frac{82.50 - 100}{100} = -17.50\%,$$

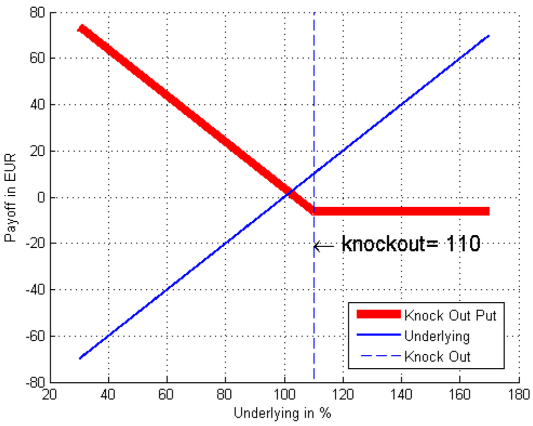
$$\text{Payoff per warrant} = 90 - 82.50 = 7.50 \text{ EUR},$$
$$\text{Performance per warrant} = \frac{7.50}{3} - 1 = 150\%.$$

- **If the underlying value, S_T, is above the Strike ($S_T > K1$):** The warrant is not exercised and the investor loses his investment (the premium).◄

5.3 Call/Put Knock Out Warrants



Definition. The Call (Put) Knock-Out Warrant is a securitized options. It is actually similar to a call (put) warrant with a knock-out barrier on the upside (downside). If the Knock-out is reached (Knock-Out event) during the lifetime of the product (American barrier) or at expiry only (European barrier) the option ceases to exist and the investor loses his investment (premium). Consequently, the investor can benefit from the underlying's upside (downside) performance only until the barrier level. Due to this feature, the leverage effect is however much higher than a regular Call (Put) Warrant. The investor has to pay a premium to receive the warrant. This premium represents the notional invested in the product and the whole amount can be lost since the value of the warrant will be zero if the underlying price is below (above) the strike or if the barrier is reached. This type of product is suitable for investors who have a moderately bullish (bearish) view on the underlying and are looking to get a high leverage on their investment.



Advantages. The Call (Put) Knock-Out Warrant allows the investor to benefit from a high leverage effect on the underlying's upside (downside) performance, limited to barrier level. It is much cheaper than a regular Call (Put) Warrant due to the barrier level. The investor has the opportunity to sell the warrant on the secondary market before it expires.

Risk. If the barrier is reached, the warrant ceases to exist and the investor loses his whole investment. In addition, if his market view is wrong (the option is not exercised), the investor will also lose all his investment. Because of the barrier, the price of the warrant on the secondary market will barely react to the movements of the underlying. Finally, as all structured products, it is also subject to the issuer's credit risk.

Pricing. ***a) European structures:*** the price is basically a long call (put) spread option on the selected underlying plus a short digital call (put) option. ***a) American structures:*** the price is basically a long American Knock-Out call (put).

Final Payoff. See Exhibit 5.3 for the final payoff of a representative example.

Exhibit 5.3: Knock-Out Call Warrant

Issue Price (Premium)	0.50 € per warrant
Underlying Value (S_0)	100 EUR
Strike (K)	100 EUR (100% of the underlying value)
Barrier (KO)	120 EUR (120% of the underlying value)

Table 21: Knock-Out Call Warrant.

- **If the underlying value at expiry, S_T, is equal or above the strike ($S_T \geq K$) and no knock-out event occurred:** the investor receives a return depending on the underlying's performance,

$$\text{Payoff per warrant} = S_T - K,$$
$$\text{Performance per warrant} = \frac{\text{Payoff}}{\text{Issue Price}} - 1.$$

Let $S_T = 115$ EUR,

$$\text{Underlying Performance} = \frac{115 - 100}{100} = 15\%,$$

$$\text{Payoff per warrant} = 115 - 100 = 15 \text{ EUR},$$
$$\text{Performance per warrant} = \frac{15}{0.50} - 1 = 2900\%.$$

- **If the underlying value, S_T, is below the strike at expiry ($S_T \le K$) or a knock-out event occurred:** The warrant cease to exist or is worth zero and the investor loses his investment (the premium).◀

Exhibit 5.3: Knock-Out Put Warrant

Issue Price (Premium)	0.50 € per warrant
Underlying Value (S_0)	100 EUR
Strike (K)	100 EUR (100%of the underlying value)
Barrier (KO)	80 EUR (80%of the underlying value)

Table 22: Knock-Out Put Warrant.

