ВТБ Капитал

PRESENTATION OF VTB CORPORATE AND INVESTMENT BANK FROM A QUANT / EXOTIC TRADING PERSPECTIVE

Nikita Novyydarskov

Kirill Klimov

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INTRODUCTION

Trading floor life

MAIN ACTIVITIES OF INVESTMENT BANK

Main investment bank activities that include trading may be split into two groups:

Helping client to raise money from investors to finance their activities

- Equity financing, ECM
- Debt financing (DCM and Loan provided)

  With possible involvement of trading to hedge potential risks by derivative instruments.

Providing client with best possible returns on his investment

- Deposit accounts
- Structured products (with embedded derivatives)
- Private equity investment etc.

MAIN CLIENTS

What are the main clients of an Investment Bank?

- Pension funds
- Hedge funds
- Corporates
- Retail banks
- Asset management companies
- High-net-worth individuals
- Etc.

DERIVATIVE PRODUCTS

Why do we need derivate products?

Derivative is a contract that derives its value from the performance of an underlying entity.

Derivatives are used in:

- Structured notes to match investor's risk/return appetite
- Loans to offer client a cheapener
- Hedging of more complex financial structures

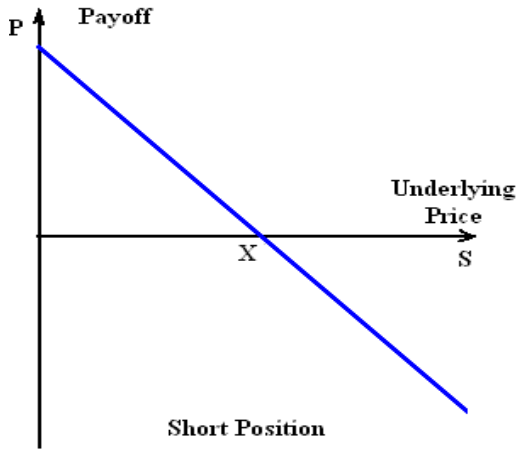
Example:

Hedging of the grain price for the agricultural producers

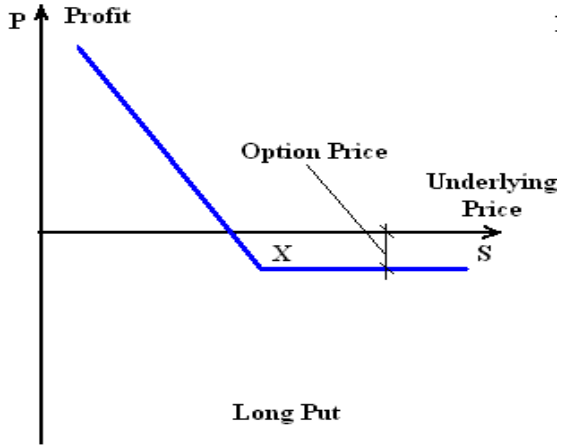
BASIC DERIVATIVES TO USE FOR HEDGING

Basic hedging strategies for the agricultural producer:

Take a short position in a Forward contract:



Take a long position in a Put option contract:



KEY PARTICIPANTS

Key players of the CIB Front-Office:

- **Derivative sales** – keep relationships with the client. Deal originators.
- **Structurers** – the main drivers for the structured trades. Coordinate the work of multiple traders, legal departments, compliance etc.
- **Traders** – people responsible for the execution. Traders daily manage risks of their open positions.
- **Front-Office Quants** – team responsible for the development of the analytics methods for pricing and risk management of derivative products.

FIRST APPROACH TO DERIVATIVES PRICING

PV of future flows

- Each product can be defined by a **term sheet** which specifies the future flows.

- Type of flows can vary significantly from a contract to the other:
  - Payment in the future
  - Possibly at an uncertain date
  - Paid in cash, or delivery of another asset
  - Amount contingent on market observable.

- **Present Value (PV)** of a flow: how much it can be bought or sold for cash. **PVs** can be compared.

