Risk training

Jan De Spiegeleer

Pricing & Modelling Convertible Bonds

November 2018

RISK
CONCILE

Jan De Spiegeleer

- Co-Founder RiskConcile
- Head of Risk Management at Jabre Capital Partners S.A.2006 - 2015

- Co-Founder of RiskConcile (www.riskconcile.com) a Risk & FinTech spin-off from KU Leuven University
- Prior to joining in June 2007, Jan co-founded Erasmus Capital NV where he was the Managing Director of the Belgian investment advisory company from 2003 to 2007. Served in the Belgian Army as a Company Commander from 1988 to 1993. Then spent the next ten years at KBC Financial Products Group where he was Managing Director and Head of Equity Derivatives Trading and Structuring.

- Received his MBA from KU Leuven (1992), having previously obtained a Masters of Science in Civil Engineering from the Royal Military Academy in Brussels (1988). He also holds a PhD from KU Leuven (2013).

- Written several books including the recently published "*The Handbook of Convertible Bonds*" and "*Contingent Convertible (CoCo) Notes: Structuring & Pricing*". (Wiley),

Introduction

Introduction to Convertible and Exchangeable Bonds

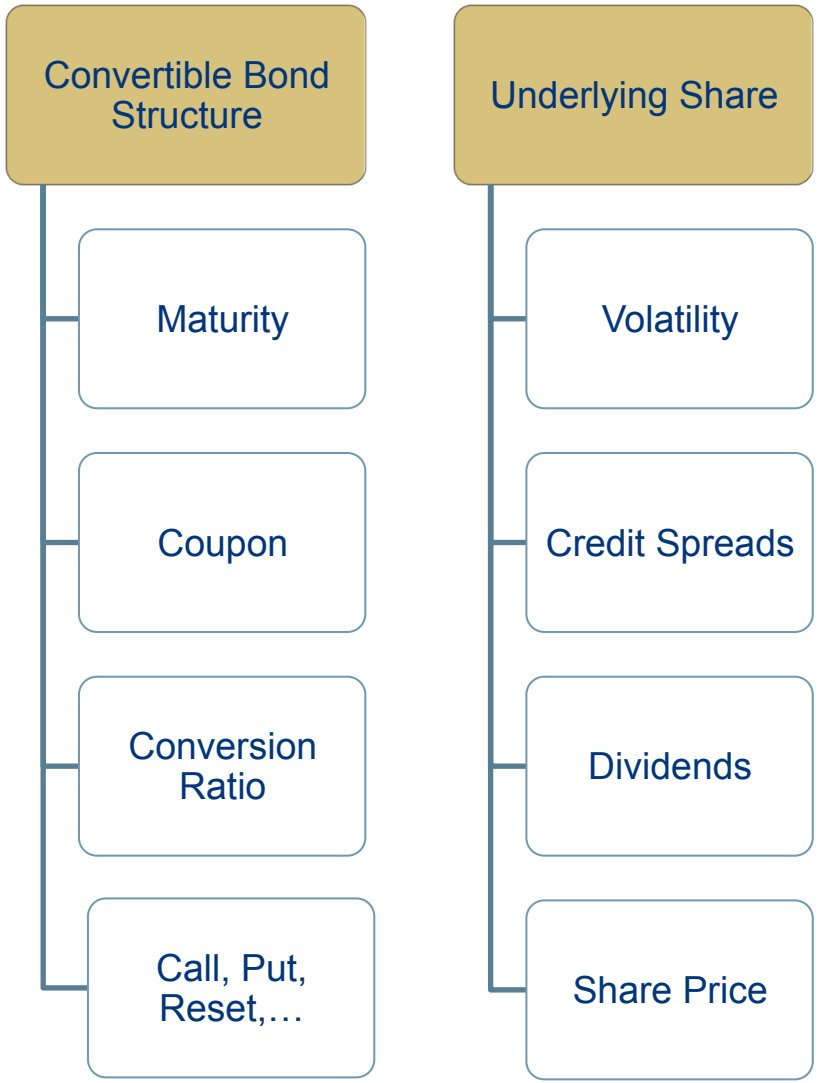
The case for buying convertible bonds

Efficient frontier for a portfolio of convertible and government bonds.
Source: UBS, JP Morgan Chase, MSCI, Bloomberg

Introduction to Convertible and Exchangeable Bonds

What is convertible debt ?

- A convertible is:
  - a bond distributing a coupon **c** with face value **N** and maturity **T**
  - where the buyer has the right to convert the bond into **Cr** shares with market price **S**.



Introduction to Convertible and Exchangeable Bonds

What is convertible debt ?

- Example :
  - On September 20, 2012 Steinhoff Finance Holding announced a EUR denominated convertible bond distributing a 6.375% semi-annual coupon on a face value of $100,000. The maturity date is May 26, 2017 and the conversion ratio is 31,146 shares per bond.

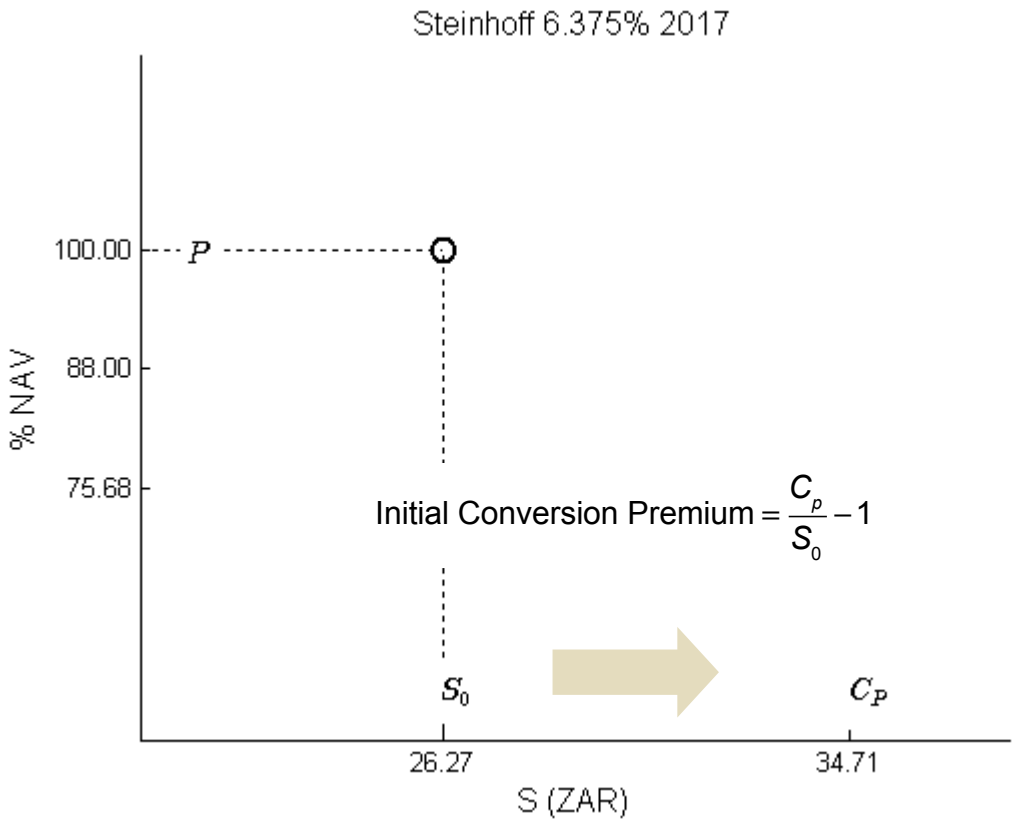
Steinhoff 6.376% 2017					
ISIN	XS0834606104		ISSUE PRICE	100%	
ISSUE DATE	September 26, 2012		FACE VALUE	100,000.00	
ISSUE SIZE	EUR 400 mn		MATURITY	May 26, 2017	
STOCK	STEINHOFF FINANCE HLDG		COUPON FREQUENCY	SA	
CONVERSION RATIO	31,146		BOND CURRENCY	EUR	
REDEMPTION	100%		STOCK CURRENCY	ZAR	
COUPON	6.375%				
CALLABLE FROM	December 11, 2015		CALL PRICE	100%	
			CALL TRIGGER	130%	

Main Structure

Structural Variation

Introduction to Convertible and Exchangeable Bonds

Example : Steinhoff 6.375% 2017

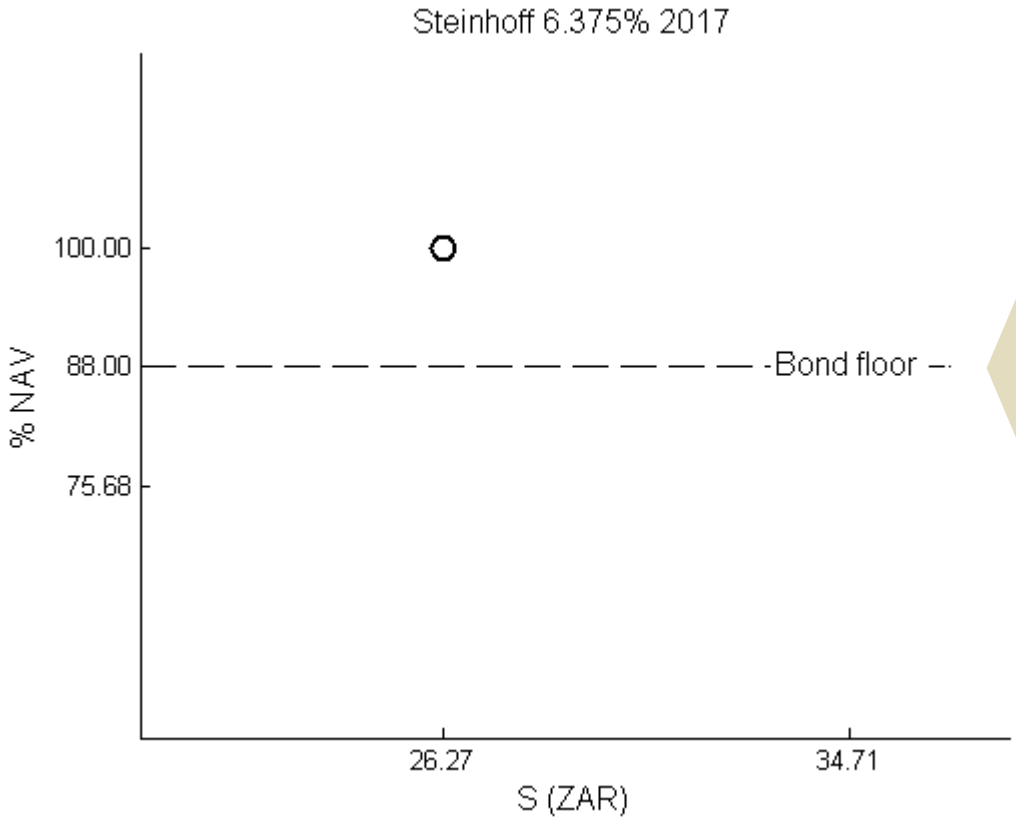


$$\text{Initial Conversion Premium} = \frac{C_p}{S_0} - 1$$

$$\text{Conversion Price} = Cp = \frac{N}{C_r}$$

Introduction to Convertible and Exchangeable Bonds

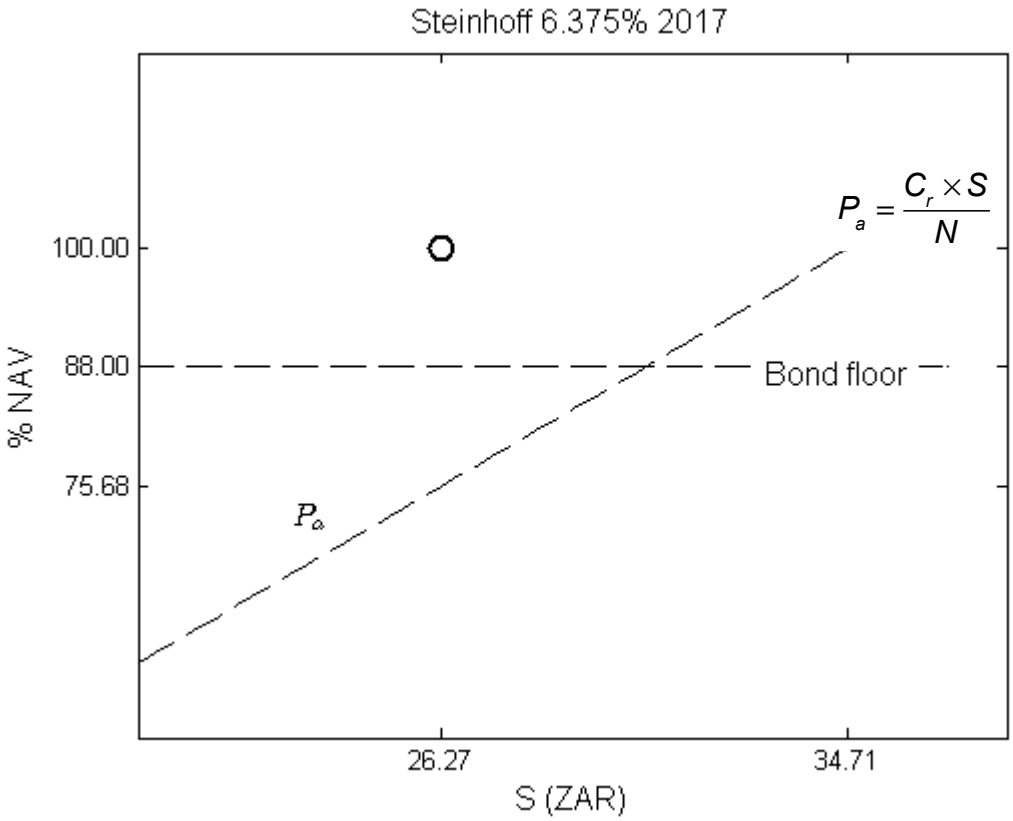
Example : Steinhoff 6.375% 2017



Date	CashFlow
05/26/2013	4.25%
11/26/2013	3.19%
05/26/2014	3.19%
11/26/2014	3.19%
05/26/2015	3.19%
11/26/2015	3.19%
05/26/2016	3.19%
11/26/2016	3.19%
05/26/2017	103.19%

