Università Commerciale
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An Introduction to Structured Financial Products

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20541– Advanced Quantitative Methods for Asset Pricing and Structuring

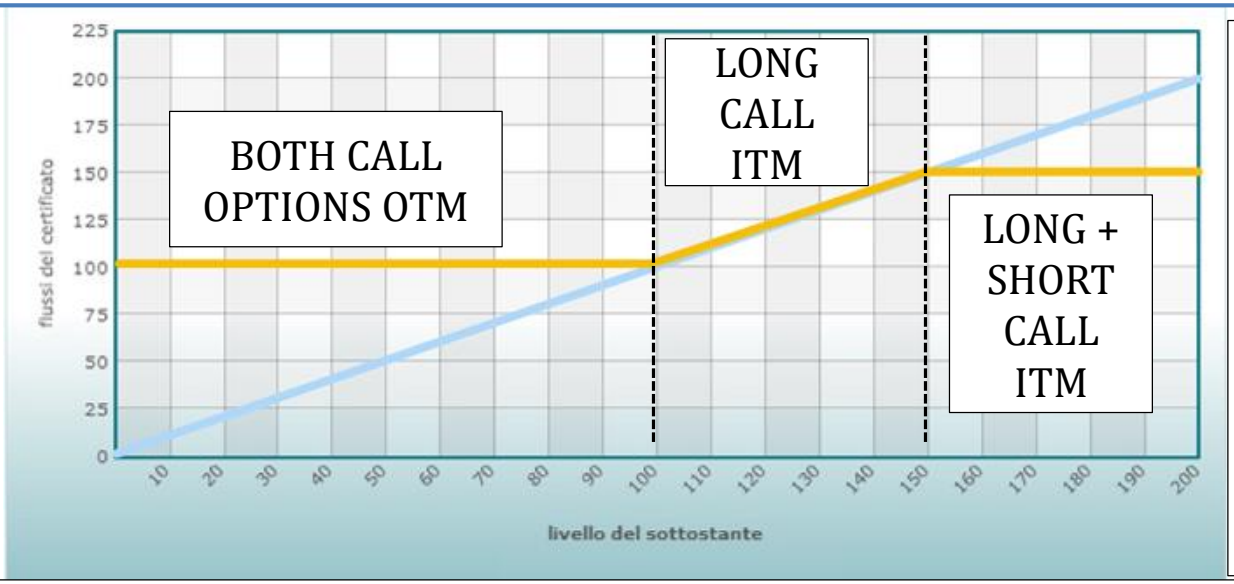
Spring 2020

Outline and objectives

- The Nature of Investment Certificates
- Market statistics for investment certificates
- Key ideas of structuring: from linear to non-linear payoffs
- Exotic options: digital, Asian, and barriers
- Reverse convertibles
- Bonus Cap certificates, certificates with (limited) capital protection
- The autocallability feature: Express certificates
- Certificates without capital protection: Benchmarks, Outperformance, and Discounts
- Leverage and Turbo certificates

Equity Protection Caps (Collar ICs)

Alternative to reduce the cost of the structure: cap the participation to the upside by adding the sale of a call out of the money increase interim participation rate



Equal to:

- a long position in a ZCB
- a long position in a call ATM
- a short position in a call OTM

Example

- invest 96.80% of the capital today to get 100% back in 5 years
- buy a call ATM on Euro STOXX 50 (Strike = 2660 index points); assume that it costs 6.40%
- I need to find what is the strike of an OTM call that is worth approximately 3.20%

Equity Protection Caps (Collar ICs)

For example, assume the following prices of different call options on the Euro STOXX 50 (SX5E)

- Strike 2700: 6.00%
- Strike 2725: 5.50%
- Strike 2750: 4.5%
- Strike 2800: 4.00%
- Strike 2900: 3.50%
- Strike 2950: 3.20%
- Strike 3050: 3.00%

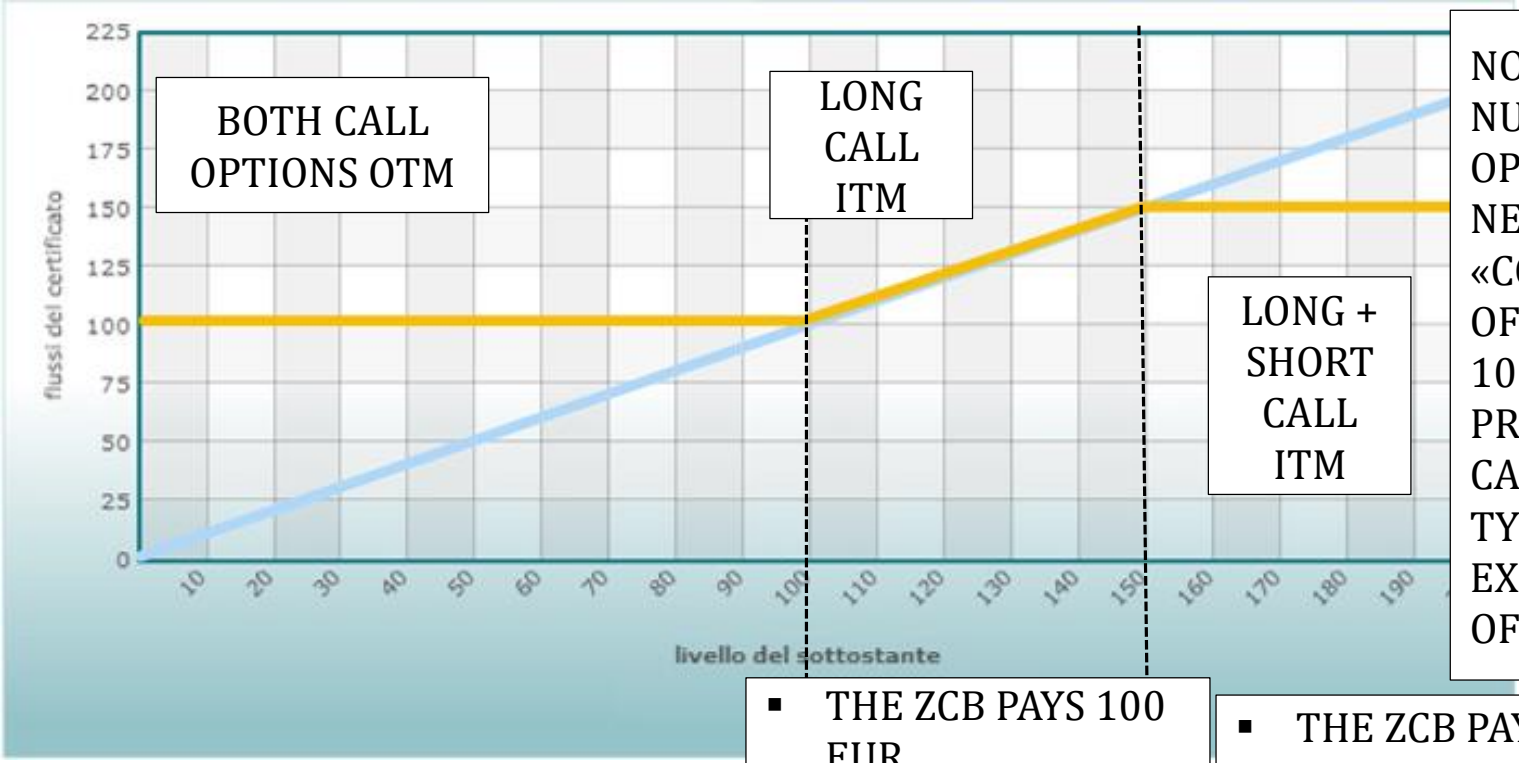
CAP = 11% (2950/2660-1)

Payoff (if SX5E>Strike):
100% + Min[SX5E_Final/SX5E_Strike-1; 11%]

TRADE OFF:

- The more we go OTM, the higher the cap, and thus the more the investor will participate to the upside
- The more we go OTM the less the price that we get from the sale of the option

Equity Protection Caps (Collar ICs)



NOTE THAT THE NUMBER OF OPTION THAT YOU NEED TO BUY TO «COVER» 100 EUR OF NOTIONAL IS 100 / K AND THE PRICE OF THE CALL IS TYPICALLY EXPRESSED IN % OF THE STRIKE