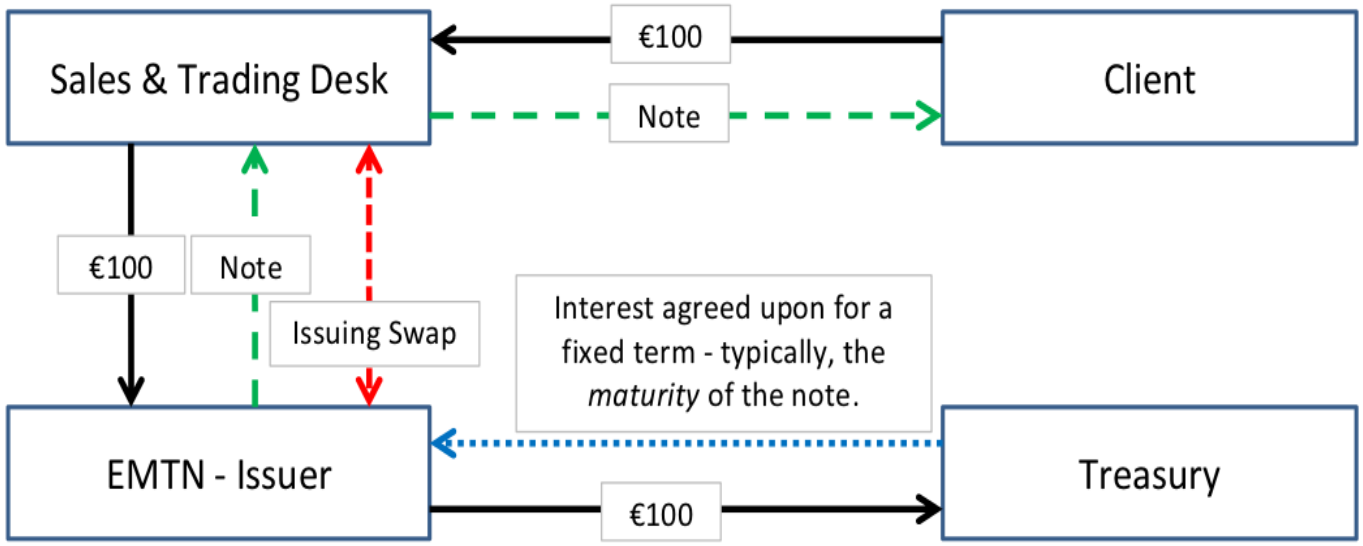
- **PV** is obtained by multiplying the value of the flow by the discount factor corresponding to the date it occurs, thus for the same flows **PV** of one flow can be lower if the corresponding discount factor is lower.

HOW THE CIB TRADERS REALLY TRADE

Product price = Replication portfolio price

- To price the contract, it's required to estimate the **cost of replication**.
- **Replicate** = synthetize a product with smaller, simpler constituents.
- **The cake analogy**: cost of cake = cost of ingredients + labor + margin
- **Quants** = people who provide a replication recipe

EXAMPLE OF THE STRUCTURED TRADE LIFE CYCLE



CASE STUDY

Autocallable Structures

PRODUCT DESCRIPTION

Main characteristics

- Asset ***S***
- Autocall trigger or threshold ***H***
- Coupon trigger or coupon level ***B***
- At each observation date, the autocall is triggered if ***S > H*** and it was not triggered before
- If called, the product pays **Redemption**
- At each observation date, coupon is paid if no autocallable event has previously occurred and the reference asset ***S*** is higher than ***B***
- If ***H = B*** we talk about autocallables with knock-out coupons.

PURPOSE OF AUTOCALLABLE

Why to trade such an exotic product?

- **Main advantages** :
  - Capital protected (amount of potential losses are limited, **at worth receive notional**),
  - Gives the coupon interest rate **is higher than the fixed coupon** bond (or deposit) interest rate,
  - Exposure on the asset **an investor has a view on.**
- **Example**:

  An investor is interested in investing in XYZ shares but does not want to worry about the constant changes in the market price. He can buy a 1-year capital-guaranteed autocallable note which pays 8% coupon if the asset is above its initial price. Otherwise it pays no coupon, but returns the full notional amount.