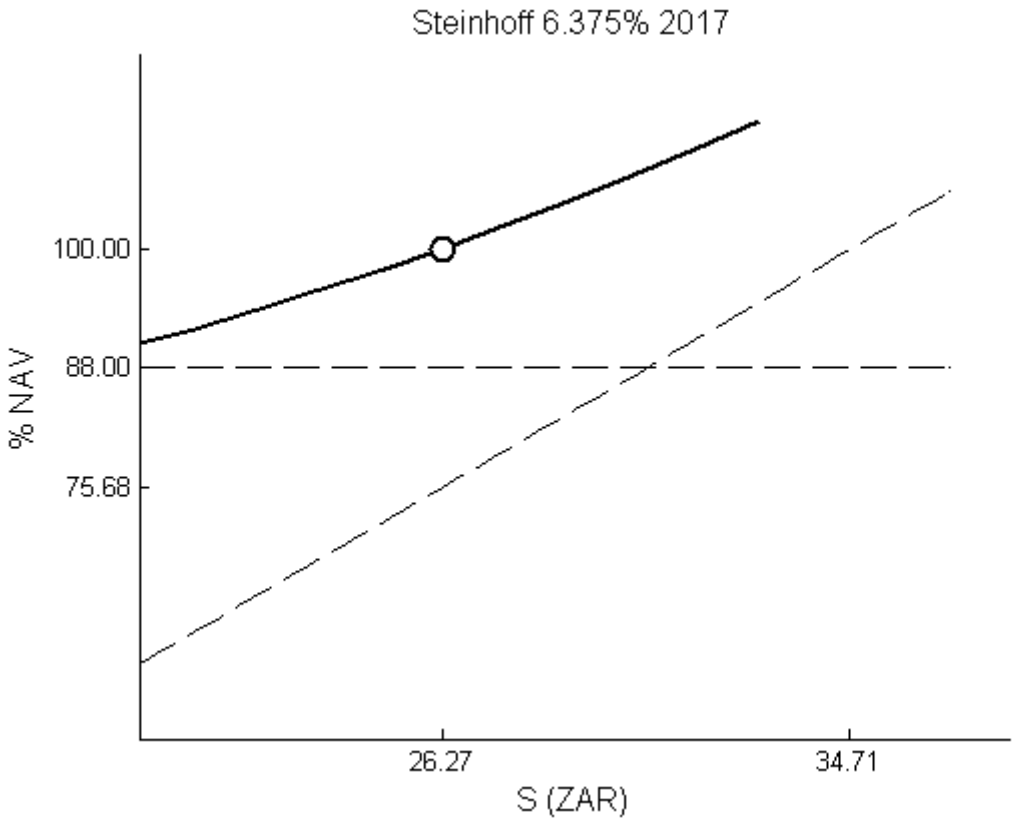
Introduction to Convertible and Exchangeable Bonds

Example : Steinhoff 6.375% 2017



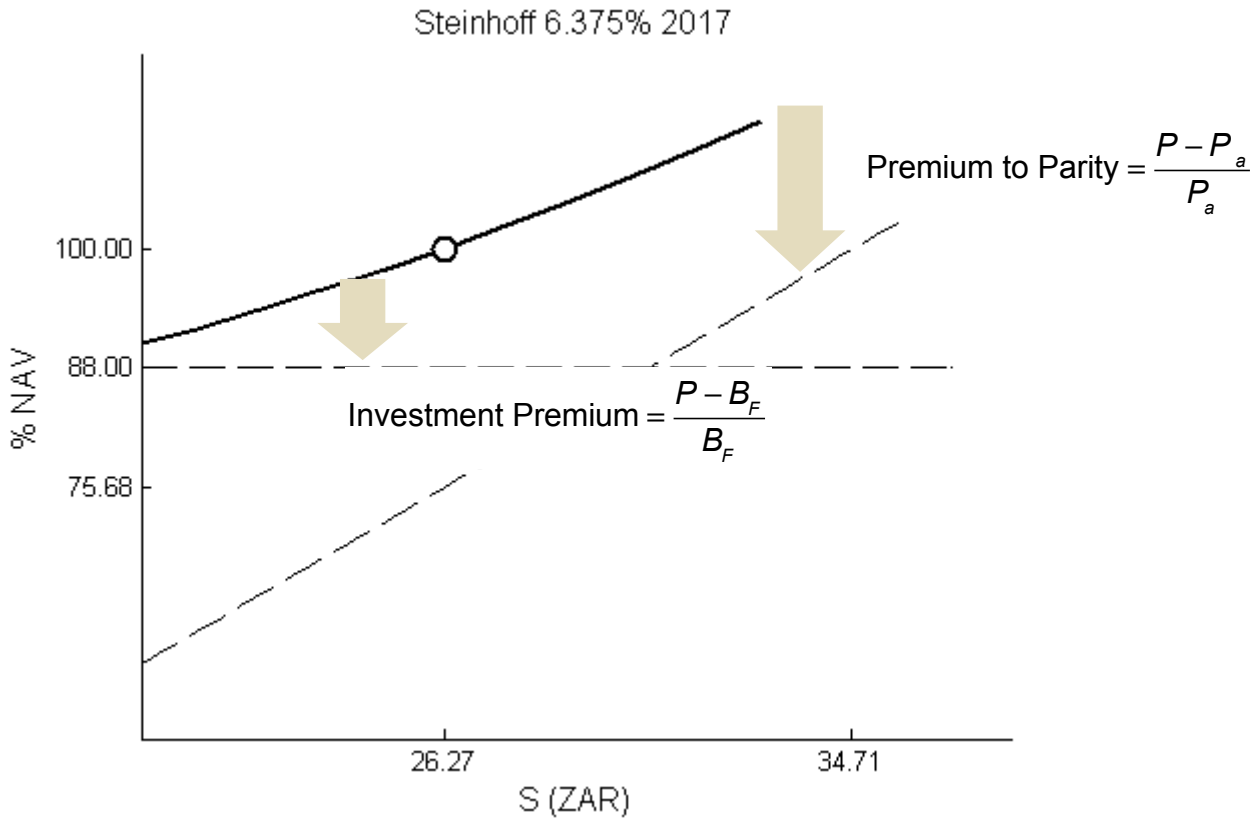
Introduction to Convertible and Exchangeable Bonds

Example : Steinhoff 6.375% 2017



Introduction to Convertible and Exchangeable Bonds

Example : Steinhoff 6.375% 2017



Convertible Bond Market

Convertible Bond Market

The convertible bond market : Regional Split

Region	*US$bn*	*Nbr Cbs*
US	214	713
Europe	112	357
Japan	22	132
Asia ex Japan	44	280
Other	26	248
Total	**418**	**1,730**

The US market is the most liquid market and has the most number of issues.

Convertible Bond Market

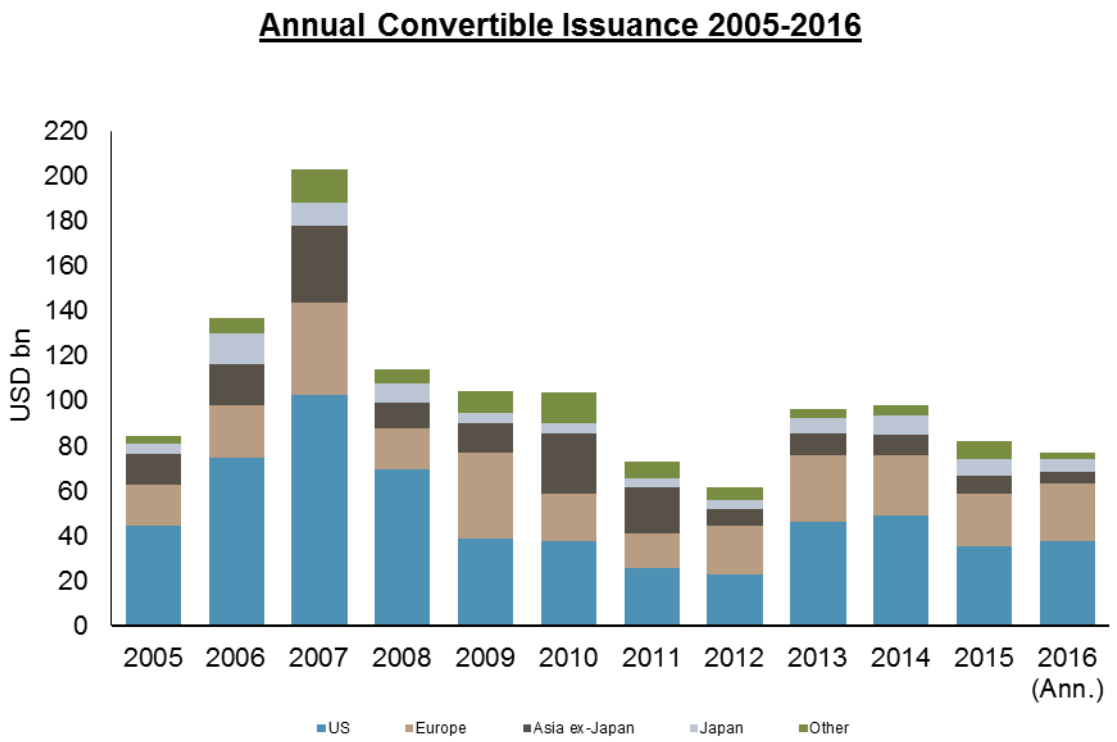
The convertible bond market :Market Cap Issuers

Market Cap ($)	%
20 bn – 100 bn	28.98
10 bn – 20 bn	23.74
5 bn – 10 bn	16.19
2.5 bn - 5.0 bn	19.91
1 bn - 2.5 bn	9.57
500 mn – 1 bn	0.99
Less than 500 mn	0.62
	Σ=100.00

Source : Bank of America Merrill Lynch

Convertible Bond Market

Importance of New Issuance 2000 - 2014



Source : UBS, September 2016

Introduction to Convertible and Exchangeable Bonds

Properties of the “average” convertible bond (Nov 2018)

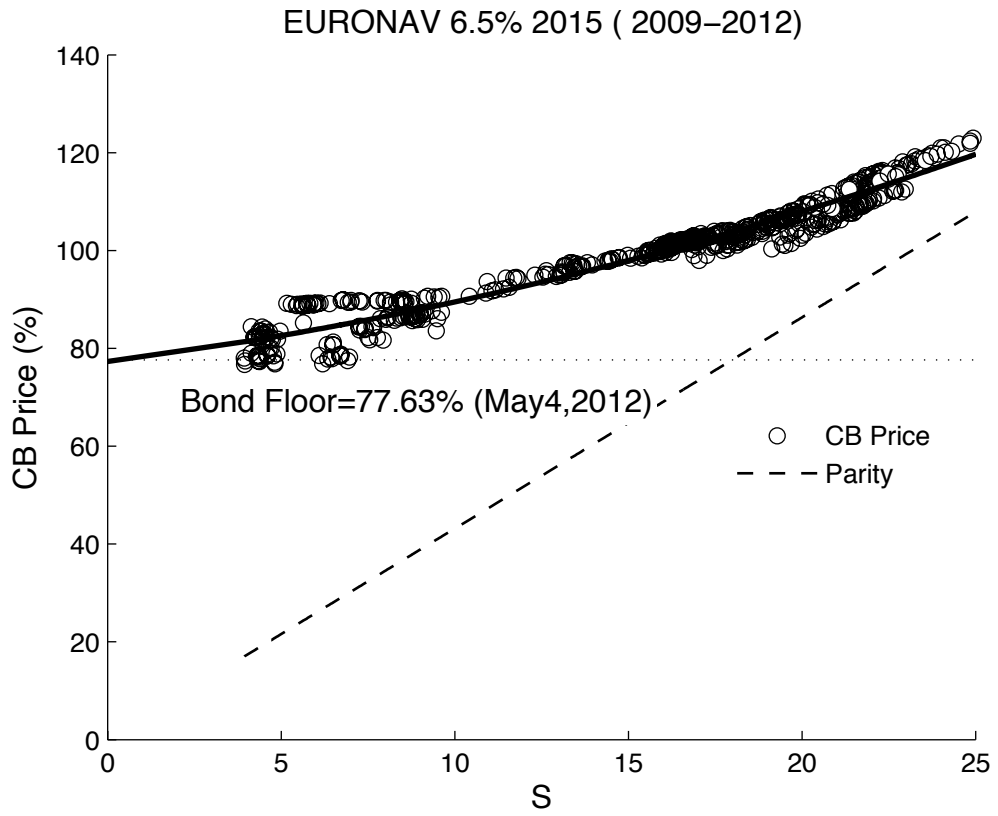
YTD	-2.61%
Rating	60% Not Rated – 24% HY
Maturity	5.0 yr
Issue Size	+/- $240 M USD
Call Protection	1.15 yrs
Yield	3.2%
Premium	39%

Source : BarCap

Theory vs. Practice

Introduction to Convertible and Exchangeable Bonds

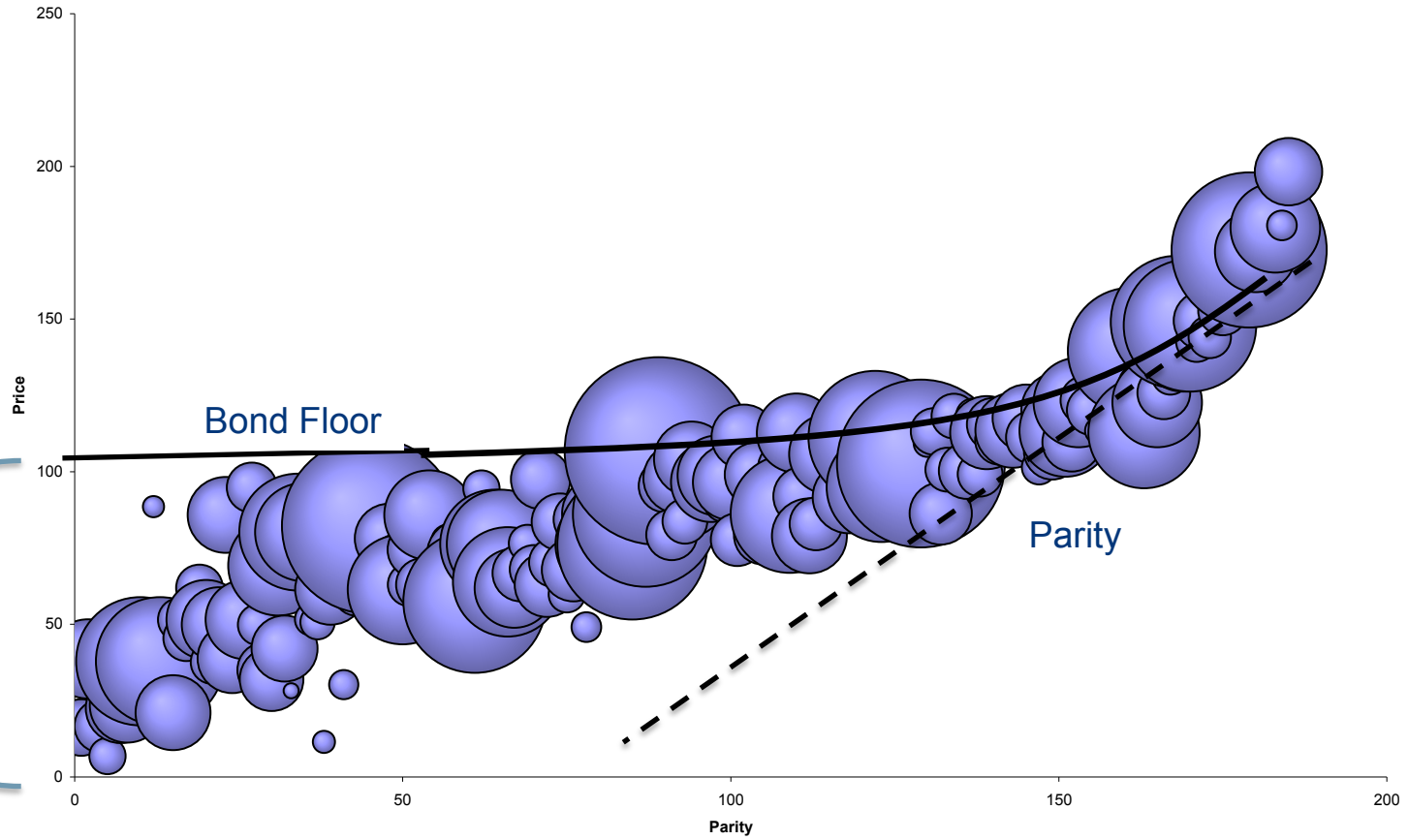
Example : EURONAV 6.5% 2015



Introduction to Convertible and Exchangeable Bonds

187 US Convertibles – Issue Date : 2002 – 2012

Convertible Bond has "***fallen through its bond floor***"