- THE ZCB PAYS 100 EUR
- PAYOFF CALL WITH STRIKE 2660 = 0
- PAYOFF CALL WITH STRIKE 2950 = 0

➔ PAYOFF IS: 100 EUR

- THE ZCB PAYS 100 EUR
- PAYOFF CALL WITH STRIKE 2660 = $S - K_1$
- PAYOFF CALL WITH STRIKE 2950 = 0

➔ PAYOFF IS: 100 EUR + $[(S - K_1) / K_1]*100$ EUR

- THE ZCB PAYS 100 EUR
- PAYOFF CALL WITH STRIKE 2660 = $S - K_1$
- PAYOFF CALL WITH STRIKE 2950 = $-(S - K_2)$

➔ PAYOFF IS: 100 EUR + $[(S - K_1) / K_1]*100 - [(S - K_2) / K_2]*100$ == 100 EUR + 11 EUR

Equity Protection: The Greeks

The price of an equity protection depends on (it is sensible to) several factors

Sensitivity of the price of an equity protection certificate:

- PRICE OF THE UNDERLYING: **POSITIVE** (however, in case of capped version, the max price of the certificate is equal to the cap level, i.e., 100 + CAP)
- VOLATILITY: **POSITIVE** (in case of capped version, note that the ATM call has a higher vega than the OTM one)
- INTEREST RATES: **NEGATIVE** ("more discounting" if interest rates increase)
- DIVIDEND YIELD: **NEGATIVE** (you are a buying the stock but are not entitled to dividend distribution; in the case of the capped version the net effect is unclear)
- TIME: (depend if the winner is the decay on the option or the effect of the increase in the price of the ZCB)

Equity Protection: The Greeks

Let's put ourselves in the shoes of a structurer…what do these sensitivities imply from her point of view?

Exercise (1)

- Suppose that you want to structure an equity protection with 5Y tenor. Given an initial offer price of € 100, and a price of the ZCB of € 95 (we have 5 € to spend in the option), which of these stocks is likely to yield the highest participation rate (ceteris paribus)?
  - Eni: implied volatility of a 5Y ATM option is 20%
  - Intesa San Paolo: implied volatility of a 5Y ATM option is 27%
  - Telecom: implied volatility of a 5Y ATM option is 18%

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  - Telecom: implied volatility of a 5Y ATM option is 18%

THE LOWER THE VOLATILITY, THE CHEAPER THE OPTION THAT YOU NEED TO BUY

Equity Protection: The Greeks

Let's put ourselves in the shoes of a structurer…what do these sensitivities imply from her point of view?

Exercise (2)

- Suppose that you want to structure an equity protection with 5Y tenor. Given an initial offer price of € 100, and a price of the ZCB of € 95 (we have 5 € to spend in the option), which of these stocks is likely to yield the highest participation rate (ceteris paribus)?
  - Eni: dividend yield 2%
  - Intesa San Paolo: dividend yield 1%
  - Telecom: dividend yield 3%

Equity Protection: The Greeks

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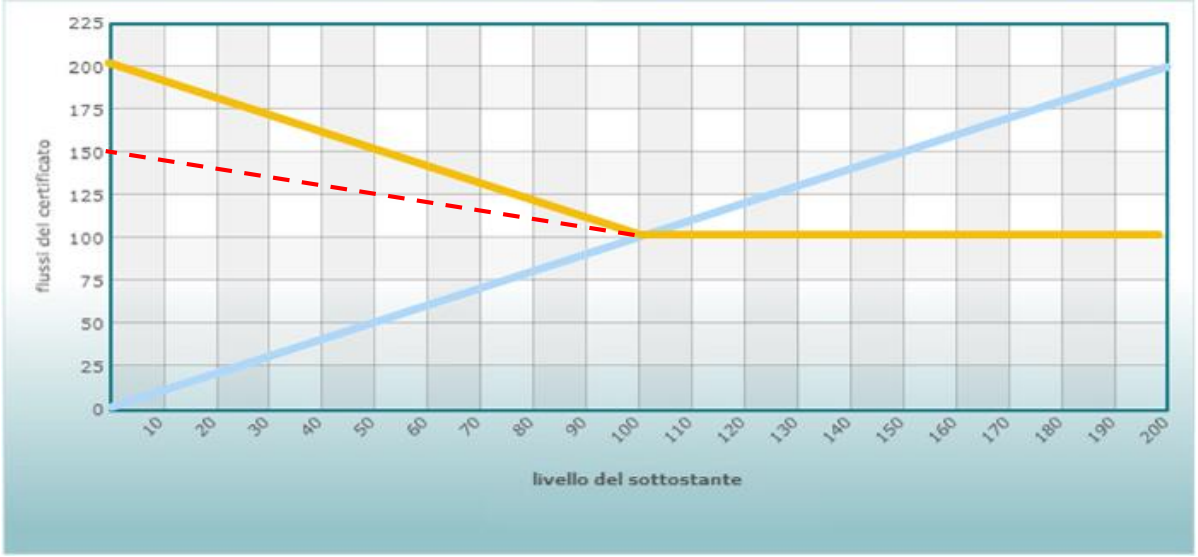
Exercise (2)

- Suppose that you want to structure an equity protection with 5Y tenor. Given an initial offer price of € 100, and a price of the ZCB of € 95 (we have 5 € to spend in the option), which of these stocks is likely to yield the highest participation rate (ceteris paribus)?
  - Eni: dividend yield 2%
  - Intesa San Paolo: dividend yield 1%
  - Telecom: dividend yield 3%

THE HIGHER THE DIVIDEND YIELD, THE CHEAPER THE OPTION THAT YOU NEED TO BUY

Equity Protection Short

If the expectation is that the price of the underlying is going to decline, an investor may be willing to buy a "short" version of the equity protection



Equal to:

- a long position in a ZCB
- a long position in a put ATM

EXAMPLE (Euro STOXX 50, see before)

- Strike=2660. Below the strike the put is ITM and the investor receives (2260- Eurostoxx_Final) / 2260 * 100 € (from the option) + € 100 (from ZCB)
- Above the strike the put is OTM, the investor receives € 100

Equity Protection Short: The Greeks

The price of an equity protection short depends on (it is sensible to) several factors

Sensitivity of the price of an equity protection short certificate:

- PRICE OF THE UNDERLYING: **NEGATIVE**
- VOLATILITY: **POSITIVE** (we are still buying an option)
- INTEREST RATES: **NEGATIVE** ("more discounting" if interest rates increase)
- DIVIDEND YIELD: **POSITIVE** (you are selling a stock but you do not have to pay the dividends)
- TIME: unclear (depend if the winner is the decay on the option or the effect of the increase in the price of the ZCB)

WHAT ARE THE CONSEQUENCES FOR A STRUCTURER?

Structuring: from Linear to Asymmetric (Nonlinear) Payoffs

ZCB can be combined not only with vanilla (European and/or American) call and put options but also with **exotics**, to obtain, peculiar (**often asymmetric/non-linear**) risk-return profiles

- Examples of exotic options are:
  - **Digital Options** (which pay a fixed amount if the underlying is above a certain level);
  - **Asian Options** (which pay the average performance of the underlying);
  - **Barrier Options** (which come into life / expiry if the knock – in / knock – out event happens, i.e., if the barrier is touched/crossed)

Exotic Options: Digital

Under Black-Scholes, the pricing of digital options only depends on the (risk-neutral) probability that the underlying will be above the strike at maturity

- Under BS, the pricing of the digital options is straightforward, because they only depend on the (risk-neutral) probability that the underlying will be above the strike at maturity:

$$P = \text{Fixed Amount} \times N(d2) \times DF$$

where N ($d2$) is the probability that the Euro STOXX 50 will exceed the strike at the expiry of the option and DF is the discount factor

- From BS formula you know that:

$$d2 = \frac{\ln\left(\frac{St}{K}\right) + r\frac{1}{2}\sigma^2(T-t)}{\sigma\sqrt[2]{(T-t)}} - \sigma\sqrt[2]{T-t}$$

Exotic Options: Digital

Suppose that, instead of paying out the performance of the SX5E at maturity, our Equity Protection pays a digital coupon every year, if the value of SX5E is above the strike

- Suppose that at issuance of , the value of Euro STOXX 50 is 2260 points
- We structure the 5Y Equity Protection so that at the end of each year the bond pays a fixed amount if the value of the Euro STOXX 50 is above 2260 points
- Suppose that the ZCB costs 92 Euro so that you have 8 Euros to spend
- Instead of buying a 5-year ATM call, we invest the 8 Eur to buy 5 European digitals (a 1-year digital, a 2-year digital option, etc.)

Exotic Options: Digital

How do we calculate the fixed amount that we can afford to pay?