TERM SHEET

Example

Underlying Asset	SPX
Notional	$10 million
Currency	USD
Maturity	3 years
Autocall level	110%
Autocall frequency	Annual
Coupon level	70%
Coupon frequency	Annual
Coupon value	8% per annum
Note price	98%
Capital protected	Yes

PAYOFF

For each observation date t_i :

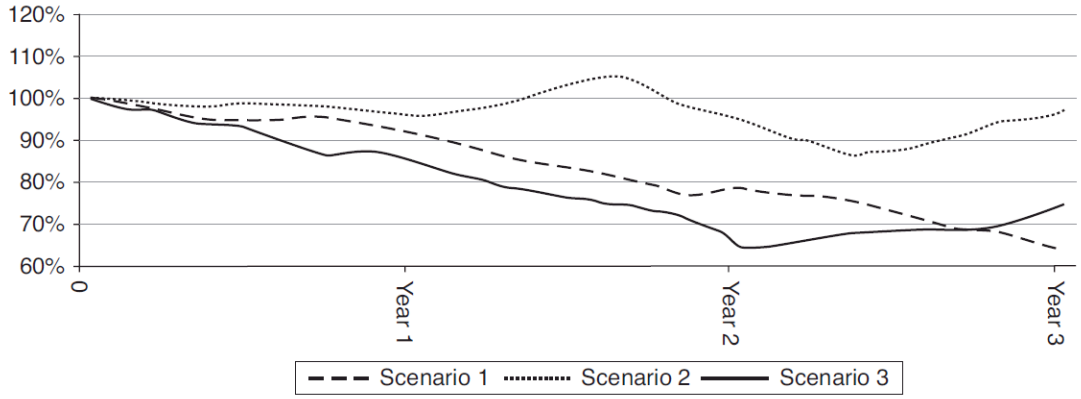
$$\mathrm{Ret}(t_i) = S(t_i)/S(0)$$

$$\mathrm{Coupon}(t_i) = \mathrm{Notional} \times C \times \mathbf{1}_{\{\mathrm{Ret}(t_i) \geq B\}} \times \mathbf{1}_{\left\{\max_{j=1,\ldots,i-1}\left(\mathrm{Ret}(t_j)\right) < H\right\}}$$

$$\mathrm{Redemption}(t_i) = \mathrm{Notional} \times \mathbf{1}_{\{\mathrm{Ret}(t_i) \geq H\}} \times \mathbf{1}_{\left\{\max_{j=1,\ldots,i-1}\left(\mathrm{Ret}(t_j)\right) < H\right\}}$$

SCENARIO ANALYSIS (1/2)

Payoff Mechanism (Coupon = 8%, H= 110%, B=70%)

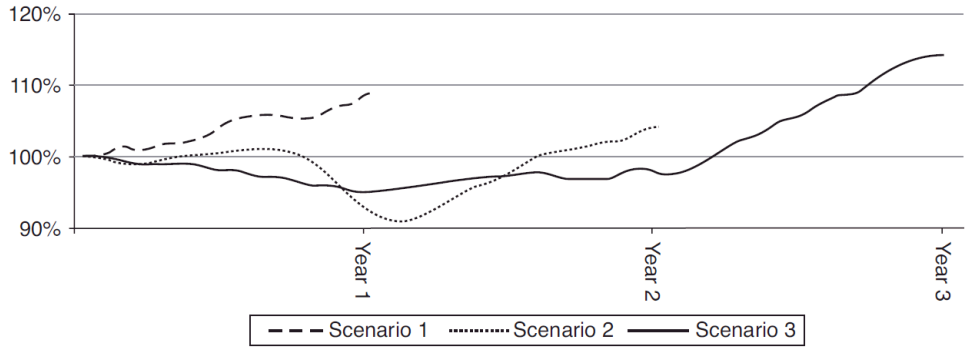


	Scenario 1	Scenario 2	Scenario 3
Coupon at the end of year 1	8%	8%	8%
Coupon at the end of year 2	8%	8%	0%
Coupon at the end of year 3	100%	108%	108%

Source: Exotic Options and Hybrids. M. Bouzoubaa, A. Osseiran

SCENARIO ANALYSIS (2/2)

Payoff Mechanism (Coupon = 8%, H= 100%, B=70%)



	Scenario 1	Scenario 2	Scenario 3
Coupon at the end of year 1	108%	8%	8%
Coupon at the end of year 2	–	108%	8%
Coupon at the end of year 3	–	–	108%

Source: Exotic Options and Hybrids. M. Bouzoubaa, A. Osseiran

CONSTRUCTION OF EQUITY FORWARD CURVE (1/3)

REPO

Some shareholders may **hold shares** and **don't want to sell them** (since wants to keep the strategic control of the company), but have a need in borrowing money.