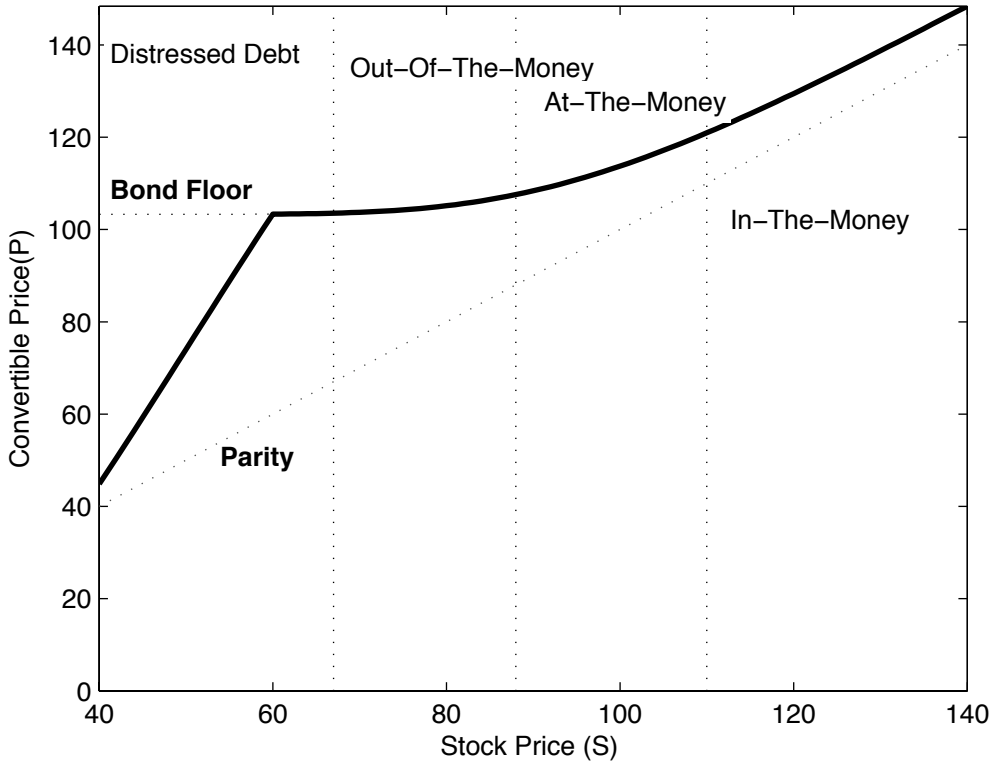
Excluding Preferreds , Mandatories, Private Placements

Calculation Date : October, 2012

RISK
CONCILE

Introduction to Convertible and Exchangeable Bonds

Example : Different sensitivities



- **Distressed Debt**
  This is the domain of the 'broken' bonds. The convertible has fallen through the theoretical bond floor and the bond has been given the 'junk' status. The premium collapses and the price of the bond converges to parity. This type of convertible has a high equity nature.

- **Out-Of-The-Money**
  The share price has fallen far below the conversion price. The delta of the convertible is lower than 40% but greater than or equal to 10%.

- **At-The-Money or "Balanced"**
  The delta of the convertible is between 40% and 80%. This is the area with the highest convexity and the share price trades in the region of the conversion price.

- **In-the-money**
  The underlying share has risen so much that all the gamma (convexity) is gone. The bond has a complete linear behavior and acts as if it was a share. The price of the convertible converges more and more towards Parity

Introduction to Convertible and Exchangeable Bonds

Positive Convexity (Gamma)

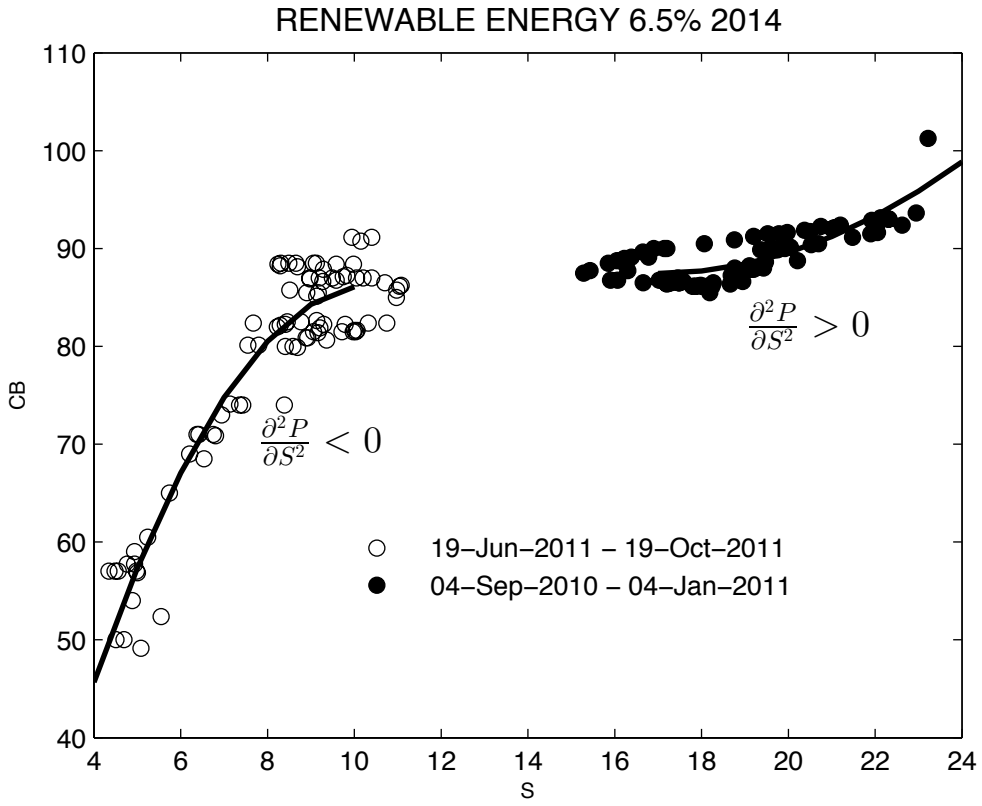
- **Positive Convexity is " Good Risk "**
  - Longer on the way up / Shorter on the way down
  - Selling shares in a rising market
  - One is willing to pay for it . Hence :
    - Coupons are lower
    - Time Decay
- **Negative Convexity is "Bad Risk"**
  - Longer on the way down
  - Selling shares in a falling market
  - One wants to be paid in order to own it
- **Convertibles sometimes have positive and negative gamma** (see next slide)

Negative – Positive Convexity

Introduction to Convertible and Exchangeable Bonds

Renewable Energy 6.5% 2014 : From balanced to distressed in less than a year

Positive and negative gamma embedded in one CB

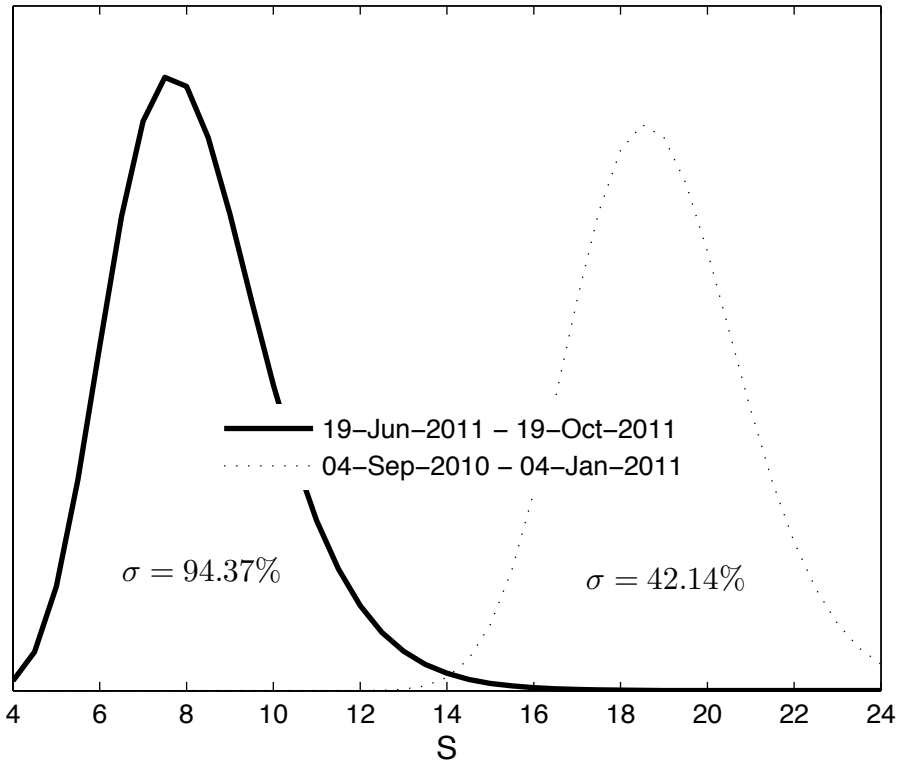


RISK
CONCILE

Introduction to Convertible and Exchangeable Bonds

Renewable Energy 6.5% 2014 : From balanced to distressed in less than a year

Positive and negative gamma embedded in one CB



Convertible Bond Valuation

Pricing convertible bonds

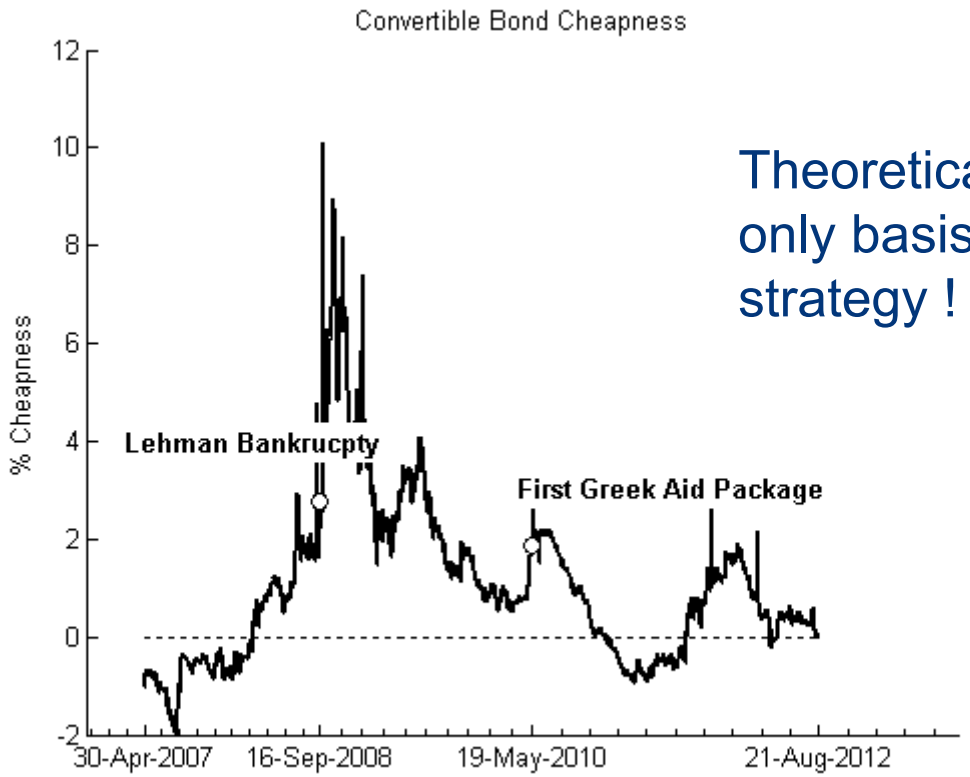
- Two Notions of Price
  - Market Price
  - Theoretical Price

- This defines the Cheapness : Theoretical Price-Market Price

- Cheapness
  - New Issues
  - Existing Convertibles

Convertible Bond Valuation

Cheapness of Convertible Bonds : 2007 - 2012

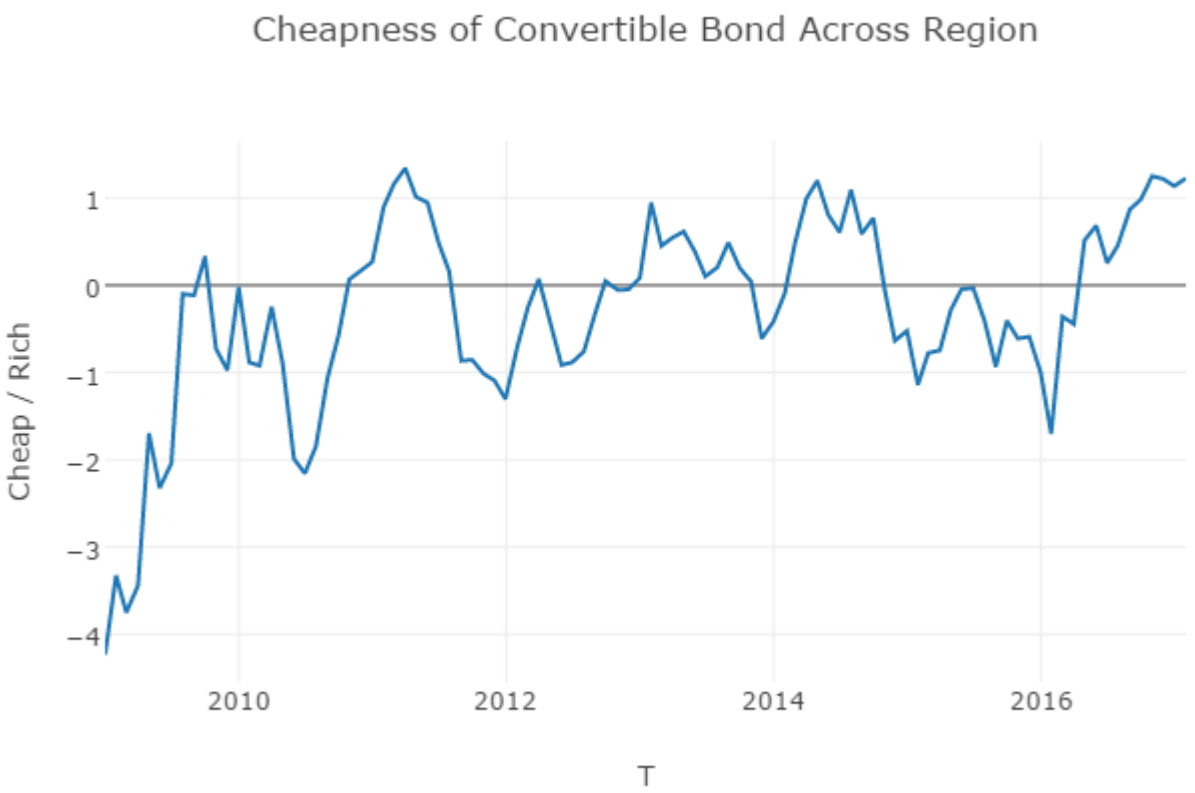


Theoretical Price cannot be the only basis of an investment strategy !