- I calculate the value of the 5 digital options (a 1-year digital option, a 2-year digital option etc.) paying a fixed amount equal to 1 Eur;
- I then sum them and divide 8 Eur (money to be spent) by that number (cost of a strip of 5 digitals paying 1 Euro at maturity)
- E.g. if the 5 digitals paying 1 Eur cost 2.40 Eur I can afford to pay a fixed amount of 3.33 Eur

Maturity	*DF*	*N(d2)*	*Premium*
1	*0.9949*	*0.52*	*0.5174*
2	*0.9816*	*0.51*	*0.5006*
3	*0.9623*	*0.50*	*0.4811*
4	*0.9403*	*0.49*	*0.4608*
5	*0.9178*	*0.48*	*0.4406*
Sum			*2.4000*

Exotic Options: Asians

An Asian option has a payoff that depends on the average value of the underlying at some predetermined dates (or during the whole life of the option)

- An Asian option has a payoff that depends on the average value of the underlying at some predetermined dates (or during the whole life of the option)
  - E.g., the payoff of an Asian call option with *n* observation dates is:

$$Payoff_n = NA \times \frac{1}{K} \times Max\left\{\frac{\sum_{t=1}^{n} S_t}{n} - K, 0\right\} = NA \times Max\left\{\frac{S_{Average}}{K} - 1, 0\right\}$$

Strike price

Average of the underlying price at the *n* observation dates

Exotic Options: Asians

Suppose that your structured bond will pay, instead of the performance of the underlying, the average performance computed at the end of each year

- Consider an Asian option on the Euro STOXX 50 with strike equal to 3,656 and 5 yearly observation dates
- The payoff of the Asian option at maturity will be:

t	S_t
1	3,700
2	3,860
3	3,850
4	3800
5	3,750
Average	**3,792**

$$NA \times Max\left\{\frac{S_{Average}}{K} - 1, 0\right\} = NA \times Max\left\{\frac{3,792}{3,656} - 1, 0\right\} = NA \times 3.72\%$$

- If the premium of the Asian option is equal to 10% and we have 8% to spend, we can afford 80% participation to any positive returns on the underlying so that at maturity, the Equity Linked Bond / Certificate (ELB) will pay:

$$ELB = 100 \times [1 + 0.8 \times 3.72\%] = 103$$

- Obviously, being path-dependent, an Asian call will always be cheaper than the equivalent European call option

Exotic Options: Barriers

A barrier option comes into life/ disappears if a certain barrier is touched

- A barrier option may be knock-in (if it comes into life when the barrier is touched) or knock-out if it vanishes when the barrier is touched)
  - According to level of barrier vs. initial underlying price, we distinguish up-and-out, down-and-out, up-and-in, and up-and-out options

Type	Barrier Location	Description
Down&In	Below	Price has to decrease below the barrier for the option to come into life
Up&In	Above	Price has to increse above the barrier for the option to come into life
Down&Out	Below	Price has not to decrease below the barrier for the option to stay alive
Up&Out	Above	Price has not to increase above the barrier for the option to stay alive

  - The barrier can be observed only at maturity (European barrier) or during the whole life of the option (American barrier)

Exotic Options: Barriers

- Let's analyze an example of how a barrier option works:
  - Consider an ATM call option on Fiat with spot price = Strike = Eur 15
  - A European Up&Out barrier at Eur 19 is written: if at maturity the price of Fiat is equal to Eur 19 the option will expire and nothing will be paid
  - Instead, if the price at maturity is equal to Eur 17, the pay-out of the option will be equal to 2
  - From the payoff table below, a barrier option with a barrier K = 19, should be cheaper than a standard, plain vanilla option (even if K = 15 for both)

	Payoff	
S_t	Knock-Out$_{B=19}$ Call	Standard Call
14	0	0
15	0	0
16	1	1
17	2	2
18	3	3
19	0	4
20	0	5

Exotic Options: Barriers

- This difference in the prices of a standard option vs. a barrier option with the same strike is exactly the reason why someone may wish to buy a barrier option
  - For instance, suppose, that you believe that Fiat will slightly increase in the next three months to a target price of 17 Eur
  - You have three options to bet on this increase of Fiat
  - (a) buy Fiat at 15 Eur and sell it in three-month's time; if you have 1,500 Eur to invest you will buy 100 shares and then sell them in three months
  - (b) buy an ATM option with three-month maturity; if the premium of the option is 1.5 Eur and you have 1,500 Eur to invest then you can underwrite an option on a notional of 15,000 Eur (1,000 shares)
  - (c) buy an ATM option with Up&Out barrier (barrier equal to 18 Eur) with a three-month maturity; if the premium of the option is 1 Eur and you have 1,500 Eur to invest you can underwrite an option on a notional of 22,500 Eur (1,500 shares)

Exotic Options: Barriers

Barrier options may (ex-post) maximize the profits from strategies based on (ex-post accurate) range-level forecasts of the underlying

- The table below considers the possible scenarios at maturity:

S_t	P&L(a)	P&L(b)	P&L(c)
13	-200	-1500	-1500
14	-100	-1500	-1500
15	0	-1500	-1500
16	100	-500	0
17	200	500	1500
18	300	1500	0
19	400	2500	0

- In essence, if you are not interested in the upside of Fiat above 18 Eur, the Up&Out option allows you not to pay for it
- Conversely, an Up&In option will be bought by a client that believes that the price increase will be higher than a certain level
- If you believe that Fiat will quote higher than 18 Eur in three months, buying an ATM Up&In call option with barrier equal to 18 Eur will be cheaper than buying a plain vanilla ATM option

Reverse Convertible Products

A reverse convertible is a structured product that pays a fixed coupon but refunds a portion of the notional principal that depends on the behavior of the price of one underlying security

- A standard Reverse Convertible is a note that pays an unconditional coupon at maturity (e.g., 10%) regardless of the behavior of the underlying
- In addition, if the price of the underlying has not declined, the note also pays back its notional
- On the contrary, if the underlying has depreciated, the investor obtains a number of shares equal to the notional divided by the Strike Price (also known as Conversion Price)
  - As an example, consider a 1-year Reverse Convertible note on Fiat:

Reverse Convertible Termsheet/Features	
Tenor	1 year
Underlying	Fiat
Strike Price (conversion price)	16 Euro
Coupon	10%
Notional	100 Euro (equal to 6.25 Fiat shares)
Payoff in case Fiat $\geq$ 16 Euro	110 Euro
Payoff in case Fiat $<$ 16 Euro	6.25 shares plus 10 Euro

Reverse Convertible Products

In a reverse convertible, an investor absorbs downside market risk in exchange of a coupon rate higher than the risk-free

- This payoff is replicated with a purchase of a ZCB plus the sale of a put option with 100% strike
  - Indeed, the payoff of the ZCB at maturity is equal to 100 Euro
  - If the value of Fiat is below 16 Euro the put option will be exercised and the payoff is: -(K - S)
  - Consequently the total payoff will be: 100 - 100 + S = S
  - Instead, if Fiat is above 16 Euro, the put option will be OTM, so it will not be exercised
- The proceeds from the sale of the put are invested at the risk-free rate to delivery a fixed coupon at maturity which is higher than the one that could be simply obtained from investing in a ZCB
- The investor is buying downside risk to obtain a higher coupon
- Note that instead of receiving a coupon at maturity, the investor may prefer to buy the note at a discounted price, the case of Discount Certificates

Reverse Convertible Products

Let's make it more realistic … how would approximately be priced today a 1Y reverse convertible on Fiat?