In these cases the shares may be used as a **collateral for a loan.**

For this purpose a REPO or repurchase agreement can be used:

- Borrower **receives** cash and provide shares as a collateral
- Borrower pays the interest rate ***r*** on cash and receives a repo rates ***q*** and dividends on the cash value of the shares.
- We assume the if the share value changes, **the amount of cash and shares are adjusted accordingly** via margin calls to be equal to each other
- Finally, borrower return the cash value and receive back the shares

CONSTRUCTION OF EQUITY FORWARD CURVE (2/3)

Dividends

Dividends are usually defined as **a fixed cash amount per share**.

For any dividend there are three important dates:

- The **announcement date** is the day when dividends declared,
- The **exclusion date (ex-date)** is the first day on which any share bought or sold doesn't have right to the closest dividend payment (the day when the share price drops),
- The **payment date** is the date when the dividend is actually paid.

Public companies tend to follow **a relatively fixed schedule** regarding dividends but the actual dividend dates are known at most one year in advance.

Usually dividends for future periods which need to be forecasted are assumed to be proportional to the share price.

CONSTRUCTION OF EQUITY FORWARD CURVE (3/3)

Forward curve

With borrowing rate ***r***, repo rate ***q*** and dividend ***D*** to be paid at T_D the forward (par strike) is:

$$F(T) = S(0) \cdot e^{(r-q)\cdot T} - D \cdot e^{(r-q)\cdot(T-T_D)}$$

VOLATILITY

Market unobservable parameters

Black-Scholes model assumes underlying stock to move following the **diffusion process:**

$$dS_t = S_t \mu dt + S_t \sigma dW_t$$

What σ to take ?

- From **historical observations** of the underlying?
- From **observable prices** on the options market?

"The wrong number one has to put in the wrong formula to get the correct price."

IMPLIED VOLATILITY

What is implied volatility?

- If the real world was consistent with Black-Scholes, all quoted options on a given stock would have the same implied volatility (in Black-Scholes, is a constant for each stock and does not depend on the option you price).

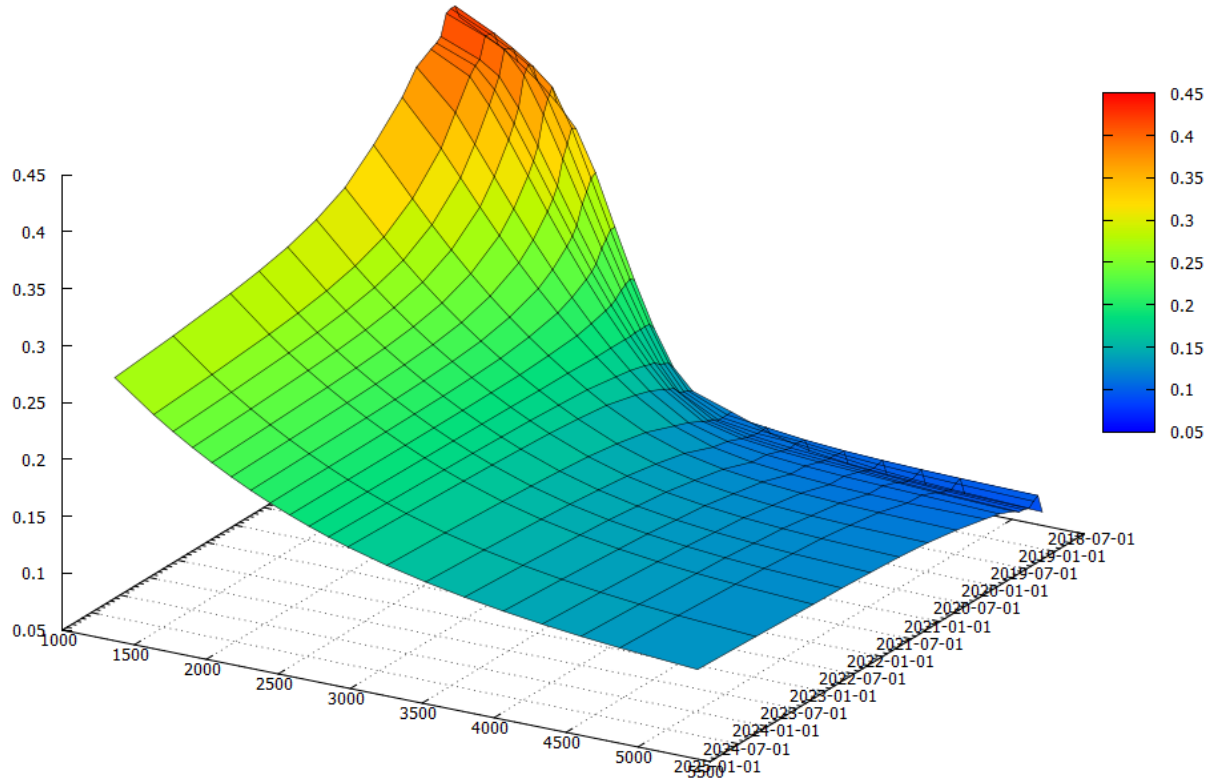
- This is not the case in practice.