- **If the underlying value at expiry, S_T, is equal or below the strike ($S_T \le K$) and no knock-out event occurred:** the investor receives a return depending on the underlying's performance,

$$\text{Payoff per warrant} = K - S_T, \text{Performance per warrant} = \frac{\text{Payoff}}{\text{Issue Price}} - 1.$$

Let $S_T = 85$ EUR,

$$\text{Underlying Performance} = \frac{85 - 100}{100} = -15\%,$$

$$\text{Payoff per warrant} = 100 - 85 = 15 \text{ EUR},$$
$$\text{Performance per warrant} = \frac{15}{0.50} - 1 = 2900\%.$$

- **If the underlying value, S_T, is above the strike at expiry ($S_T \le K$) or a knock-out event occurred:** The warrant cease to exist or is worth zero and the investor loses his investment (the premium).◀

Appendix: Valuation Models

Risk-neutral Pricing

Risk-neutral pricing has become a powerful method for computing prices of derivative securities. This approach is based on the construction of the so called *risk-neutral measure* $\mathbb{Q}$, which is obtained form the underlying's assumed model after imposing no arbitrage conditions. After computing the underlying's dynamics under this new measure, one can apply all the power of Martingale Theory to obtain the price of any derivative with payoff X_T as

$$V_t = \mathrm{E}^{\mathbb{Q}}\left[D(t,T)X_T \,|\, \mathcal{F}_t\right],$$

where $D(t,T)$ is the discount factor from t to T.

The key of risk-neutral pricing is thus the computation of the underlying's dynamic under the risk-neutral measure, dynamic that one may choose in order to capture certain aspects such as random volatility, smile and skew, or a set of market prices.

Valuation Models:

Black-Scholes-Merton	$dS_t = rS_t dt + \sigma S_t dW_t$
Garman-Kohlhagen (FX)	$dS_t = (r_d - r_f)S_t dt + \sigma S_t dW_t$
Gibson-Schwartz (Commodities)	$\begin{cases} dS_t = (r-\delta_t)S_t dt + \sigma^S S_t dW_t^S \\ d\delta_t = \kappa(\alpha - \delta_t)dt + \sigma^\delta dW_t^\delta \\ dW_t^S dW_t^\delta = \rho dt \end{cases}$
Local volatility-Dupire	$\frac{\partial C}{\partial T} = \frac{1}{2}\sigma^2(K,T)K^2\frac{\partial^2 C}{\partial K^2} - (r-q)K\frac{\partial C}{\partial K} - qC$
Mixture models	$dS_t = rS_t dt + \sqrt{\frac{\sum_i \lambda_i v_i^2(t,S_t)p_t^i(S_t)}{\sum_i \lambda_i p_t^i(S_t)}}S_t dW_t$
CEV	$dS_t = rS_t dt + \sigma S_t^\gamma dW_t$
Heston	$\begin{cases} dS_t = rS_t dt + \sqrt{V_t}S_t dW_t^S \\ dV_t = \kappa(\theta - V_t)dt + \sigma^V dW_t^V \\ dW_t^S dW_t^V = \rho dt \end{cases}$
SABR	$\begin{cases} dF_t = \sigma_t F_t dW_t^F \\ d\sigma_t = \alpha\sigma_t dW_t^\sigma \\ dW_t^S dW_t^\sigma = \rho dt \end{cases}$
Jump-diffusion	$dS_t = rS_{t\_}dt + \sigma(t,S_{t\_})S_{t\_}dW_t + \left((e^J - 1)dN_t - \lambda\nu dt\right)S_{t\_}$

Table 23: Valuation Models

Obtaining closed-form formulas for the value of structured products is an important issue, not only for obvious reasons like precision and ease of implementation, but also for several secondary features like Greeks computation and risk management. Unfortunately, this is not always a straightforward task, and some extensively used exotic products like Average Asian Options remain without a closed-form solution. The alternative in those cases where there is not a closed-form solution is approximating the price using partial differential equations and numerical methods, or Monte Carlo methods, with the stability, robustness, variance error, and other issues they come with.

In the next sections we present the derivation of some closed-form formulas.

Example: Express Certificate

We consider an Express Certificate linked to the underlying asset S_t which is autocalled at dates $t_1, \dots, t_M$ with strikes $K_1, \dots, K_M$ and prices $1 + C_1, \dots, 1 + C_M$ per unit of notional. At expiration $T = t_M$, if the value of the underlying is below the strike K_M but above a barrier B, the product pays the notional amount, and if the underlying is below the barrier, the product pays the notional amount plus the final performance $(S_{t_M} - S_{initial})/S_{initial}$, where $S_{initial}$ is a prespecified value. Assuming that the payments are made at dates $t_1, \dots, t_M$, this payoff function per unit of notional can be written as

$$\begin{aligned} X_T = & \sum_{j=1}^{M} (1 + C_j) \mathbf{1}_{\{S_1 < K_1, \dots, S_{j-1} < K_{j-1}, S_j \geq K_j\}} \\ & + \mathbf{1}_{\{S_1 < K_1, \dots, S_{M-1} < K_{M-1}, B \leq S_M < K_M\}} \\ & + \frac{S_M}{S_{initial}} \mathbf{1}_{\{S_1 < K_1, \dots, S_{M-1} < K_{M-1}, S_M < B\}}. \end{aligned} \tag{1}$$