Source : Bank of America Merrill Lynch

Convertible Bond Valuation

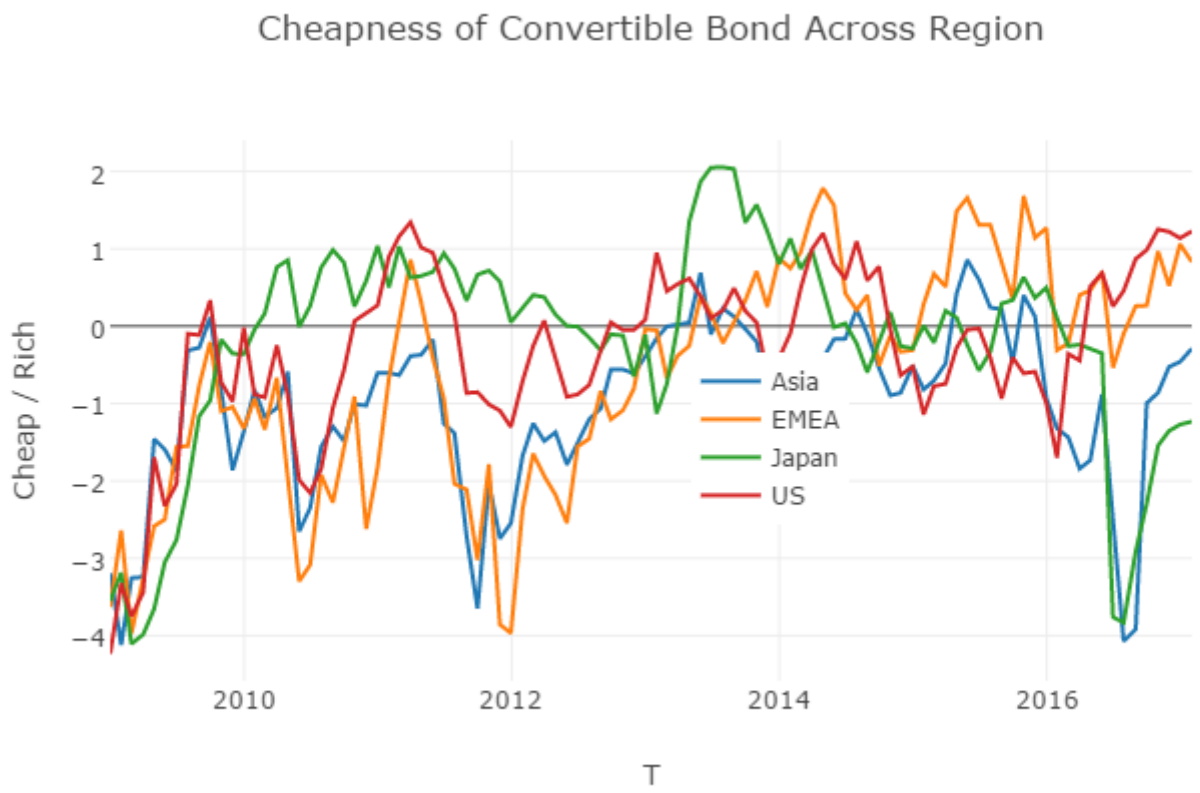
Cheapness of Convertible Bonds : 2010- 2016



Source : Barclays

Convertible Bond Valuation

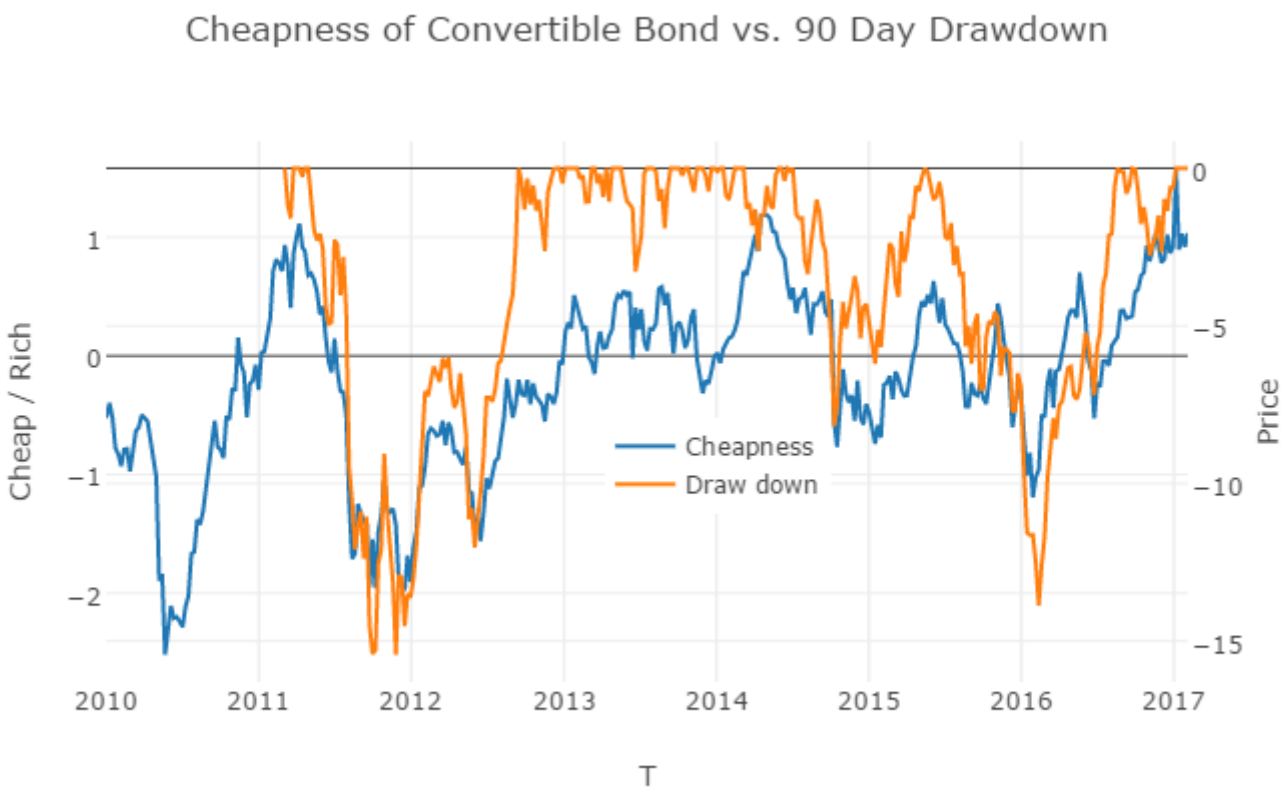
Cheapness of Convertible Bonds : 2010- 2016



Source : Barclays

Convertible Bond Valuation

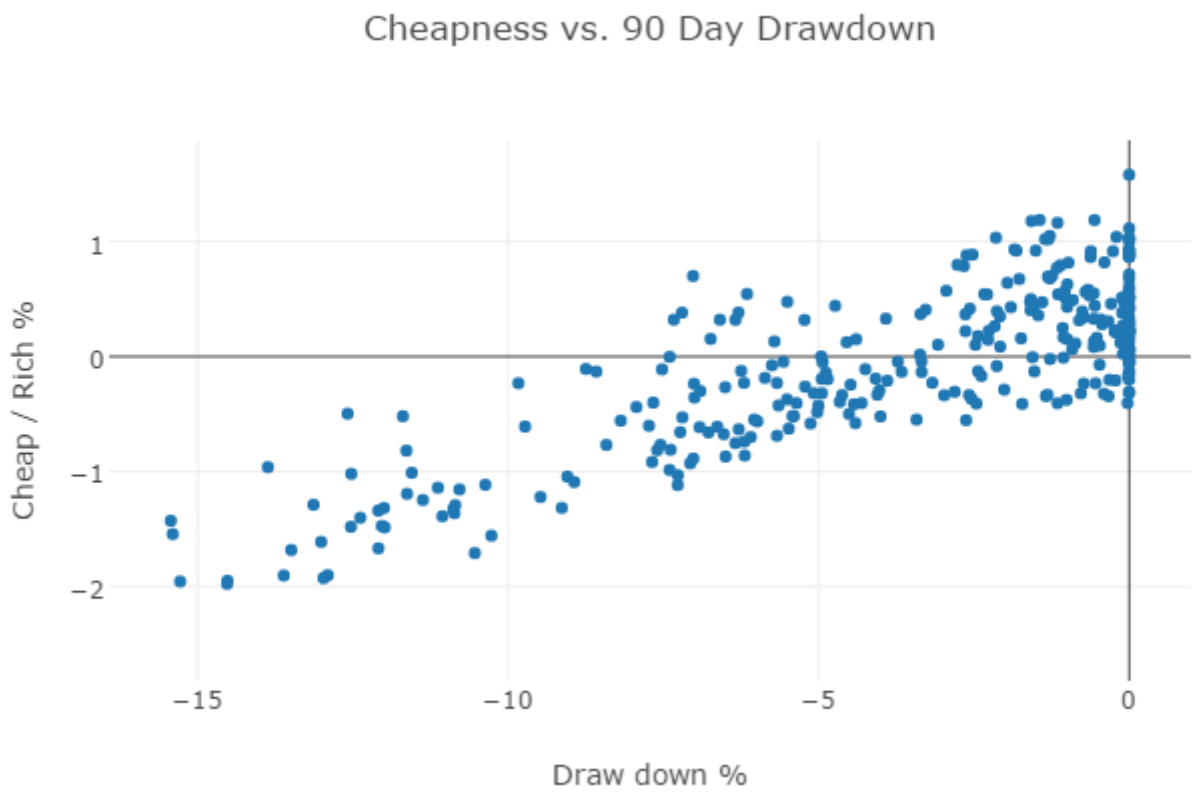
Cheapness of Convertible Bonds : 2010- 2016



Source : Barclays

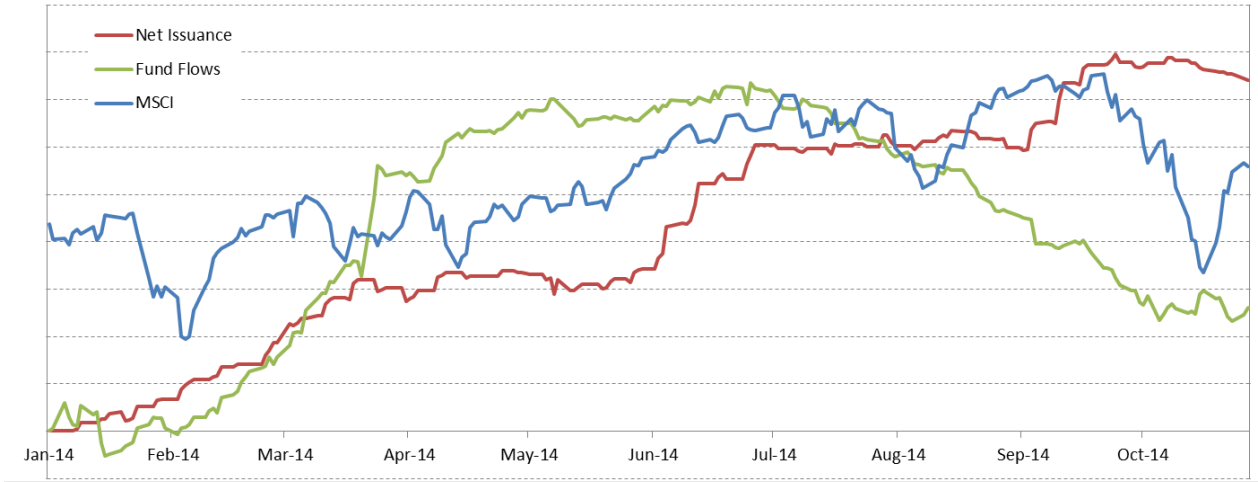
Convertible Bond Valuation

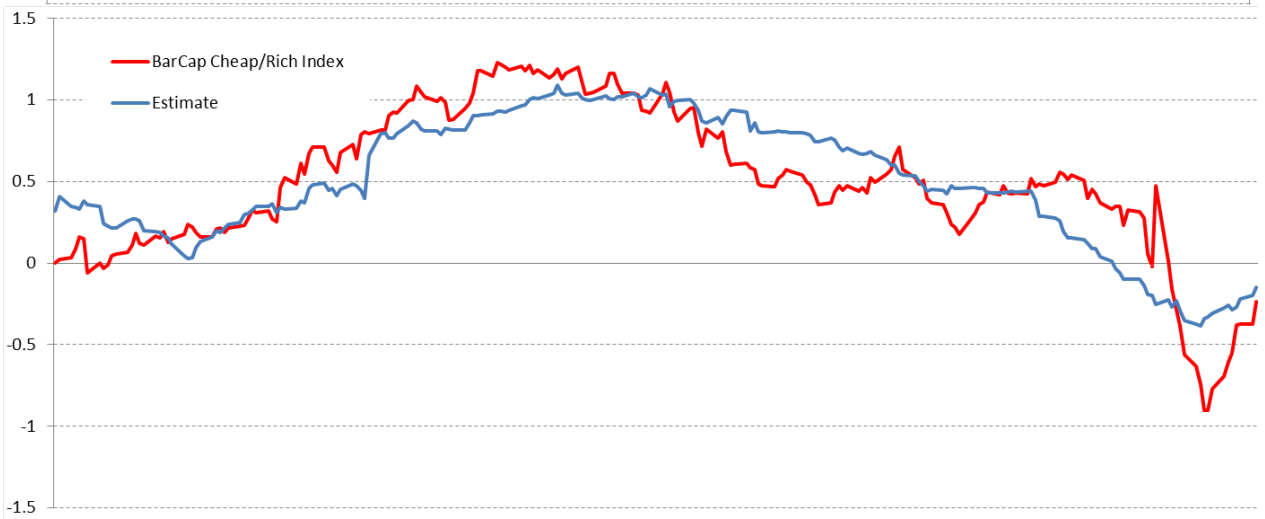
Cheapness of Convertible Bonds : 2010- 2016