- The implied volatility surface, that is the graph of implied volatility of a quoted options as a function of strike and maturity is not constant (flat).

- This phenomenon is often referred to as the implied volatility **smile or skew** (depending on the shape).

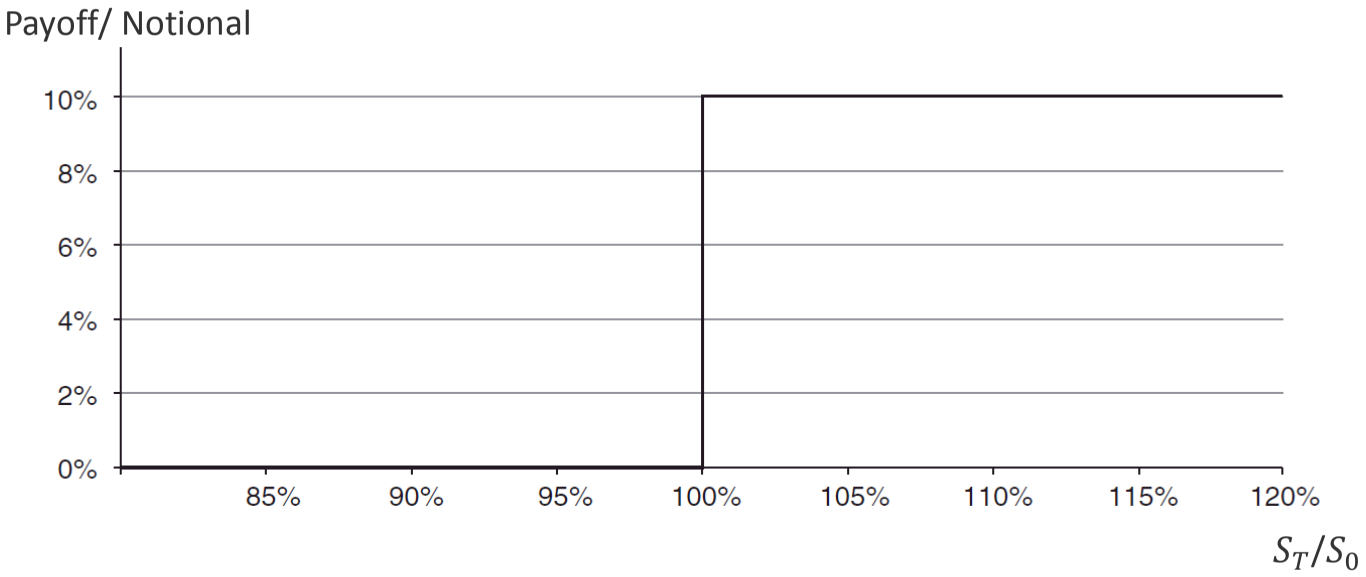
IMPLIED VOLATILITY

Example: SPX implied volatility surface as of 28 Nov 2018



EUROPEAN DIGITAL OPTIONS

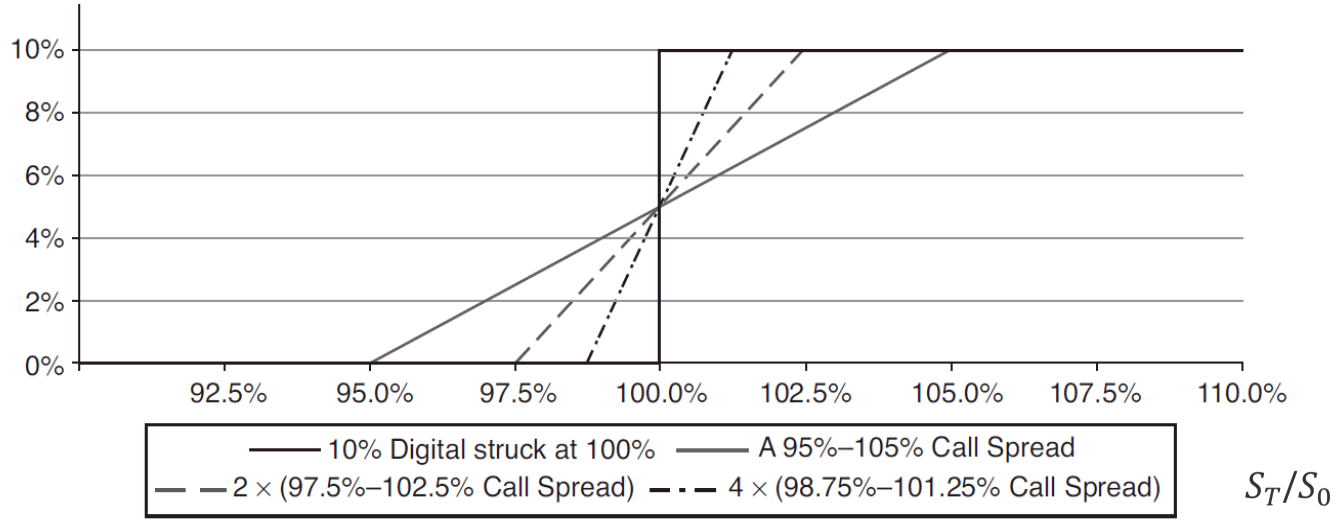
Payoff of the 10% European digital option with strike at 100%



HEDGING OF EUROPEAN DIGITAL OPTIONS

How the payoff can be replicated?

Payoff/ Notional



$$100\%\ \text{Digital}(K) = \lim_{\epsilon \to 0} \frac{1}{\epsilon} (\text{Call}(K - \epsilon) - \text{Call}(K + \epsilon))$$

As implied volatility depends on the strike thus, price of Digital is sensitive to the **implied volatility skew**

RISK ANALYSIS (1/3)

Price sensitivities

- Autocall can be seen as a strip of digital options, the first being the classical European digital and all others being path-dependent digitals.

- The seller must be careful when offering a very large digital with a low exercise probability due to hedging constraints.

RISK ANALYSIS (2/3)

Price sensitivities

- Seller of Autocallable:
  - **Loses money if** the price of underlying **Forward goes up:**
    - **Loses money if IR goes up**
    - **Gains if Dividends goes up**
    - **Gains if Borrowing costs goes up**
- **Loses money if the implied volatility skew increases**
- Position in **Volatility** depends on the **coupon level** and the **Forward price** of the underlying (by analogy with digital options).
  - Vega of digitals is positive if the underlying's Forward price is lower than the trigger , and negative otherwise.
- Vega is split in buckets per time periods and changes over the time w.r.t. the level of the **Forward price.**

RISK ANALYSIS (3/3)

IR/Asset Correlation

- **Case 1: Positive correlation**
  If Asset goes up (the same reasoning applies if asset price goes down)
  - Discount Factors go down
  - Duration goes down
  - Seller loses money while rebalancing it's hedging portfolio