- Fiat's yesterday closing price was 6.20 Eur
- We can almost ignore the ZCB part: rates are so low that the discounting effect is negligible, so all the unconditional coupon that I want to pay should come from the sale of the put

Numero di risultati 20 Intorno al prezzo 6,43 CERCA marzo 2021

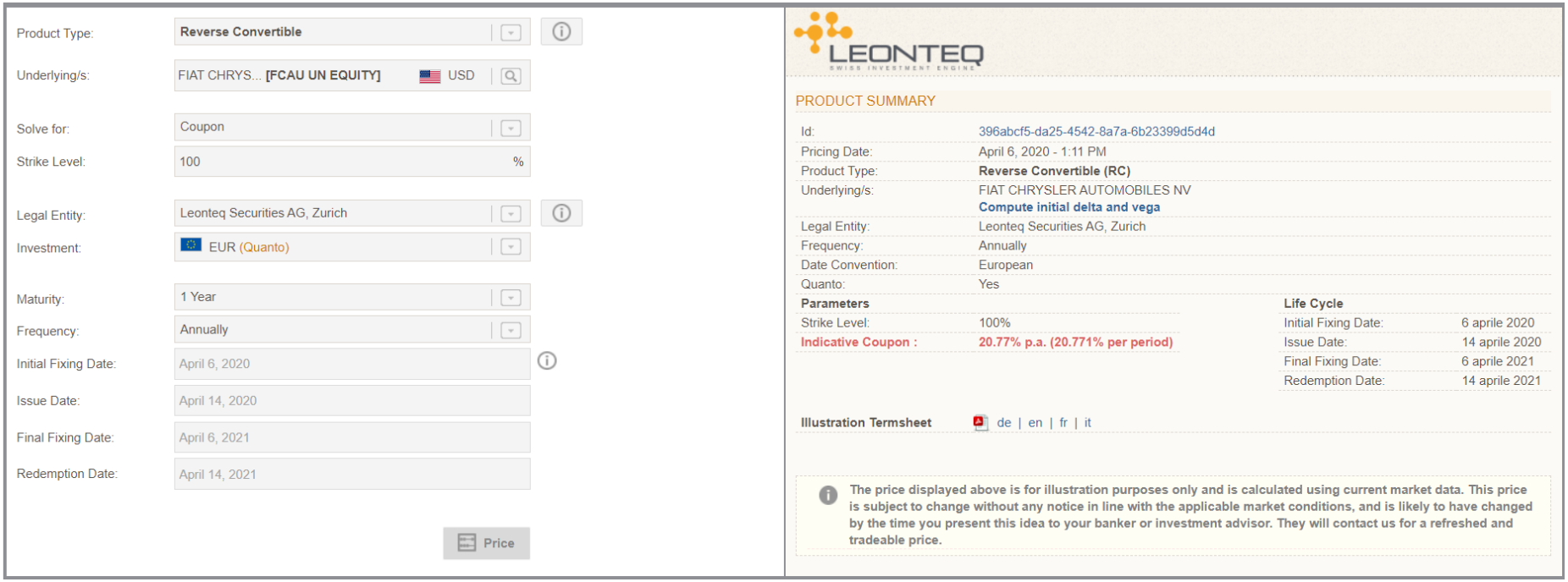
	CALL								PUT						
Simbolo	Prezzo	Q.Den	P.Den	P.Let	Q.Let	Volume	Ora	STRIKE	Simbolo	Prezzo	Q.Den	P.Den	P.Let	Q.Let	Volume	Ora
FCA1C4.60	0,0	65	1,968	2,5285	40	0	n.d.	4,6000	FCA1O4.60	0,0	40	0,569	0,7675	40	0	n.d.
FCA1C4.80	0,0	65	1,8405	2,3895	40	0	n.d.	4,8000	FCA1O4.80	0,7595	40	0,6355	0,845	40	0	10:07:14
FCA1C5	1,936	40	1,7185	2,246	40	0	14:18:48	5,0000	FCA1O5	0,836	40	0,707	0,927	40	0	10:07:14
FCA1C5.20	0,0	40	1,6025	2,105	40	0	n.d.	5,2000	FCA1O5.20	0,9175	40	0,7905	1,014	40	0	10:07:14
FCA1C5.40	1,7065	4											1,106	40	0	10:07:12
FCA1C5.60	1,5775	4											1,202	40	0	n.d.
FCA1C5.80	0,0	4											1,3035	40	0	n.d.
FCA1C6	0,0	40	1,232	1,5915	40	0	n.d.	6,0000	FCA1O6	1,241	40	1,1305	1,4095	40	0	14:46:37
FCA1C6.20	0,0	40	1,126	1,4815	65	0	n.d.	6,2000	FCA1O6.20	1,351	40	1,2305	1,5055	40	0	14:46:45

SELL 100/6.2 = 16.3 OPTIONS
AT A PRICE OF 1.23
COUPON WILL BE 20 Eur

Reverse Convertible Products

Let's make it even more realistic … Use a pricing tool from Leonteq: https://services.leonteq.com/constructor/c2/public

- Even if there is some (non negligible) degree of approximation in what we did, we were not too far from the price…



Reverse Convertible: The Greeks

The price of a Reverse Convertible depends (it is sensible to) a number of factors

Sensitivity of the price of an reverse convertible certificate:

- PRICE OF THE UNDERLYING: **POSITIVE** (the investor is SHORT of a put option)
- VOLATILITY: **NEGATIVE** (the vega of short options is negative)
- INTEREST RATES: **NEGATIVE** ("more discounting" if interest rates increase)
- DIVIDEND YIELD: **NEGATIVE** (a put costs more if the dividend is high, but you are selling it)
- TIME: generally **POSITIVE** (but depends…)

Bonus Cap ICs

Bonus (Cap) are investment certificates that embed barrier options (can be either American or European)

- If the price of the underlying does not touch the barrier (either at maturity or during the life of the product, depending whether the option is American or European) the investor receives capital + a bonus
- Otherwise the investor gets an amount proportional to the performance of the underlying

Bonus Cap ICs

Let us make an example of Bonus Cap Certificate with European Barrier (with Bonus = Cap which is quite typical although non compulsory)

Bonus Certificate Termsheet/Features	
Tenor	1 year
Strike	100% (15 Euro)
Underlying	Fiat
Barrier	80% (12 Euro)
Notional	100 Euro
Bonus Amount	110 Euro
Cap Amount	110 Euro

- If at maturity Fiat is above 12 Euro, the investor receives a "Bonus Amount" equal to 110 Euros (which is also the maximum amount that the investor can get, i.e., the "Cap Amount")
- Otherwise the investor gets an amount proportional to the performance of Fiat, i.e., **100 x min[110%, S_t/S_0]**

- A Bonus Cap is replicated with a ZCB plus a short Down&In put option (with strike 110% and barrier 80%)

Bonus Cap ICs

Let's focus on the case in which the 1-year discount factor is equal to 99% and a Down&In put with 80% barrier and K = 110% has a premium equal to 8.9%; spot is 15 euros

- Today we can invest 108.9% x NA in ZC bonds with 1-year to expiry to get 110% x NA at maturity
- At maturity we can have the two scenarios:

	Fiat $\geq$ 12 Euro	**Fiat $<$ 12 Euro**
ZC	110 Euro	110 Euro
Put D&I	Not triggered	$-(K-S) = -110+S$
Total	110 Euro	S

- In the case of an American Barrier, the payoff will be the same, but the barrier of the Down&In put will be observed during the whole life of the product
- At this point pricing the Bonus Cap just implies an ability to price the down-and-in put option with strike 110% and 80% barrier
- Clearly, the lower the Barrier, the lower the risk that it gets hit (and thus the cheaper the short option and the lower the Bonus we can afford)

Bonus Cap ICs

Alternative decomposition (which is equivalent): buy a call with strike zero, **buy** a **put down & out** with strike 110% and barrier 80%, sell a call with strike 110%

- If S is above 110%
  - The call with strike zero is ITM and pays S
  - The put is OTM while
  - The short call with strike 110% is ITM so payoff is 110%– S
- If S is between 110% and 80%
  - The call with strike zero is ITM and pays S
  - The put with strike 110% is ITM and pays 110%- S (barrier is not touched)
  - The short call with strike 110% is OTM
- If S is below 80%
  - The call with strike zero is ITM and pays S
  - The barrier is touched and put with strike 110% dies;
  - The short call is OTM

Bonus Cap ICs: The Greeks (at issuance)

As this product is really exotic, its Greeks are going to depend on:

- Proximity of the barrier
- Time to maturity

- However, we can derive some precise information about what Greeks are "at issuance"

- This helps the structurer to understand what to expect depending on the characteristics of the underlying

- If the underlying is very volatile, the product is going to have a higher bonus (because the D&I put option that we sell is going to be more expensive and we have more money to invest in the ZCB)

- If the underlying has high dividends the put option is going to have a higher value and, therefore, I have more money to spend for the ZCB

- Volatility typically receives the lion's share in the determination of the Bonus Amount