Convertible Bond Market

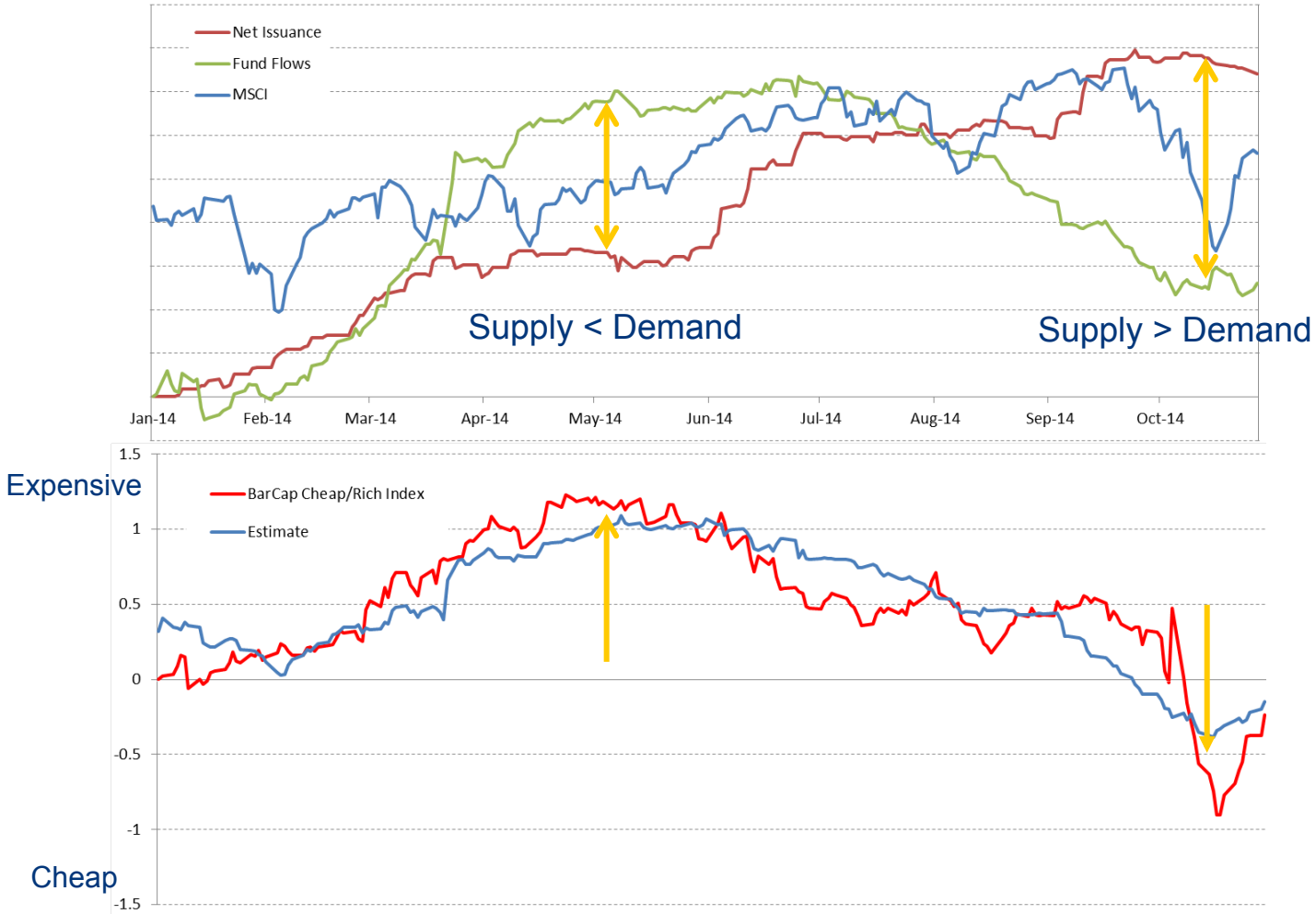
Importance of New Issuance





Convertible Bond Market

Importance of New Issuance



Complexity Models

Introduction to Convertible and Exchangeable Bonds

Structural variations

The life of a convertible bond can terminate in several ways :

- **Final Redemption**
  - At the maturity date if S < Cp
  - The investor will not convert because S x Cr < FV (+ Coupon)
  - The issuer will pay the redemption value (FV + (Coupon)) to the investor
- **Default**
  - The investor might recover a fraction (R) from the remaining debt (FV)
- **Optional Conversion**
  - At certain points in time, when the share price is high enough the rational investor will convert
- **Put**
  - The investor can sell the put back to the issuer on the put date against an agreed amount of cash (Pv)
- **Call**
  - The issuer can call back the bond and pay an early redemption amount K to the investor
- **Forced Conversion**
  - When an investor is forced to accept the early redemption K, he can always convert if Cr x S > K
- **Mandatory Conversion**
  - Some convertible bonds will always be converted in shares at the expiration date.

Introduction to Convertible and Exchangeable Bonds

Structural variations

The life of a convertible bond can terminate in several ways : Steinhoff 6.375% 2017

Valuation Model

	Probability (Oct 11, 2013)
Optional Conversion	22.49 %
Forced Conversion	3.95 %
Call	25.65 %
Put	0.00 %
Default	11.31 %
Redemption	36.60 %
Mandatory Conversion	0.00 %
	Σ = 100.00 %

The maturity of the convertible is **3.59 yr**. Because of the different instrument features, the expected life is shorter.
The expected life (= Fugit) is equal to **2.97 yr**

Introduction to Convertible and Exchangeable Bonds

Structural variations

The life of a convertible bond can terminate in several ways : Steinhoff 6.375% 2017

	Probability (Oct 11, 2013)	Probability (May5th, 2014)	Probability (Oct 21, 2014
Optional Conversion	22.49 %	58.49%	67.55%
Forced Conversion	3.95 %	3.89%	3.84%
Call	25.65 %	22.57%	18.46%
Put	0.00 %	0.00%	0.00%
Default	11.31 %	6.63%	3.87%
Redemption	36.60 %	8.42%	6.28%
Mandatory Conversion	0.00 %	0.00%	0.00%
	Σ = 100.00 %		

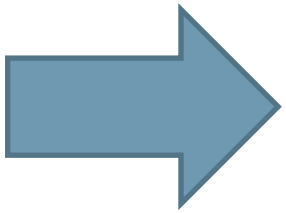
Probabilities did change. Why ?

Introduction to Convertible and Exchangeable Bonds

Structural variations

The life of a convertible bond can terminate in several ways : Steinhoff 6.375% 2017

	Probability (Oct 11, 2013)	Probability (May5th, 2014)	Probability (Oct 21, 2014
Optional Conversion	22.49 %	58.49%	67.55%
Forced Conversion	3.95 %	3.89%	3.84%
Call	25.65 %	22.57%	18.46%
Put	0.00 %	0.00%	0.00%
Default	11.31 %	6.63%	3.87%
Redemption	36.60 %	8.42%	6.28%
Mandatory Conversion	0.00 %	0.00%	0.00%
	Σ = 100.00 %		
Share Price (EUR)	**2.69**	**3.65**	**3.85**



Introduction to Convertible and Exchangeable Bonds

Structural variations : Call

Possibility for the Issuer to terminate the life of the convertible and force the investor into conversion

- **Hard Call**
  - Unconditional
  - The investor will receive an early redemption amount K
- **Soft Call**
  - Conditional :
    - Share proces must higher than K% of the conversion price
    - K% =Trigger Level
    - During n out of m consecutive business days
  - Example Steinhoff
    - K=100%
    - K% = 130%
    - n out of m = 20 out of 30
    - Callable Dec 2015 – Maturity
- **Call Protection**
  - The call feature only kicks in after an intital period. This is called the call protection

Introduction to Convertible and Exchangeable Bonds

Structural variations : Put

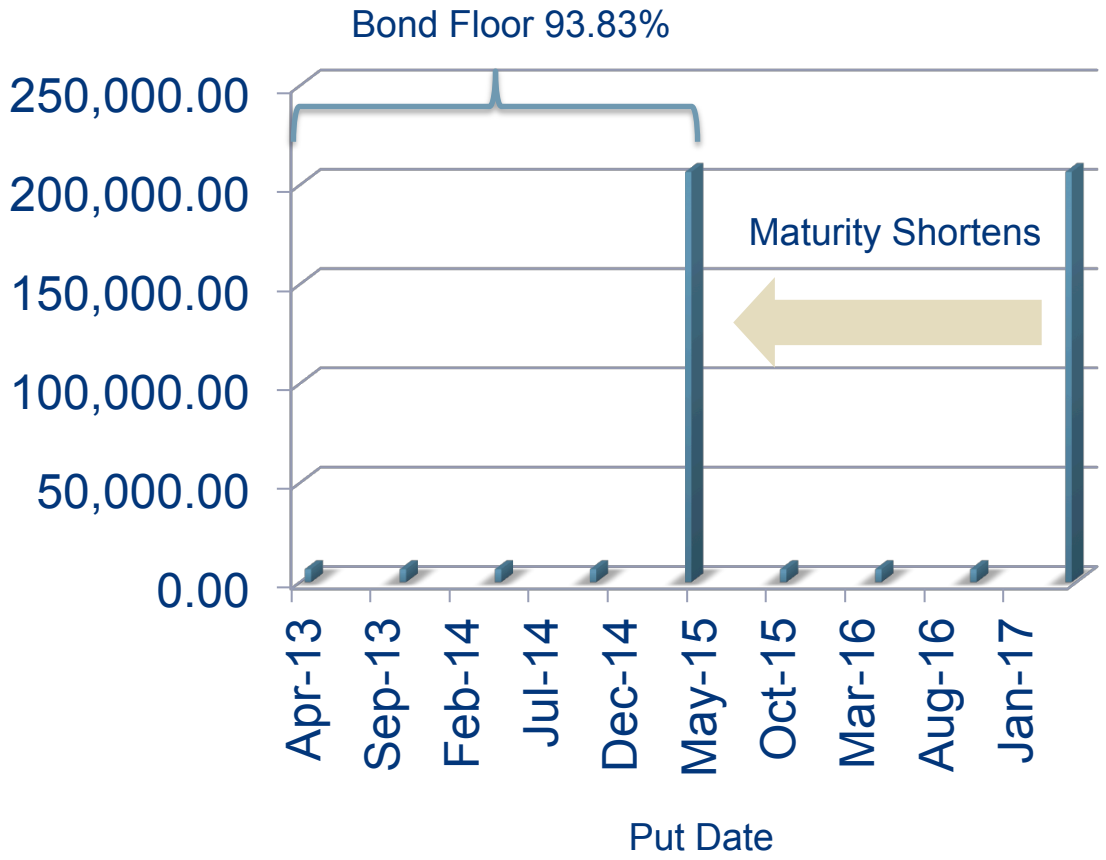
- **Properties**
  - Shortens the expected life of the convertible bond
  - The put increases the value of a convertible bond
  - The value of the put depends on
    - Put Amount Pv
    - Put Date
    - Credit Quality of the Issuer
- **Bond Floor**
  - The calculation of the bond floor changes :
  - Bond Floor = Present value of the cash flows up till the put date

Introduction to Convertible and Exchangeable Bonds

Structural variations : Put

Theoretical value of the put embedded in the China Hongqiao convertible bond.

Pricing date : May 25, 2012



Advanced Convertible Bond Features

Dividend Protection

A convertible is a forward purchase of shares

- An investor is economically exposed to changes in the share price
- An investor does not own the share (yet)
- An increase in dividends is detrimental for the convertible bond investor

A dividend protection feature

- Will transfer some of the benefits of the dividend increase to the bond holders
- There are two possible mechanisms:
  - **Pass-Through**
    Entire dividend increase (above treshold) will be passed on by amending the next coupon payment
  - **Conversion Ratio increase** (Formula based)
    - D: Next Dividend
    - S : share price
    - T_D: Treshold dividend yield
    - The new conversion ratio is given by the following formula

$$C_r^* = C_r \times \frac{S}{S - \text{Max}(D - T_D, 0)}$$

Advanced Convertible Bond Features

From the prospectus to the model

Dividend Protection

The Surplus Dividend will therefore be equal to the difference between the Total Dividend Per Share during a given financial year of the Company and the Threshold of Dividends Distributed Per Share in such financial year.

For the purpose of this paragraph 10, there will be a "Surplus Dividend" if the Total Dividend Per Share (defined below) during the Company's financial year exceeds the Threshold of Dividends Distributed Per Share as set out in the table below.

Advanced Convertible Bond Features

Make Whole Clauses

General Description

- The “make whole” is a compensation offered to the investors
- In case of an early redemption (Call)
- Compensation
  - Remaining coupons are paid out
  - More advantageous conditions for the forced conversion
  - …

Advanced Convertible Bond Features

Make Whole Clauses

Example : NAVISTAR 4.15% 2018

Optional Redemption:

On or after October 15, 2016, the Notes will be subject to redemption, in whole or in part, at the Issuer's option, at a redemption price equal to 100% of the principal amount of Notes to be redeemed, plus accrued and unpaid interest (including any additional interest) to, but excluding, the redemption date, if the last reported sale price of the Common Stock for at least 20 trading days (whether or not consecutive) during the period of 30 consecutive trading days ending within 10 trading days immediately prior to the date of the redemption notice exceeds 130% of the applicable conversion price for the Notes on each applicable trading day. If the Issuer calls any or all of the Notes for redemption, holders of the Notes will have the right to convert their Notes at any time until the close of business on the business day preceding the redemption date. ***If a holder elects to convert its notes in connection with a redemption notice, the Issuer will increase the conversion rate*** as set forth under "Description of notes—Conversion rights—Adjustment to shares delivered upon conversion upon a make-whole fundamental change or notice of redemption" in the Preliminary Offering Memorandum.