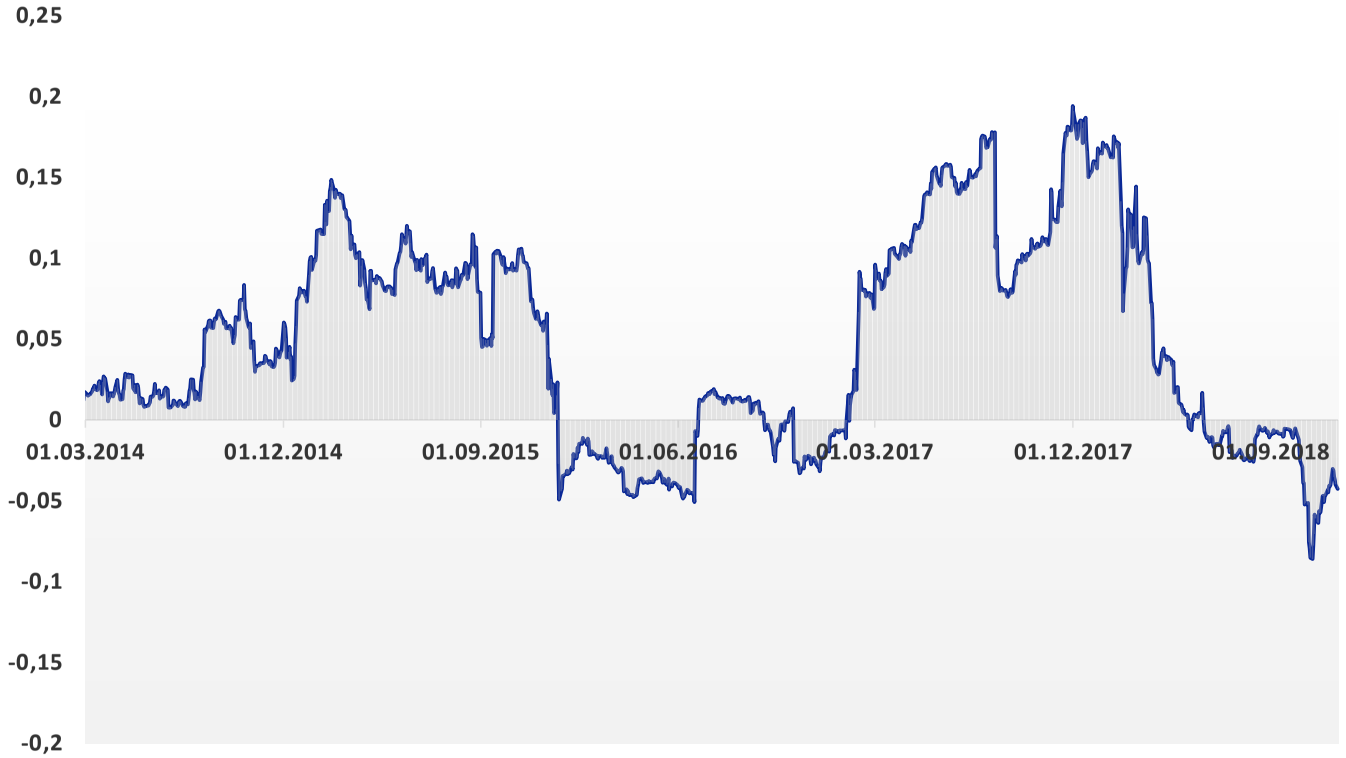
- **Case 2: Negative correlation**
  If Asset goes up (the same reasoning applies if asset price goes down)
  - Discount Factors go up
  - Duration goes down
  - Seller gains money while rebalancing its hedging portfolio

Thus, the price of the Autocallable structure should be **higher** if correlation is assumed to be **positive.** And **lower** if correlation is assumed to be **negative.**

Thus stochastic interest rate model is needed in order to account for correlation parameter.

CORRELATION

SPX vs USD 3M LIBOR Historical correlation



Source: Bloomberg quotes

OTHER VARIATIONS OF AUTOCALLABLE STRUCTURES

Many other variations of Autocallable structures are available

- Autocallable participating note
- Autocallables with embedded down-and-in puts
- Multi-Asset Autocallables
- Etc.

In all cases the investor can adjust his return expectations w.r.t. his risk appetite.

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THANK YOU!

Questions