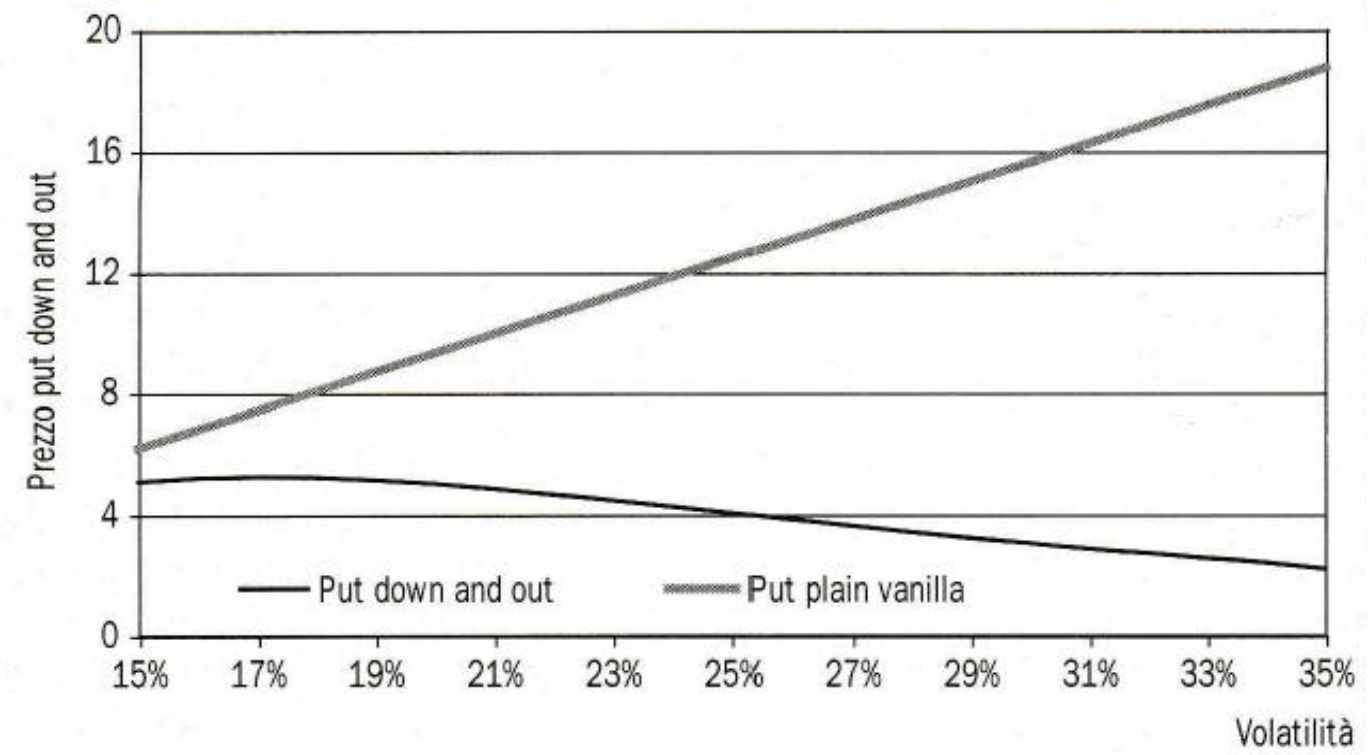
Bonus Cap ICs: The Greeks (during life)

We can also get some hints about what the Greeks are like during the life of the product

- Delta is always positive
- Below (and close) to the barrier delta is very close to one (because if the barrier is touched the product simply replicates the underlying)
- In case of American barrier, once the barrier is touched delta actually becomes one
- Vega is quite difficult to determinate after issuance, depends on many things (see e.g., next slide); in general vega negative products but see below
- For example, if we are below the barrier and the certificate has an European barrier, we still have the chance that the price will rise and we recover the Bonus; therefore Vega must turn positive

Bonus Cap ICs: Vega

- The plot shows the different sign of vega for plain vanilla puts vs. a down and out put
- Calculations are performed with reference to $S_t = K = 100$, volatility = 25%, T = 3 years, Barrier = 60, $r = 3\%$
- Calculations are performed using the model by Rubinstein and Reiner (1991)



Bonus Cap ICs: American vs. European

Clearly, with an American barrier there is much more risk that the Barrier will be touched => higher Bonus all else being equal

PRODUCT SUMMARY	
Id:	89f8e82f-1d07-4eae-ab51-378e9ffc2b9(
Pricing Date:	April 18, 2018 - 12:43 PM
Product Type:	**Barrier Reverse Convertible (BRC)**
Underlying/s:	FIAT CHRYSLER AUTOMOBILES NV **Compute initial delta and vega**
Legal Entity:	Leonteq Securities AG, Zurich
Frequency:	Annually
Date Convention:	European
Quanto:	No
Life Cycle	
Initial Fixing Date:	18 aprile 2018
Issue Date:	30 aprile 2018
Final Fixing Date:	18 aprile 2019
Redemption Date:	30 aprile 2019
Parameters	
Barrier:	70% (American)
Strike Level:	100%
Indicative Coupon :	**7,99% p.a. (7,989% per period)**

PRODUCT SUMMARY	
Id:	31cdb402-5c4d-492a-87a0-73387245a2fe
Pricing Date:	April 18, 2018 - 12:46 PM
Product Type:	**Barrier Reverse Convertible (BRC)**
Underlying/s:	FIAT CHRYSLER AUTOMOBILES NV **Compute initial delta and vega**
Legal Entity:	Leonteq Securities AG, Zurich
Frequency:	Annually
Date Convention:	European
Quanto:	No
Life Cycle	
Initial Fixing Date:	18 aprile 2018
Issue Date:	30 aprile 2018
Final Fixing Date:	18 aprile 2019
Redemption Date:	30 aprile 2019
Parameters	
Barrier:	70% (European)
Strike Level:	100%
Indicative Coupon :	**5,27% p.a. (5,268% per period)**

*Barrier Reverse Convertible is the Swiss version of the Bonus Cap (Bonus Amount = Coupon)

Bonus Cap ICs: Examples

Check the intuition: a Bonus Cap on an index (typically less volatile than single stocks) will generally offer lower bonus amount than a Bonus Cap on Intesa San Paolo ceteris paribus

PRODUCT SUMMARY	
Id:	4955ee1c-be41-49c1-bc3a-4741b6f6bcc2
Pricing Date:	April 19, 2018 - 10:01 AM
Product Type:	**Barrier Reverse Convertible (BRC)**
Underlying/s:	EURO STOXX 50 Price Index **Compute initial delta and vega**
Legal Entity:	Leonteq Securities AG, Zurich
Frequency:	Annually
Date Convention:	European
Quanto:	No
Life Cycle	
Initial Fixing Date:	19 aprile 2018
Issue Date:	30 aprile 2018
Final Fixing Date:	23 aprile 2019
Redemption Date:	30 aprile 2019
Parameters	
Barrier:	70% (American)
Strike Level:	100%
Indicative Coupon :	**1,08% p.a. (1,082% per period)**

PRODUCT SUMMARY	
Id:	5e7fb7e2-ccc5-4c7b-8b91-a4bd42b25c8a
Pricing Date:	April 19, 2018 - 10:02 AM
Product Type:	**Barrier Reverse Convertible (BRC)**
Underlying/s:	INTESA SANPAOLO **Compute initial delta and vega**
Legal Entity:	Leonteq Securities AG, Zurich
Frequency:	Annually
Date Convention:	European
Quanto:	No
Life Cycle	
Initial Fixing Date:	19 aprile 2018
Issue Date:	30 aprile 2018
Final Fixing Date:	23 aprile 2019
Redemption Date:	30 aprile 2019
Parameters	
Barrier:	70% (American)
Strike Level:	100%
Indicative Coupon :	**3,97% p.a. (3,969% per period)**

*Barrier Reverse Convertible is the Swiss version of the Bonus Cap (Bonus Amount = Coupon)

Bonus Cap ICs: Examples

Check the intuition: the lower the Barrier the lower the risk that it will be touched and thus the lower the bonus amount ceteris paribus

PRODUCT SUMMARY	
Id:	0f5b9ab5-03a7-4375-9257-d72d65aec792
Pricing Date:	April 19, 2018 - 10:04 AM
Product Type:	**Barrier Reverse Convertible (BRC)**
Underlying/s:	INTESA SANPAOLO **Compute initial delta and vega**
Legal Entity:	Leonteq Securities AG, Zurich
Frequency:	Annually
Date Convention:	European
Quanto:	No
Life Cycle	
Initial Fixing Date:	19 aprile 2018
Issue Date:	30 aprile 2018
Final Fixing Date:	23 aprile 2019
Redemption Date:	30 aprile 2019
Parameters	
Barrier:	80% (American)
Strike Level:	100%
Indicative Coupon :	**6,83% p.a. (6,827% per period)**