We set $\mathbb{Q}$ the risk-neutral probability measure. Under the Black-Scholes framework we assume that S_t follows (under the risk-neutral measure $\mathbb{Q}$) a geometric Brownian motion with constant volatility σ, constant short rate r, and constant continuously compounded dividend q , that is

$$dS_t = (r - q) S_t dt + \sigma S_t dW_t^{\mathbb{Q}}),$$

or equivalently

$$S_t = S_{t_0} e^{(r - q - \frac{1}{2}\sigma^2)(t - t_0) + \sigma W \mathbb{Q}_{t - t_0}}. \tag{2}$$

When taking into account counterparty credit risk we will use $e^{-(r+sprd)(T-t)}$ as the discount factor form t to T, where *sprd* is a static credit spread for simplicity.

We are interested in the joint probability of the multidimensional random variable $(S_1, \dots, S_M) =$

$(S_{t_1},\ldots,S_{t_M})$. Making use of (2), its probability function under $\mathbb{Q}$ is given by

$$F(K_1,\ldots,K_M)=\mathbb{Q}(S_1\le K_1,\ldots,S_M\le K_M)$$
$$=\mathbb{Q}\left(\frac{W^{\mathbb{Q}}_{t_1}}{\sqrt{\tau_1}}\le d(K_1,\tau_1),\ldots,\frac{W^{\mathbb{Q}}_{t_M}}{\sqrt{\tau_M}}\le d(K_M,\tau_M)\right),$$

where $\tau_j=t_j-t_0$ and

$$d(K,\tau)=\frac{\log\left(\frac{K}{S_{t_0}}\right)-\left(r-q-\frac{1}{2}\sigma^2\right)\tau}{\sigma\sqrt{\tau}}.$$

The vector $\left(\frac{W^{\mathbb{Q}}_{t_1}}{\sqrt{\tau_1}},\ldots,\frac{W^{\mathbb{Q}}_{t_M}}{\sqrt{\tau_M}}\right)$ is a M-dimensional normal random variable with zero mean and covariance matrix given by

$$\Sigma_{l,m}=\mathrm{Cov}\left(\frac{W^{\mathbb{Q}}_{t_l}}{\sqrt{\tau_l}},\frac{W^{\mathbb{Q}}_{t_m}}{\sqrt{\tau_m}}\right)=\frac{\min(\tau_l,\tau_m)}{\sqrt{\tau_l\tau_m}}. \tag{3}$$

Taking the expectation under $\mathbb{Q}$ of the discounted payoff (1) we obtain that the present value of the structured product at time t_0 is

$$V_{t_0}=\sum_{j=1}^{M}e^{-(r+spread)\tau_j}(1+C_j)P_j+e^{-(r+spread)\tau_M}\bar{P}_M$$
$$+\,e^{-(r+spread)\tau_M}\mathrm{E}^{\mathbb{Q}}\left[\frac{S_M}{S_{initial}}\mathbf{1}_{\{S_1<K_1,\ldots,S_{M-1}<K_{M-1},S_M<B\}}\,|\,\mathcal{F}_{t_0}\right]$$

where

$$P_j=\mathbb{Q}(S_1<K_1,\ldots,S_{j-1}<K_{j-1},S_j\ge K_j),$$

and

$$\bar{P}_M=\mathbb{Q}\left(S_1<K_1,\ldots,S_{M-1}<K_{M-1},B\le S_M<K_M\right).$$

We first compute the probabilities

$$P_j=\mathbb{Q}(S_1<K_1,\ldots,S_{j-1}<K_{j-1},S_j\ge K_j)=\mathbb{Q}(S_1<K_1,\ldots,S_{j-1}<K_{j-1},-S_j\le -K_j),$$

for $j=1,\ldots,M$. Following the previous arguments that is

$$P_j=\mathbb{Q}\left(\frac{W^{\mathbb{Q}}_{t_1}}{\sqrt{\tau_1}}\le d(K_1,\tau_1),\ldots,\frac{W^{\mathbb{Q}}_{t_{j-1}}}{\sqrt{\tau_{j-1}}}\le d(K_{j-1},\tau_{j-1}),-\frac{W^{\mathbb{Q}}_{t_j}}{\sqrt{\tau_j}}\le -d(K_j,\tau_j)\right)$$
$$=\Phi_j(d(K_1,\tau_1),\ldots,d(K_{j-1},\tau_{j-1}),-d(K_j,\tau_j);\Sigma^j),$$

where $\Phi_j(\ldots;\Sigma)$ is the probability function of a j-dimensional normal random variable with zero mean and covariance matrix Σ, and the matrix Σ^j is given by

$$\Sigma^j_{l,m} = \frac{\min(\tau_l,\tau_m)}{\sqrt{\tau_l\tau_m}}, \qquad l,m<j,$$

$$\Sigma^j_{l,j} = \Sigma^j_{j,l} = -\sqrt{\frac{\tau_l}{\tau_j}}, \qquad l<j,$$

and $\Sigma^j_{j,j} = 1$.