Advanced Convertible Bond Features

Make Whole Clauses

Example : NAVISTAR 4.15% 2018

Adjustment to Shares Delivered upon Certain Conversions: The following table sets forth the number of additional shares of the Common Stock by which the conversion rate shall be increased for certain conversions in connection with a make-whole fundamental change or a notice of redemption based on the stock price and effective date for such make-whole fundamental change or notice of redemption:

Effective Date	$36.50	$40.00	$45.00	$50.00	$60.00	$75.00	$100.00	$125.00	$150.00	$200.00	$250.00
October 15, 2013 ...	10.2739	8.9618	7.3858	6.1968	4.5531	3.1062	1.8896	1.2819	0.9294	0.5475	0.3495
October 15, 2014 ...	10.2739	8.8968	7.2270	5.9788	4.2795	2.8248	1.6544	1.0982	0.7872	0.4599	0.2929
October 15, 2015 ...	10.2739	8.7271	6.9461	5.6301	3.8747	2.4311	1.3440	0.8663	0.6136	0.3578	0.2288
October 15, 2016 ...	10.2739	8.3977	6.4745	5.0753	3.2657	1.8729	0.9401	0.5843	0.4123	0.2451	0.1593
October 15, 2017 ...	10.2739	7.9301	5.7633	4.2186	2.3304	1.0750	0.4453	0.2747	0.2020	0.1272	0.0846
October 15, 2018 ...	10.2739	7.8767	5.0989	2.8767	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

The conversion ratio change takes places according to the table above.

Advanced Convertible Bond Features

Make Whole Clauses

Example : NAVISTAR 4.15% 2018

Adjustment to Shares Delivered upon Certain Conversions: The following table sets forth the number of additional shares of the Common Stock by which the conversion rate shall be increased for certain conversions in connection with a make-whole fundamental change or a notice of redemption based on the stock price and effective date for such make-whole fundamental change or notice of redemption:

Effective Date	$36.50	$40.00	$45.00	$50.00	$60.00	$75.00	$100.00	$125.00	$150.00	$200.00	$250.00
October 15, 2013 ...	10.2739	8.9618	7.3858	6.1968	4.5531	3.1062	1.8896	1.2819	0.9294	0.5475	0.3495
October 15, 2014 ...	10.2739	8.8968	7.2270	5.9788	4.2795	2.8248	1.6544	1.0982	0.7872	0.4599	0.2929
October 15, 2015 ...	10.2739	8.7271	6.9461	5.6301	3.8747	2.4311	1.3440	0.8663	0.6136	0.3578	0.2288
October 15, 2016 ...	10.2739	8.3977	6.4745	5.0753	3.2657	1.8729	0.9401	0.5843	0.4123	0.2451	0.1593
October 15, 2017 ...	10.2739	7.9301	5.7633	4.2186	2.3304	1.0750	0.4453	0.2747	0.2020	0.1272	0.0846
October 15, 2018 ...	10.2739	7.8767	5.0989	2.8767	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

The conversion ratio change takes places according to the table above.

Advanced Convertible Bond Features

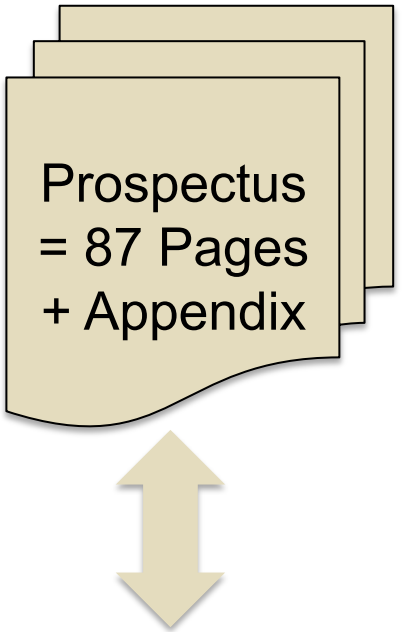
From the prospectus to the model

PRICING TERM SHEET
Dated September 11, 2012

Sequenom, Inc.
Offering of
$110,000,000 aggregate principal amount of
5.00% Convertible Senior Notes due 2017

The information in this pricing term sheet supplements Sequenom, Inc.'s preliminary offering memorandum, dated September 10, 2012 (the "Preliminary Offering Memorandum"), and supersedes the information in the Preliminary Offering Memorandum to the extent inconsistent with the information in the Preliminary Offering Memorandum. In all other respects, this pricing term sheet is qualified in its entirety by reference to the Preliminary Offering Memorandum, including all of the documents incorporated by reference therein. Terms used herein but not defined herein shall have the respective meanings as set forth in the Preliminary Offering Memorandum. All references to dollar amounts are references to U.S. dollars.

Issuer:	Sequenom, Inc., a Delaware corporation (the "Company").
Ticker / Exchange for Common Stock:	SQNM / The NASDAQ Global Select Market ("Nasdaq").
Trade Date:	September 12, 2012.
Settlement Date:	September 17, 2012.
Notes:	5.00% Convertible Senior Notes due 2017 (the "Notes").
Aggregate Principal Amount Offered:	$110,000,000 aggregate principal amount of Notes ($130,000,000 if the initial purchasers exercise in full their option to purchase additional Notes solely to cover over-allotments, if any).
Offering Price:	100% of the principal amount, plus accrued interest, if any, from the Settlem Date.



Term sheets are a summary of the convertible's features

RISK
CONCILE

Contingent Convertibles ≠ Convertible Bonds

CoCo Bonds

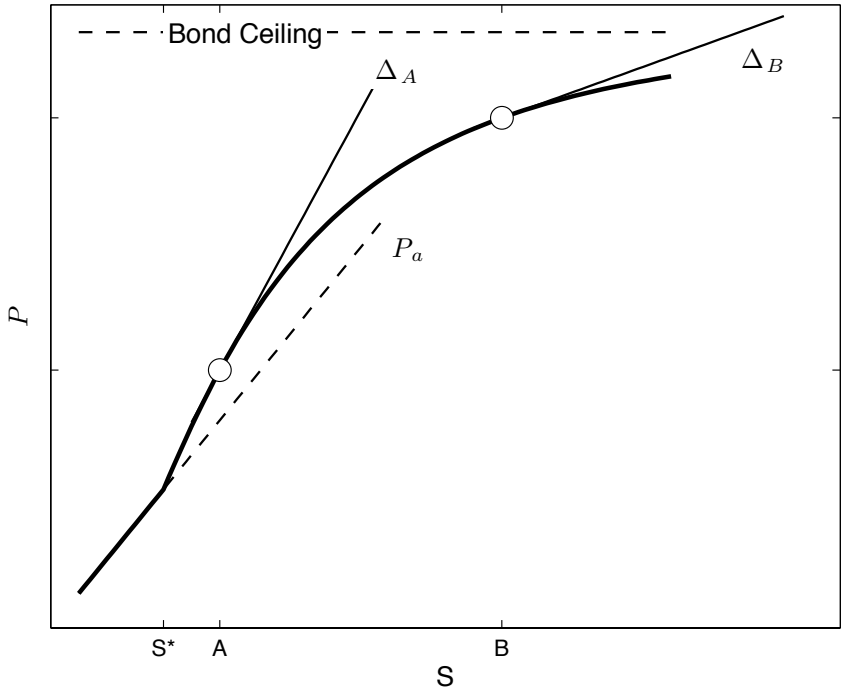
Contingent Convertibles : Definition

- Bond issued by a Financial Institution
- With an **embedded loss aborption** mechanism
  - Conversion into shares
    Example : Credit Suisse, Lloyds ,
  - Haircut :
    Example : Rabobank, UBS,...
- This mechanism is triggered
  - **Accounting Trigger**
    Core Tier 1 ratio drops below treshold
  - **Non-Viability Trigger**
    Regulator decides to convert the bond into shares or to apply a haircut, when it deems that the bank is not longer viable without state support.

CoCo Bonds

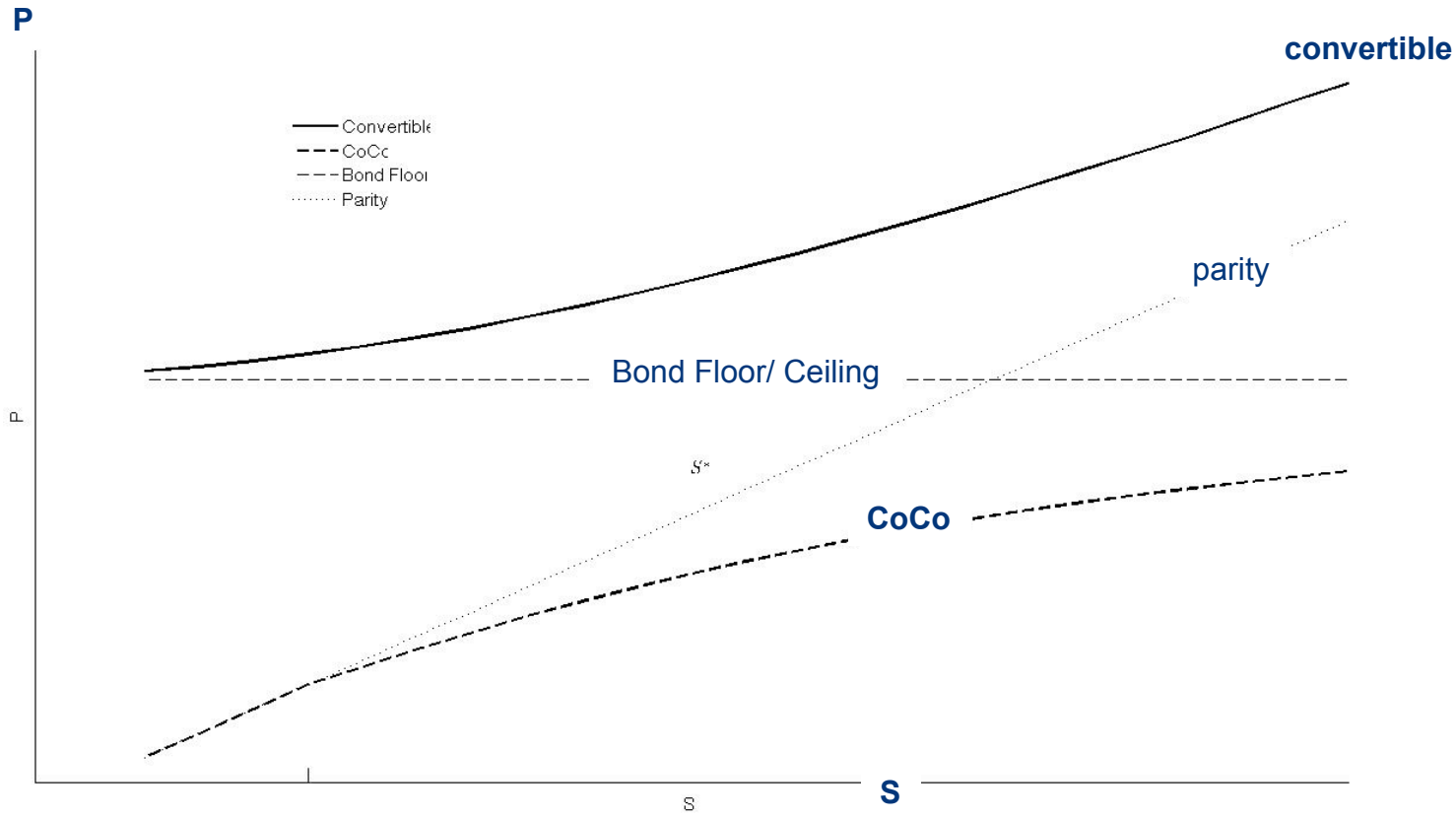
Contingent Convertibles : Properties

- **Advantages**
  - Automatic recapitalization of the bank when need
  - Tax Payers money os not need to save banks
  - The investors run a clear downside risk and get compensated for this
- **Disadvantage**
  - Death-Spiral Risk



CoCo Bonds

Contingent Convertibles : A CoCo is not another kind of Convertible



RISK
CONCILE

Initial Models

Convertible Bond Valuation

Heuristic Models vs. Pricing Model

- **Heuristic Models**
  - Rule of Thumb Models
  - Based on Fixed Income or Equity measures
    - Fixed Income : Bond Floor, Coupon, Yields, Break-Even
    - Equity : Parity

- **Pricing Model**
  Simulates the stock price behavior and implements the payoff ot the convertible and the instrument specific features.

Convertible Bond Valuation

Fixed Income Approach : Using Yields

- **Different Yield Definitions**
  - **Current Yield (CY)**
    Coupon / Cb Price
  - **Yield to Maturity (YTM)**
    The discount rate so that the present values of the cash flows equal the price of the convertible bond
  - **Yield to Put (YTP)**
    Only the cash flows up till the put date are taken into account
  - **Yield to Call**
    Only the cash flows up till the call date are taken into account
  - **Yield to Best**
    Best possible yield from a bond
  - **Yield to Worst**
    Worst possible yield from a bond
- **Which yield to use ?**
  - Convertible ≈ Bond Floor : Use YTM
  - Convertible ≈ Parity: Use CY

Convertible Bond Valuation

Fixed Income Approach : Using Blended Yield

- **Blended Yield (BY)**

$$BY = \Delta_{\%} \times CY + (1 - \Delta_{\%}) \times YTM / P$$

- **Example of mis-using yield to maturity :**
  In some cases such as deep in the money convertible bonds, the yield to maturity (YTM) can become negative.