PRODUCT SUMMARY	
Id:	5e7fb7e2-ccc5-4c7b-8b91-a4bd42b25c8a
Pricing Date:	April 19, 2018 - 10:02 AM
Product Type:	**Barrier Reverse Convertible (BRC)**
Underlying/s:	INTESA SANPAOLO **Compute initial delta and vega**
Legal Entity:	Leonteq Securities AG, Zurich
Frequency:	Annually
Date Convention:	European
Quanto:	No
Life Cycle	
Initial Fixing Date:	19 aprile 2018
Issue Date:	30 aprile 2018
Final Fixing Date:	23 aprile 2019
Redemption Date:	30 aprile 2019
Parameters	
Barrier:	70% (American)
Strike Level:	100%
Indicative Coupon :	**3,97% p.a. (3,969% per period)**

*Barrier Reverse Convertible is the Swiss version of the Bonus Cap (Bonus Amount = Coupon)

The Autocallability Feature

Autocallable certificates are characterized by the possibility of early redemption if the underlying is higher than a certain level

- Autocallable Certificates are certificates which are **characterized by the possibility of early redemption if the underlying is higher than a certain level** (usually the **strike**)
- A type of autocallable certificates are the Express certificates: in case they are redeemed early, they pay the notional amount plus a coupon, multiplied by the number of observation periods elapsed
- In case they are not redeemed early, at maturity the capital is protected if the underlying is above some threshold level (**barrier**)
  - E.g., this certificate can be redeemed early at the end of year 1 and at the end of year 2, if the price of Fiat exceeds the trigger level (15 Euro)
  - If redeemed at the end of year 1 the certificate will pay 106

Autocallable Certificate Term Sheet/Features	
Maturity	3 years
Underlying	Fiat
Strike	15 Euro
Observation Dates	End of each year
Trigger	100% of the Strike
Barrier	70% of the Strike
Coupon	6%

The Autocallability Feature

Autocallable certificates are path-dependent as their expiry depends on the price of the underlying at the observation dates

- If redeemed at the end of year 2 the certificate will pay 112 Eur
- If instead the product reaches maturity, the certificate will pay 118 Euros, if the underlying is above the trigger level, 100 Euro if the underlying is below the trigger level, but above the barrier, and Eur $100 \times (S_T/S_0)$ otherwise

- Because autocallable certificates are path-dependent, given that their maturity depends on the underlying at some future dates (observation dates), they are priced using Monte Carlo simulations

- A stochastic volatility model (Heston model) is in general needed to capture the probability of kickout, and to asses the remaining value of the structure if no kickout has occurred

The Autocallability Feature – Heston Model

The price dynamics for options are not only a result of the random behavior of the underlying asset but also affected by a random mean reverting stochastic process describing the volatility of the asset

An asset price is assumed to be governed by the following system of stochastic differential equations

$$dS_t = (r - q)S_t dt + \sqrt{v_t} S_t dW_{1t}^Q$$

PRICE PROCESS

$$dv_t = k(\theta - v_t)dt + \eta\sqrt{v_t} dW_{2t}^Q$$

VOLATILITY PROCESS

$$dW_{1t}^Q dW_{2t}^Q = \rho dt$$

ISTANTANEOUS CORRELATION BETWEEN WIENER PROCESSES

$\boldsymbol{r}$ => risk-free rate

$\boldsymbol{q}$ => dividend yield

$\boldsymbol{\theta}$ => long term variance

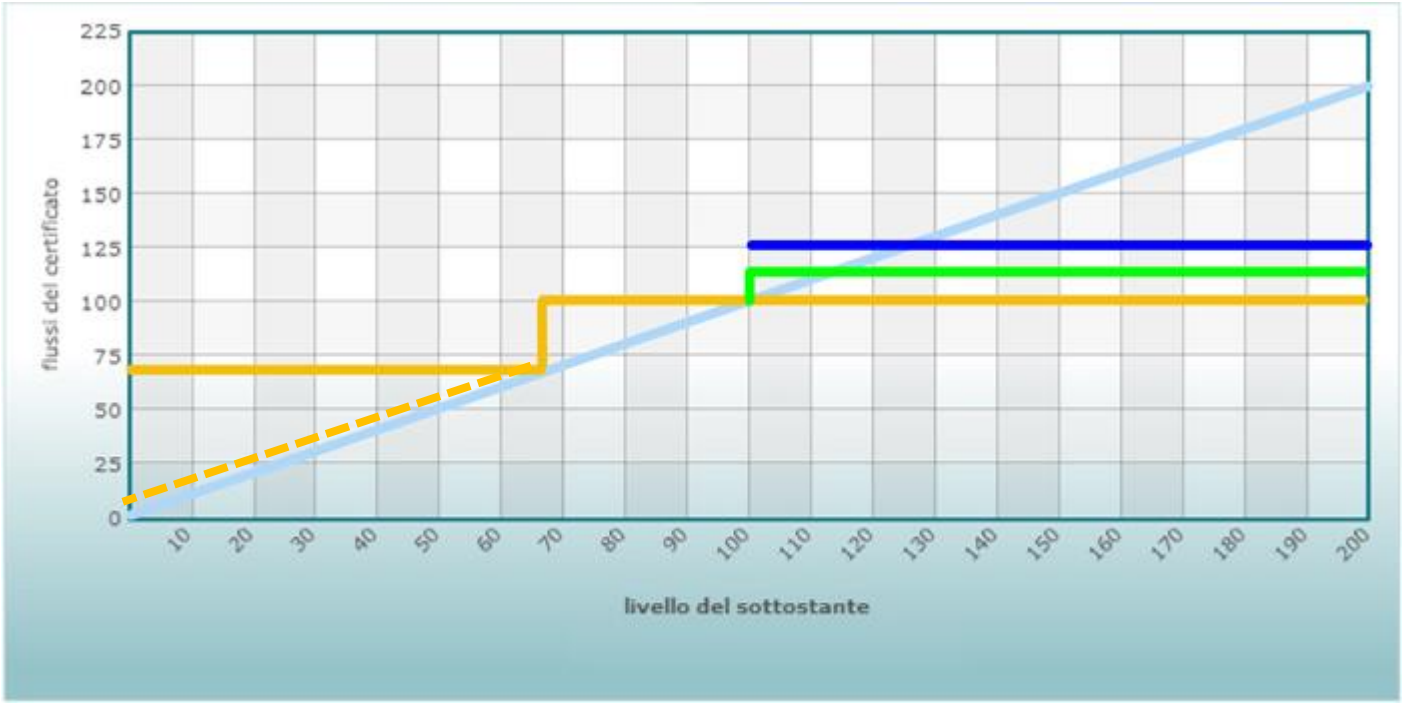
$\mathbf{k}$ => mean reversion speed coefficient

$\boldsymbol{\eta}$ => volatility of the variance

Express IC: option decomposition

- An Express IC is replicated by:
  - Buying a call at strike zero (equivalent to a forward)
  - Buying a barrier option put down-and-out; if the price goes below the barrier, then the express makes an investor fully participate in the losses of the underlying; otherwise it compensates any losses between strike and barrier
  - Selling a call with strike equal to the express strike; this cancels any profits from increases in the prices of the underlying
  - Buying a series of digital calls of knock-out type with strike = express strike, maturities equal to the liquidation dates, in number equal to the coupons paid in case the option stays alive
- The number of knock-out digitals increases with the difference in price between the call sold and the put down-and-out barrier

Express IC: the Payoff

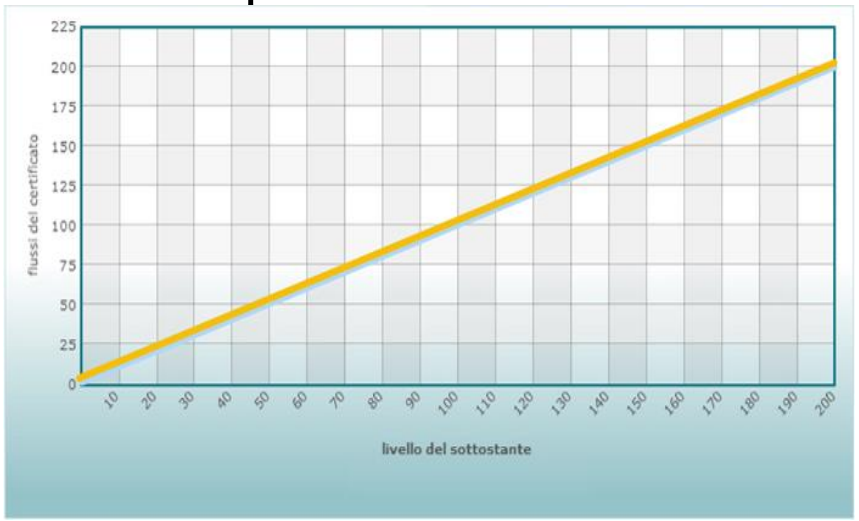


- Delta is positive but not monotonically increasing with strike
- Vega generally negative but depends on the distance from the barrier and time to maturity
- The dividends negatively impact the price of the certificate