We also compute

$$\begin{aligned}\bar{P}_M &= \mathbb{Q}\left(S_1 < K_1, \ldots, S_{M-1} < K_{M-1}, B \le S_M < K_M\right)\\ &= \mathbb{Q}\left(S_1 < K_1, \ldots, S_{M-1} < K_{M-1}, S_M < K_M\right) - \mathbb{Q}\left(S_1 < K_1, \ldots, S_{M-1} < K_{M-1}, S_M \le B\right)\\ &= \Phi_M(d(K_1,\tau_1),\ldots,d(K_M,\tau_M);\bar{\Sigma}^M) - \Phi_M(d(K_1,\tau_1),\ldots,d(K_{M-1},\tau_{M-1}),d(B,\tau_M);\bar{\Sigma}^M),\end{aligned}$$

where

$$\bar{\Sigma}^M_{l,m} = \frac{\min(\tau_l,\tau_m)}{\sqrt{\tau_l\tau_m}}, \qquad l,m \le M.$$

We finally compute

$$\mathrm{E}^{\mathbb{Q}}\left[\frac{S_M}{S_{initial}}\mathbf{1}_{\{S_1<K_1,\ldots,S_{M-1}<K_{M-1},S_M<B\}}\,|\,\mathcal{F}_{t_0}\right]. \tag{4}$$

For that purpose we consider the random variable

$$\xi_T = e^{-(r-q)\tau_M}\frac{S_T}{S_{t_0}}.$$

Since ξ_T is positive and $\mathrm{E}^{\mathbb{Q}}[\xi_T] = 1$, we can interpret ξ_T as a Radon-Nikodym derivative defining a new probability measure $\mathbb{Q}^S$ by means of

$$\mathbb{Q}^S(A) = \mathrm{E}^{\mathbb{Q}}[\xi_T\mathbf{1}_A].$$

Therefore, the expectation (4) is equal to

$$\begin{aligned}&e^{(r-q)\tau_M}\frac{S_{t_0}}{S_{initial}}\mathrm{E}^{\mathbb{Q}}\left[e^{-(r-q)\tau_M}\frac{S_M}{S_{t_0}}\mathbf{1}_{\{S_1<K_1,\ldots,S_{M-1}<K_{M-1},S_M<B\}}\,|\,\mathcal{F}_{t_0}\right]\\ &= e^{(r-q)\tau_M}\frac{S_{t_0}}{S_{initial}}\mathbb{Q}^S\left(S_1<K_1,\ldots,S_{M-1}<K_{M-1},S_M<B\right).\end{aligned}$$

The dynamics of the Radom-Nikodym process ξ_t is given by

$$d\xi_t = \sigma\xi_t dW_t^{\mathbb{Q}},$$

so that $W_t^S = W_t^{\mathbb{Q}} - \sigma t$ is a Wiener process under $\mathbb{Q}^S$. This means that, under $\mathbb{Q}^S$, S is given by

$$S_t = S_{t_0} e^{\left(r-q+\frac{\sigma^2}{2}\right)t+\sigma W_t^S}.$$

We thus have

$$\mathbb{Q}^S\left(S_1 < K_1, \ldots, S_{M-1} < K_{M-1}, S_M < B\}\right) = \Phi_M(d'(K_1,\tau_1), \ldots, d'(K_{M-1},\tau_{M-1}), d'(B,\tau_M); \bar{\Sigma}^M),$$

where

$$d'(K,\tau) = \frac{\log\left(\frac{K}{S_{t_0}}\right) - \left(r - q + \frac{1}{2}\sigma^2\right)\tau}{\sigma\sqrt{\tau}}.$$

The final closed-form solution for the present value of the product is

$$V_{t_0} = \sum_{j=1}^{M} e^{-(r+spread)\tau_j}(1+C_j)P_j + e^{-(r+spread)\tau_M}\bar{P}_M$$
$$+ e^{-(q+spread)\tau_M}\frac{S_{t_0}}{S_{initial}}\Phi_M(d'(K_1,\tau_1), \ldots, d'(K_{M-1},\tau_{M-1}), d'(B,\tau_M); \bar{\Sigma}^M).$$