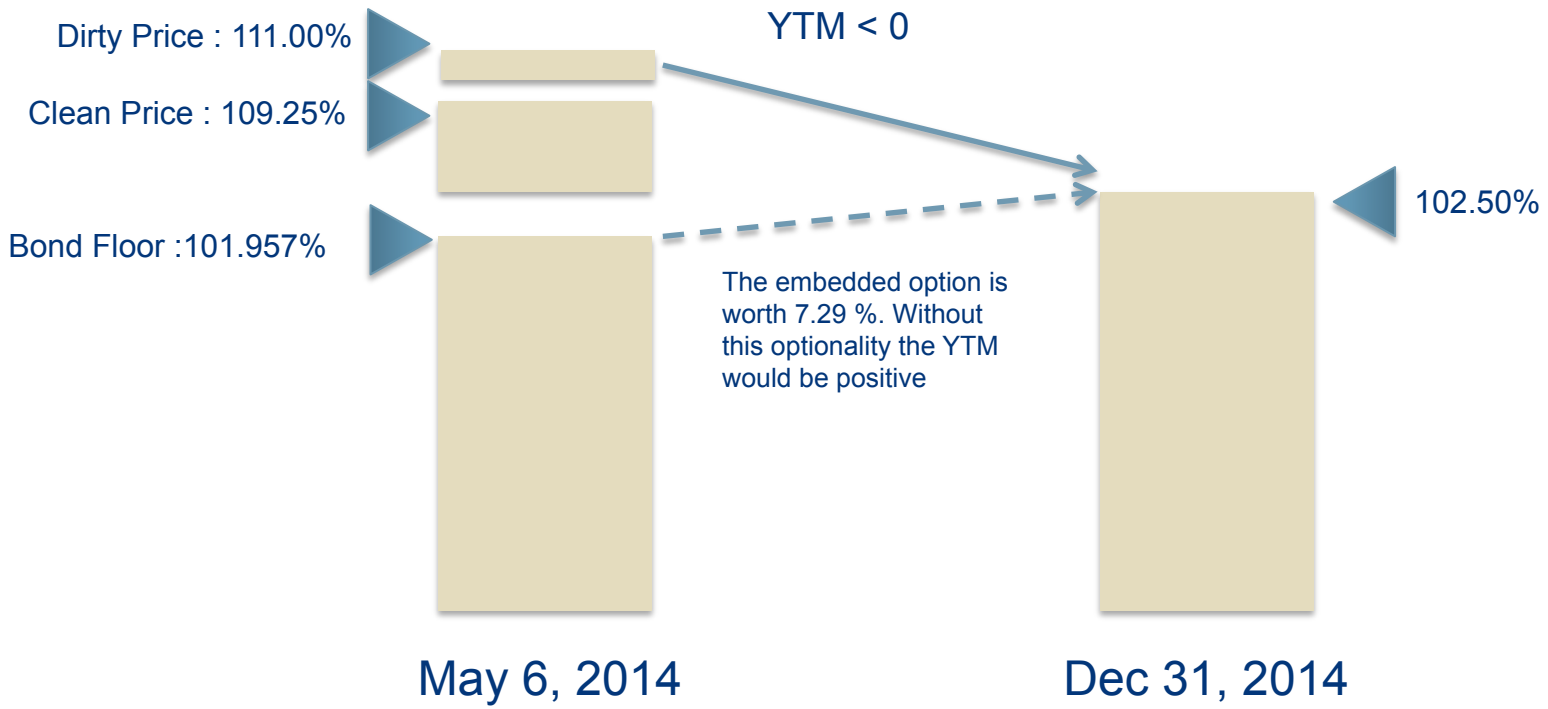
Convertible Bond Valuation

Fixed Income Approach : Glencore 5% 2014

Glencore 5% 2014					
ISIN	XS0475310396		ISSUE PRICE	100%	
ISSUE DATE	Sep 13, 2011		FACE VALUE	100,000	
ISSUE SIZE	2.3 bn		MATURITY	Dec 31, 2014	
STOCK	GLENCORE		COUPON FREQUENCY	SA	
CONVERSION RATIO	18735		BOND CURRENCY	USD	
REDEMPTION	100%		STOCK CURRENCY	USD	
COUPON	5%				

Convertible Bond Valuation

Fixed Income Approach : Glencore 5% 2014



Convertible Bond Valuation

Break Even Analysis

- **Both the convertible bond and the underlying share have a cash income**
  - Share : dividend yield (q)
  - Convertible : current yield (CY)
- **Yield Advantage of the convertible** : CY – q
- **Break-Even Analysis**
  - Convertible has a premium over the current share price : P – Parity
  - The convertible has a yield advantage over the share price
  - Break-Even (years) is the period one needs to hold the convertible to earn back the premium paid over the parity.

$$\text{Break-Even (years)} = \frac{P - P_a}{P \times \left(CY - q\right)}$$

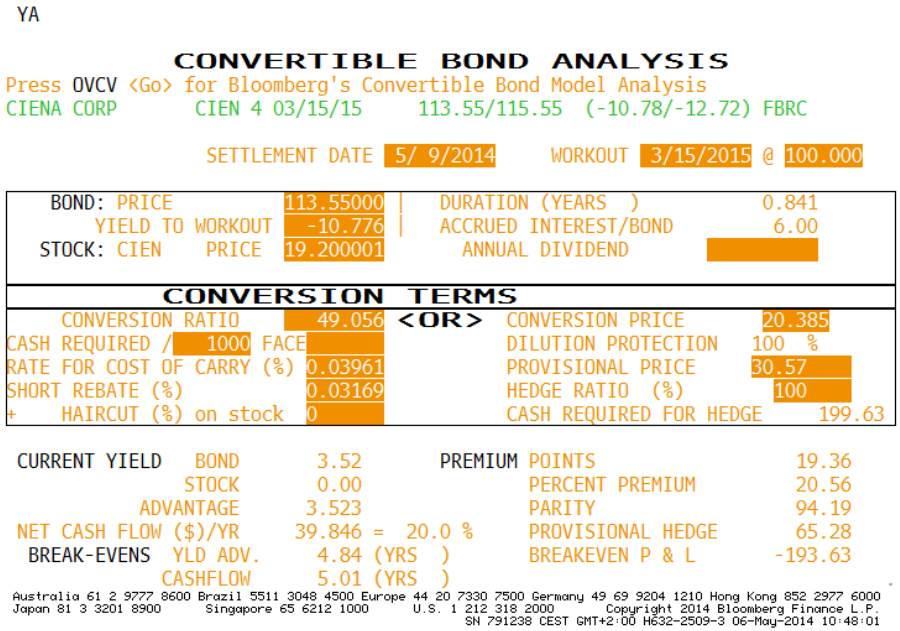
Convertible Bond Valuation

Break Even Analysis : Ciena 4% 2015

CIENA 4% 2015					
ISIN	US171779AF84		ISSUE PRICE	100%	
ISSUE DATE	March 15, 2010		FACE VALUE	1000	
ISSUE SIZE	375mn		MATURITY	March 15, 2015	
STOCK	CIENA		COUPON FREQUENCY	Semi-Annual	
CONVERSION RATIO	49.0557		BOND CURRENCY	USD	
REDEMPTION	100%		STOCK CURRENCY	USD	
COUPON	4%		SOFT TRIGGER START	March 15, 2013	
SOFT CALL TRIGGER	150%				

Convertible Bond Valuation

Break Even Analysis : Ciena 4% 2015



YA

CONVERTIBLE BOND ANALYSIS

Press OVCV <Go> for Bloomberg's Convertible Bond Model Analysis

CIENA CORP CIEN 4 03/15/15 113.55/115.55 (-10.78/-12.72) FBRC

SETTLEMENT DATE 5/ 9/2014 WORKOUT 3/15/2015 @ 100.000

BOND: PRICE	113.55000	DURATION (YEARS)	0.841
YIELD TO WORKOUT	-10.776	ACCRUED INTEREST/BOND	6.00
STOCK: CIEN PRICE	19.200001	ANNUAL DIVIDEND	

CONVERSION TERMS

CONVERSION RATIO	49.056 <OR>	CONVERSION PRICE	20.385
CASH REQUIRED / 1000 FACE		DILUTION PROTECTION	100 %
RATE FOR COST OF CARRY (%)	0.03961	PROVISIONAL PRICE	30.57
SHORT REBATE (%)	0.03169	HEDGE RATIO (%)	100
+ HAIRCUT (%) on stock	0	CASH REQUIRED FOR HEDGE	199.63

CURRENT YIELD	BOND	3.52	PREMIUM	POINTS	19.36
	STOCK	0.00		PERCENT PREMIUM	20.56
	ADVANTAGE	3.523		PARITY	94.19
NET CASH FLOW ($)/YR		39.846 = 20.0 %		PROVISIONAL HEDGE	65.28
BREAK-EVENS	YLD ADV.	4.84 (YRS)		BREAKEVEN P & L	-193.63
	CASHFLOW	5.01 (YRS)			

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2014 Bloomberg Finance L.P.
SN 791238 CEST GMT+2:00 H632-2509-3 06-May-2014 10:48:01

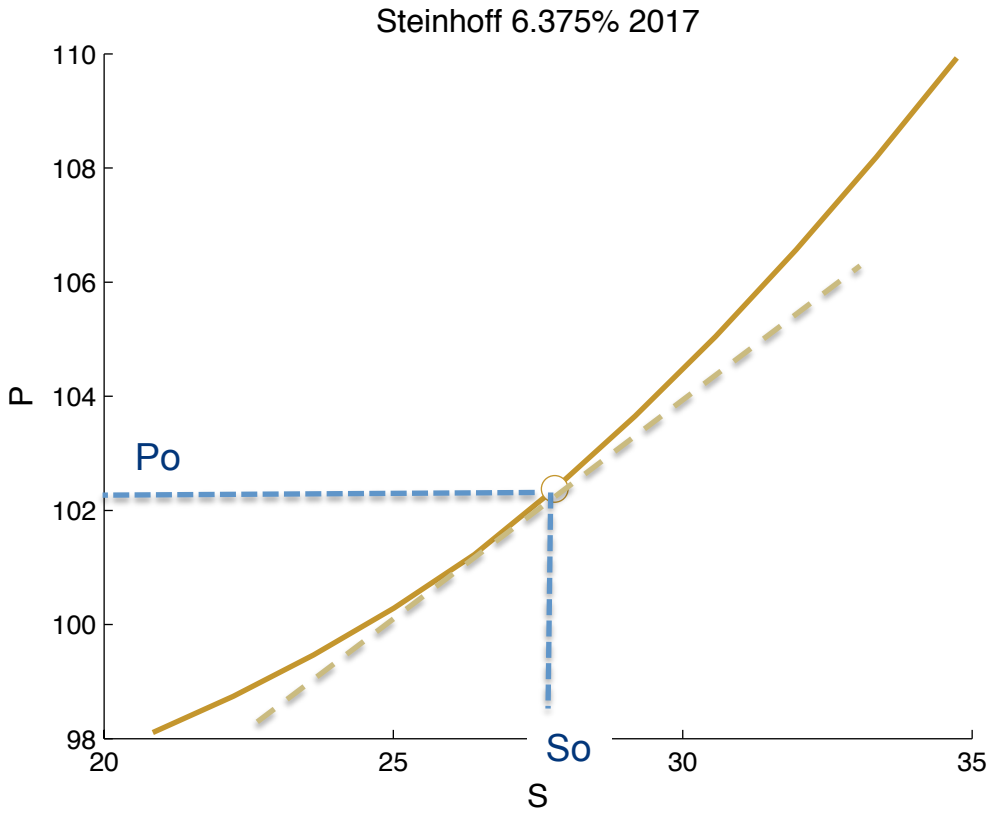
RISK
CONCILE

Convertible Bond Valuation

Dollar Neutral Pricing

- At the beginning of the trading day, calculate Δ% for the share price So and the convertible price Po
- Use the dollar neutral formula when calculating updates for the convertible bond price :

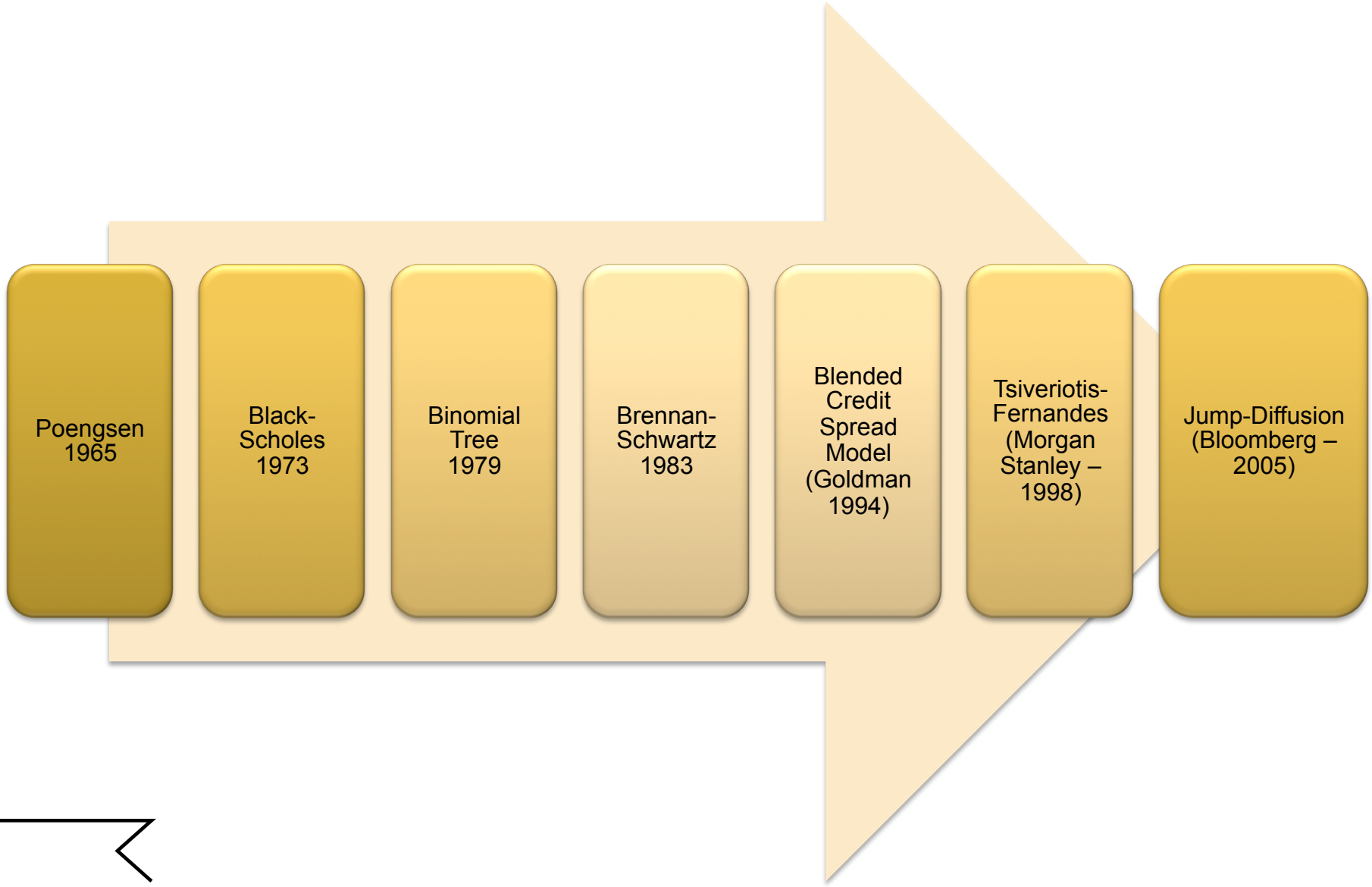
$$P = P_o + \Delta_{\%} \times \frac{C_r \times (S - S_o)}{N}$$