ICs Without Capital Protection

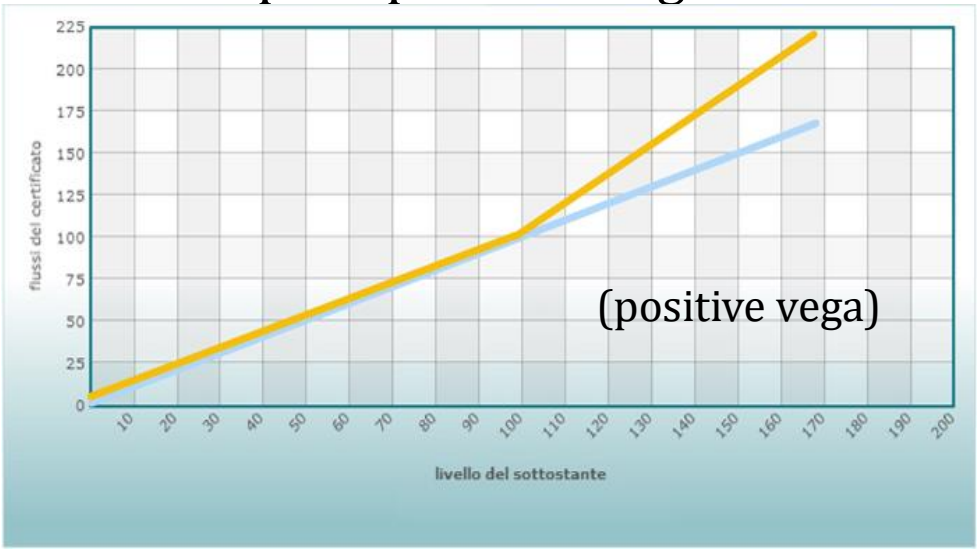
Benchmark and outperformance ICs are examples of symmetric, approximately linear payoffs

- Benchmarks replicate some underlying index with a 100% participation rate to profits and losses (linear symmetric payoffs)
- Therefore they are similar to ETFs and index mutual funds
  - However, differently from ETFs they (typically) have a maturity date (however open-end certificates exist)
  - ETF prices fluctuates with dividends and stock splits, while any expected dividends are deducted from IC prices at issuance
  - Their tax treatment is different
  - Their vega is nil because they are not options
  - Benchmarks on baskets of commodities are popular
  - When written on futures, they pose rollover issues



ICs Without Capital Protection

- Outperformance ICs are benchmarks in which participation to positive returns on the underlying are magnified
  - This is replicated by adding ATM European call options in quantity = outperformance rate/100
  - The outperformance feature is typically possible when the dividend is high enough
- No capital protection; the investor fully participates to the downside
- You can also see this as ZCB + short ATM put option + long ATM call options in an amount that is more than proportional
- E.g., if the participation to the upside is 150% you buy 1.5 times call options



Other investment certificates

Many other payoff variations are possible (and also many different commercial names for the same thing, depending on the country)

Have a look here: https://eusipa.org/governance/#EusipaDMap

EUROPE		AUSTRIA		FRANCE		GERMANY		ITALY		SWEDEN		SWITZERLAND		UK	
1	INVESTMENT PRODUCTS	1	ANLAGEPRODUKTE	1	PROD. D'INVESTISSEMENT	1	ANLAGEPRODUKTE	1	PRODOTTI DI INVESTIMENTO	1	INVESTERINGSPRODUKTER	1	ANLAGEPRODUKTE	1	INVESTMENT PRODUCTS
11	CAPITAL PROTECTION PRODUCTS	11	ANLAGEPRODUKTE MIT KAPITALSCHUTZ	11	PROD. À CAPITAL GARANTI À L'ÉCHÉANCE	11	ANLAGEPRODUKTE MIT KAPITALSCHUTZ	11	PRODOTTI A CAPITALE PROTETTO	11	KAPITALSKYDDADE PRODUKTER	11	KAPITALSCHUTZ	11	PROTECTED INCOME / PROTECTED GROWTH
1100	Uncapped Capital Protection	1100	Kapitalschutz Zertifikate	1100	Capital Garanti	1100	Kapitalschutz Zertifikate	1100	Equity protection senza cap	1100	Kapitalskydd utan maxnivå	1100	Kapitalschutz-Zertifikat mit Partizipation	1100	Protected Uncapped Growth
1110	Exchangeable Certificates											1110	Wandel-Zertifikat		
1120	Capped Capital Protected							1120	Equity protection con cap	1120	Kapitalskydd med maxnivå			1120	Protected Capped Growth
1130	Capital Protection with Knock-Out									1130	Kapitalskydd med knock-out	1130	Kapitalschutz-Zertifikat mit Barriere		
1140	Capital protection with Coupon					1140	Strukturierte Anleihen			1140	Kapitalskydd med kupong	1140	Kapitalschutz-Zertifikat mit Coupon	1140	Protected Conditional Income
1199	Miscellaneous Capital Protection	1199	Weitere Anlageprodukte mit Kapitalschutz	1199	Autres produits à Capital Garanti à l'échéance	1199	Weitere Anlageprodukte mit Kapitalschutz	1199	Altri prodotti a capitale protetto	1199	Blandade Kapitalskyddade produkter	1199	Weitere Kapitalschutz-Zertifikate	1199	Protected Growth Other (1198 Protected Income Other)
12	YIELD ENHANCEMENT PRODUCTS	12	ANLAGEPRODUKTE OHNE KAPITALSCHUTZ	12	PRODUITS DE RENDEMENT	12	ANLAGEPRODUKTE OHNE KAPITALSCHUTZ	12	PRODOTTI A CAP. NON PROT. E CONDIZ. PROT.	12	AVKASTNINGSFÖRBÄTTRANDE INST.	12	RENDITEOPTIMIERUNG	12	NON PROTECTED INCOME
1200	Discount Certificates	1200	Discount Zertifikate	1200	Discount	1200	Discount Zertifikate	1200	Discount	1200	Maxcertifikat	1200	Discount-Zertifikat		
1210	Barrier Discount Certificates											1210	Discount-Zertifikat mit Barriere		
1220	Reverse Convertibles	1220	Aktienanleihen	1220	Reverse Convertibles	1220	Aktienanleihen			1220	Omvänd konvertibel	1220	Reverse Convertible		
1230	Barrier Reverse Convertibles			1230	Reverse Convertibles knock-in					1230	Autokupong/Omvänd konvertibel med barriär	1230	Barrier Reverse Convertible	1230	Fixed Income
1240	Capped Outperformance Certificates			1240	Sprint	1240	Sprint Zertifikate	1240	Outperformance con cap						
1250	Capped Bonus Certificates			1250	Bonus Cappés			1250	Bonus con cap						
1260	Express Certificates	1260	Express Zertifikate			1260	Express Zertifikate	1260	Express	1260	Autocall / Expresscertifikat	1260	Express-Zertifikat	1260	Kick Out
1299	Miscellaneous Yield Enhancement			1299	Autres produits de Rendement					1299	Blandade avkastningsförbättrande instrument	1299	Weitere Renditeoptimierungs-Zertifikate	1299	Income Other
13	PARTICIPATION PRODUCTS			13	PRODUITS DE PARTICIPATION					13	DELTAGANDEINSTRUMENT	13	PARTIZIPATION	13	NON PROTECTED GROWTH
1300	Tracker Certificates	1300	Index / Partizipations Zertifikate	1300	100% (1301 100% Bear)	1300	Index / Partizipations Zertifikate	1300	Benchmark	1300	Trackercertifikat	1300	Tracker-Zertifikat		
1310	Outperformance Certificates	1310	Outperformance Zertifikate			1310	Outperformance Zertifikate	1310	Outperformance senza cap	1310	Tillväxtcertifikat	1310	Outperformance-Zertifikat		
1320	Bonus Certificates	1320	Bonus Zertifikate	1320	Bonus	1320	Bonus Zertifikate	1320	Bonus senza cap	1320	Bonuscertifikat	1320	Bonus-Zertifikat	1320	Uncapped Growth
1330	Outperformance Bonus Certificates											1330	Bonus-Outperformance-Zertifikat		
1340	Twin-Win Certificates			1340	Twin Win			1340	Twin Win	1340	Winwincertifikat	1340	Twin-Win-Zertifikat		
1399	Miscellaneous Participation	1399	Weitere Anlageprodukte ohne Kapitalschutz	1399	Autres produits de Participation	1399	Weitere Anlageprodukte ohne Kapitalschutz	1399	Altri prodotti a cap non protetto e condiz. prot.	1399	Blandade deltagandeinstrument	1399	Weitere Partizipations-Zertifikate	1399	Growth Other
2	LEVERAGE PRODUCTS	2	HEBELPRODUKTE	2	PROD. À EFFET DE LEVIER	2	HEBELPRODUKTE	2	PRODOTTI A LEVA	2	HÄVSTÅNGSINSTRUMENT	2	HEBELPRODUKTE		
21	LEVERAGE PRODUCTS WITHOUT KNOCK-OUT	21	HEBELPRODUKTE OHNE KNOCK-OUT	21	SANS BARRIÈRE DÉSACTIVANTE	21	HEBELPRODUKTE OHNE KNOCK-OUT	21	PRODOTTI A LEVA SENZA KNOCK-OUT	21	HÄVSTÅNGSINST. UTAN STOPP-LOSS				
2100	Warrants	2100	Optionsscheine	2100	Warrants	2100	Optionsscheine	2100	Covered warrant	2100	Warranter	2100	Warrant		
2110	Spread Warrants			2110	Cappés & Floorés			2110	Spread warrant			2110	Spread Warrant		
2199	Miscellaneous Leverage without Knock-Out	2199	Weitere Hebelprodukte ohne Knock-Out	2199	Autres prod. de levier sans barrière désactivante	2199	Weitere Hebelprodukte ohne Knock-Out	2199	Altri prodotti a leva senza knock-out	2199	Blandade hävstångsinst. utan stopp-loss				
22	LEVERAGE PRODUCTS WITH KNOCK-OUT	22	HEBELPRODUKTE MIT KNOCK-OUT	22	AVEC BARRIÈRE DÉSACTIVANTE	22	HEBELPRODUKTE MIT KNOCK-OUT	22	PRODOTTI A LEVA CON KNOCK-OUT	22	HÄVSTÅNGSINST. MED STOPP-LOSS				
2200	Knock-Out Warrants	2200	Knock-Out Produkte	2200	Turbos	2200	Knock-Out Produkte	2200	Turbo	2200	Knock-Out warranter	2200	Warrant mit Knock-Out		
2205	Open-end Knock-Out Warrants			2205	Turbos illimités / infinis BEST					2205	Open-end Knock-Out Warrants	2205	(grouped in category 2200)		
2210	Mini-Futures			2210	Turbos illimités / infinis			2210	Mini future	2210	Mini Future	2210	Mini-Future		
2230	Double Knock-Out Warrants			2230	Stability Warrants										
2299	Miscellaneous Leverage with Knock-Out	2299	Weitere Hebelprodukte mit Knock-Out	2299	Autres produits de levier avec barrière	2299	Weitere Hebelprodukte mit Knock-Out	2299	Altri prodotti a leva con knock-out	2299	Blandade hävstångsinst. med stopp-loss				
23	CONSTANT LEVERAGE PRODUCTS	23	PRODUKTE MIT KONSTANTEM HEBEL	23	PRODUITS À EFFET DE LEVIER CONSTANT	23	PRODUKTE MIT KONSTANTEM HEBEL			23	INSTRUMENT MED KONSTANT HÄVSTÅNG				
2300	Constant Leverage Certificate	2300	Faktor-Zertifikate	2300	Leverages & Shorts	2300	Faktor-Zertifikate			2300	Bull & Bear Certifikat	2300	Constant Leverage-Zertifikat		
2399	Miscellaneous Constant Leverage Products	2399	Weitere Produkte mit konstantem Hebel	2399	Autres produits à effet de levier constant	2399	Weitere Produkte mit konstantem Hebel			2399	Blandade instrument med konstant hävstång	2099	Weitere Hebelprodukte		

Leveraged Certificates and Turbos

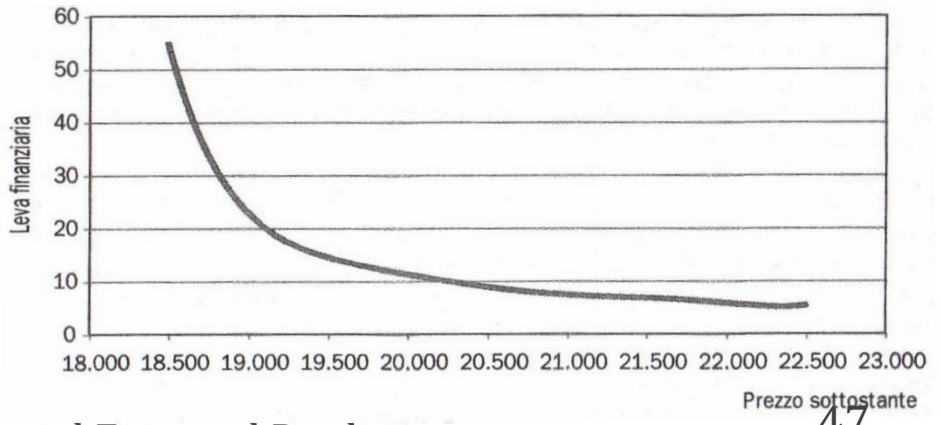
Leverage certificates allow an investor to participate to profits and losses on the underlying in a more-than-proportional way

- A Turbo certificate allows to participate in profits and losses of the underlying asset on the basis of a multiple and a stop loss level determines the underlying price at which the Turbo is extinguished
  - There is an implicit, mechanical auto-callability feature produced by the fact that losses cannot be magnified to go below -100%
  - A key parameter is leverage, the ratio btw. the underlying price at issuance and (underlying price - certificate strike)
- A Turbo can be replicated by a long position in the underlying + the sale of a ZCB with notional = strike price
- They are natural trading tools

Leveraged Certificates and Turbos

While under dynamic leverage the strike is fixed and effective leverage continuously moves as a (inverse!) function of the underlying price, under fixed leverage the strike is dynamically adjusted to make the leverage ratio constant over time

- A Turbo implies dynamic leverage, i.e., a leverage ratio that is a function of the underlying price, given a fixed strike
- Turbos may often offer abysmal performances that are caused by these dynamic effects, which make them riskier than thought of
  - E.g., Camelia's book reports one example of a Turbo on the FTSE MIB with 10.9 leverage at issuance that, over time and in the face of a +12.5% by the index, makes a 117% return, i.e., 117/12.5 = 9.4 only
  - In the case of a -5.6% by the underlying, Turbo yields a loss of 70%, i.e., 70/5.6 =12.5
- Also fixed leverage structured products have a drawback: the compounding effect



Leveraged Certificates and Turbos

- When volatility is high, the performance of fixed leverage ICs tends to significantly diverge from the performance of the underlying
- In principle, under fixed leverage you may record losses even though between t and T on net (averaging) the underlying has not moved…
- Ideally, this can be avoided by dynamically changing the amount invested in fixed leverage products, at least on every trading day
- Therefore fixed leverage products are ideal for trading and they tend to imply modest transaction costs

- Fixed leverage is typically packaged as a leveraged benchmark IC
  - A few examples of the compounding effect

Favorable Example

	Indice	Performance giornaliere indice	Indice leva 5	Performance giornaliere Indice a leva 5
giorno 1	10,000	5,00%	10,000	25,00%
giorno 2	10,500	1,00%	12,500	5,00%
giorno 3	10,605	3,00%	13,125	15,00%
Complessivo	10,923	9,23%	15,093	50,93%

X 5 =46% < 51%

Unfavorable Example

	Indice	Performance giornaliere indice	Indice leva 5	Performance giornaliere Indice a leva 5
giorno 1	10,000	2,00%	10,000	10,00%
giorno 2	10,200	-4,00%	11,000	-20,00%
giorno 3	9,792	3,00%	8.800	15,00%
Complessivo	10,08576	0,8576%	10,120	1,20%

X 5 =4.3% > 1.2%

Leveraged Certificates and Turbo Short

The bearish-view motivated ICs that accomplish what Turbos do on the long end are the Shorts

- A Short certificate allows reverse participation to profits and losses of the underlying on the basis of a multiple and a stop loss level determines the underlying price at which the Short is extinguished
  - There is an implicit, mechanical auto-callability feature produced by the fact that losses cannot be magnified to go below -100%
  - A key parameter is leverage, the ratio btw. the underlying price at issuance and strike
- A Short can be replicated by a short position in the underlying + the purchase of a ZCB with notional = strike price
- Expected dividend corrections are necessary to avoid arbitrage