Derivative Models

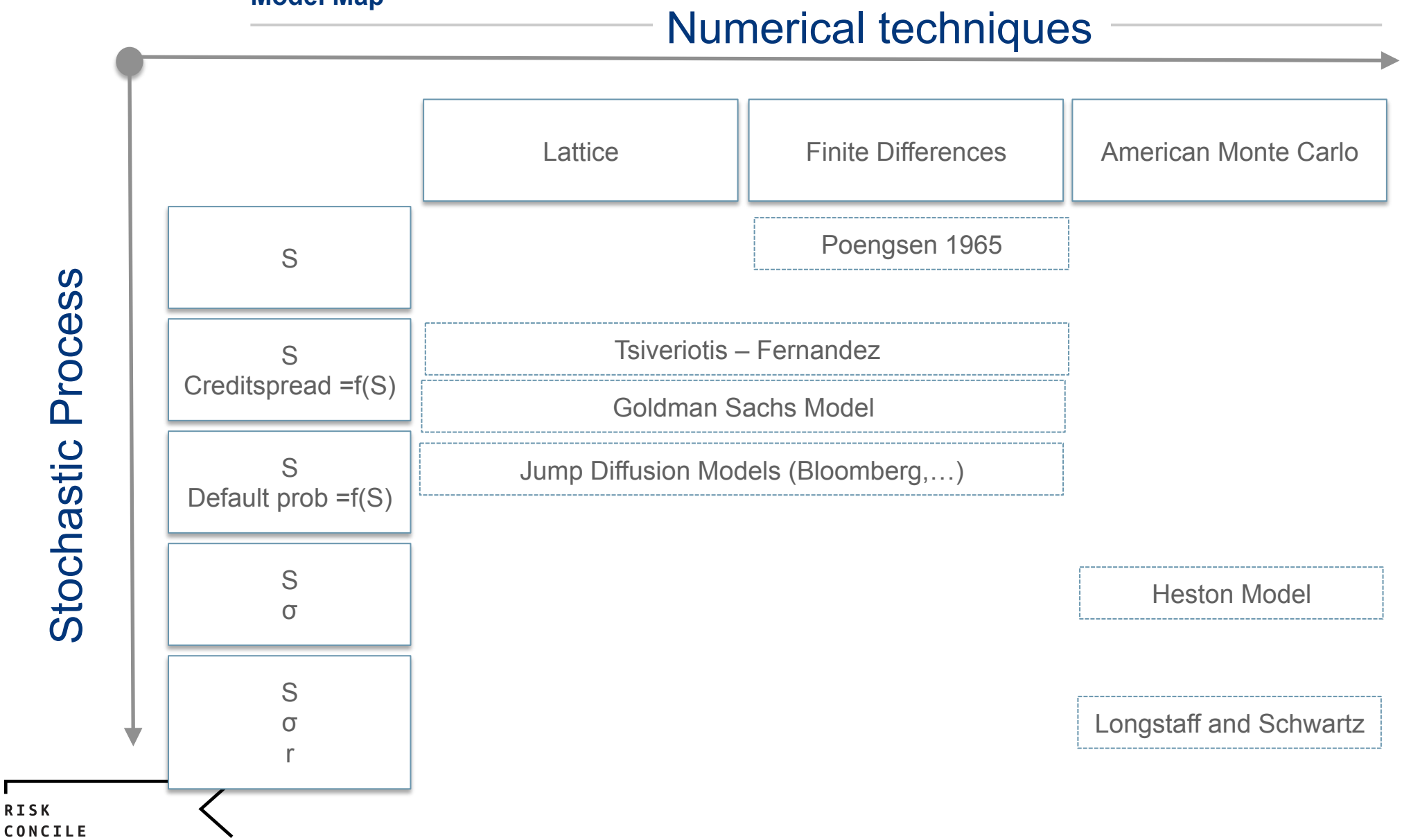
Convertible Bond Valuation

Valuation of convertible bonds : Constant Evolution….



Convertible Bond Valuation

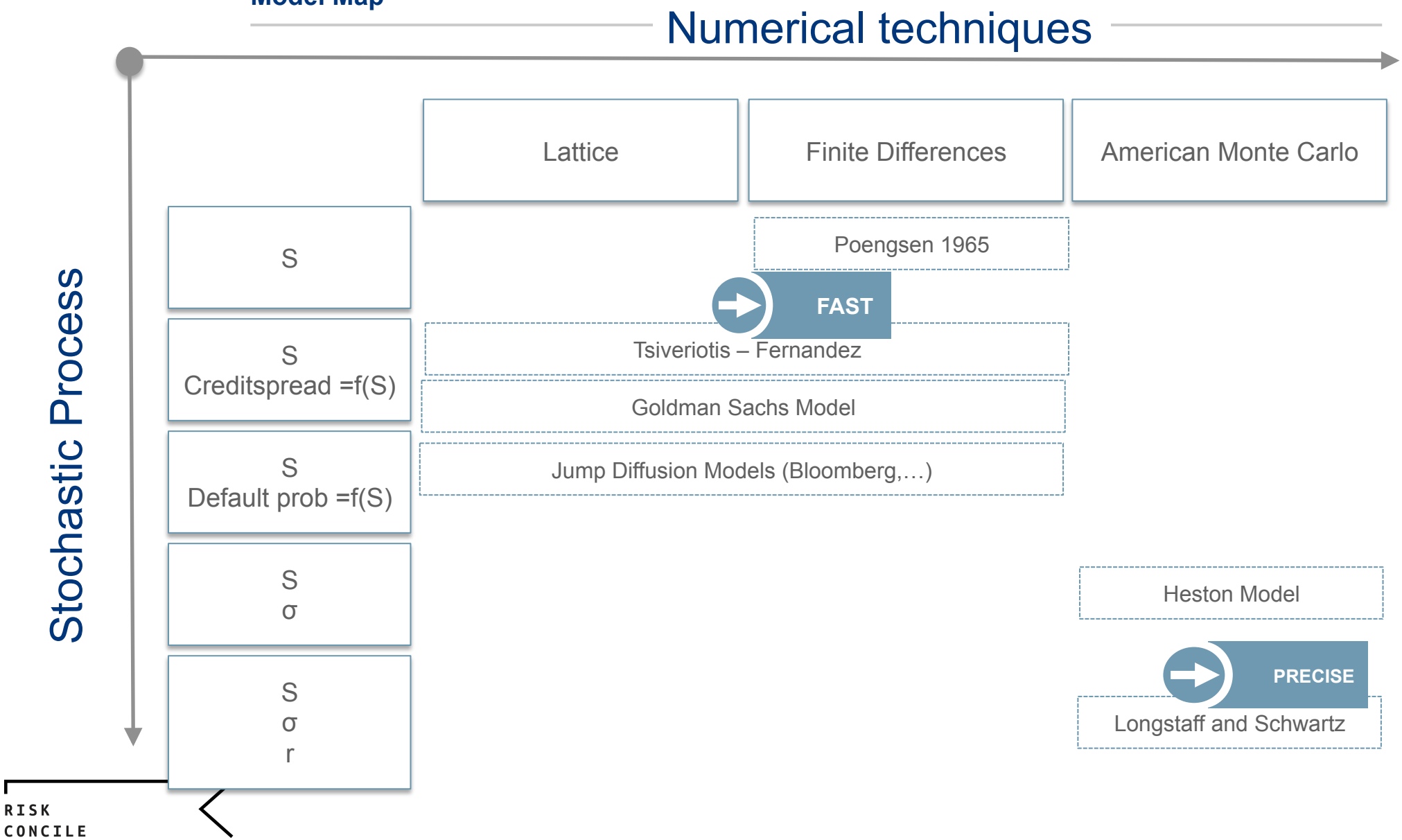
Model Map



RISK
CONCILE

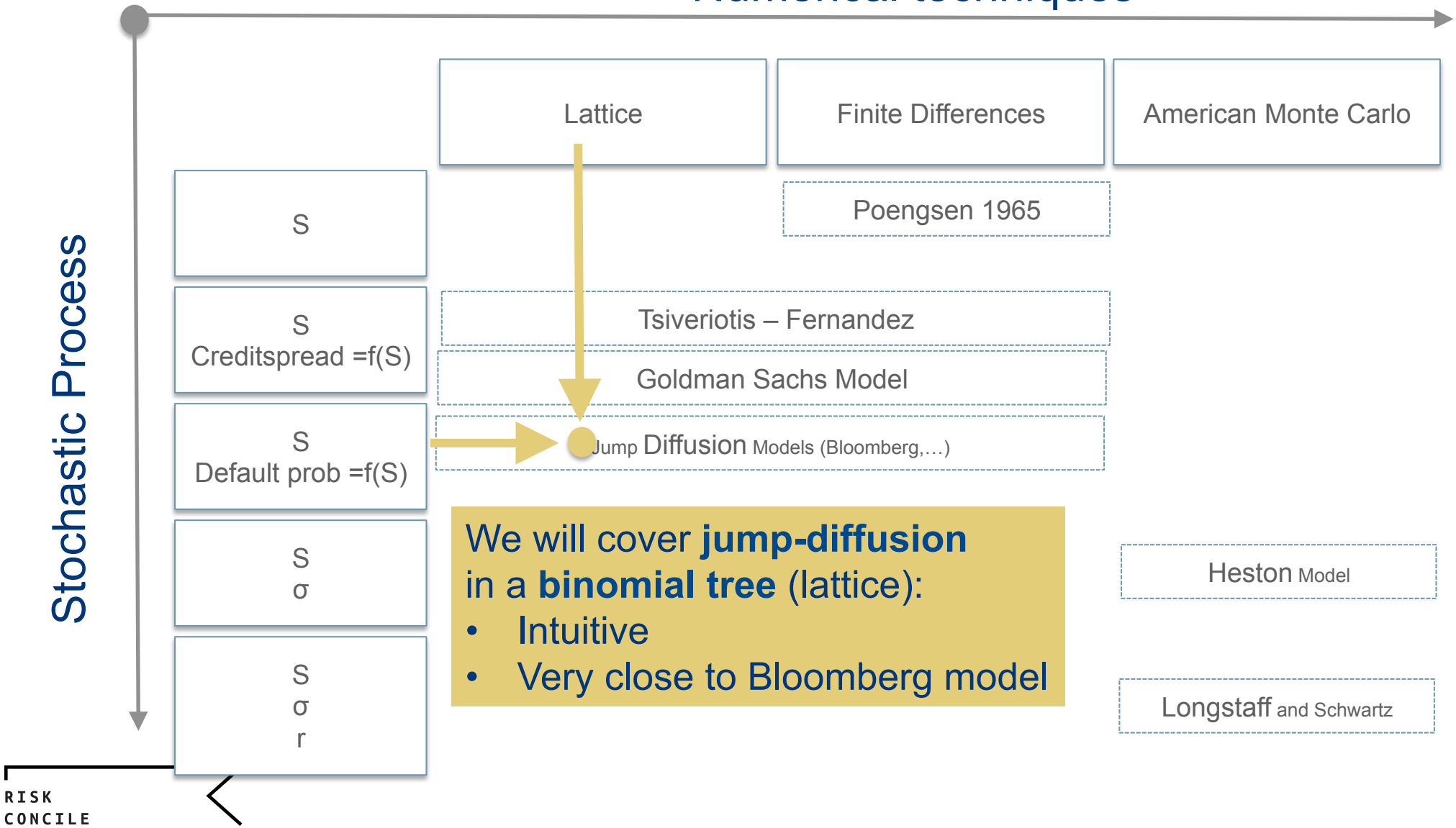
Convertible Bond Valuation

Model Map



Convertible Bond Valuation

Model Map



Convertible Bond Valuation

Jump-Diffusion and Binomial Trees

- Binomial trees are a **numerical technique** to
  - Simulate a share price process
  - Price a derivative product
- **Assumptions** (Black-Scholes world)
  - (log)returns of the share price follows a **Normal distribution**
  - No transaction costs
  - Constant parameters
    - Volatility
    - interest rate curve
    - Dividends
  - The share price is the only random variable

Convertible Bond Valuation

Jump-Diffusion and Binomial Trees

- **Jumps** can be added to the binomial process to simulate the bankrupcty of the convertible security
- **On Default :**
  - The share price drops to zero
  - The convertible bond is worth R x N : a certain fraction (Recovery rate) of the face value N is recovered
- **Default probability (Pd) over a horizon T :**
  - Driven by a **default intensity** or **hazard rate** (λ)
  - $Pd=1-\exp(-\lambda T)\approx\lambda T$
  - The default intensity (λ) can be derived from
    - CDS levels
    - Corp Bond Spreads

Convertible Bond Valuation

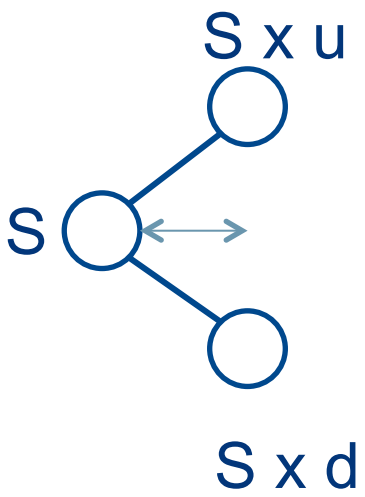
Jump-Diffusion and Binomial Trees

- Building a binomial tree is a 3-step process
  - **STEP 1**
    Simulate the share price process from t=0 to t=T
  - **STEP 2**
    Calculate the final payoff of the bond at t=T
  - **STEP 3**
    Discount the payoff backwards to t=0 , while checking at each node in the tree :
    - Shouldn't I convert the bond
    - Will the (rational) investor call?
    - Should I Put the bond

Convertible Bond Valuation

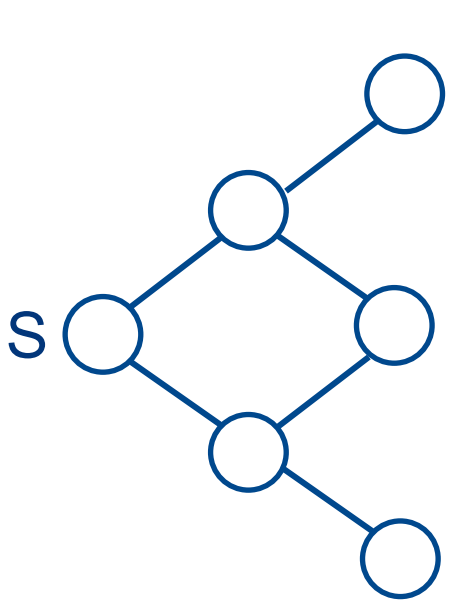
Jump-Diffusion and Binomial Trees : STEP 1

1 STEP



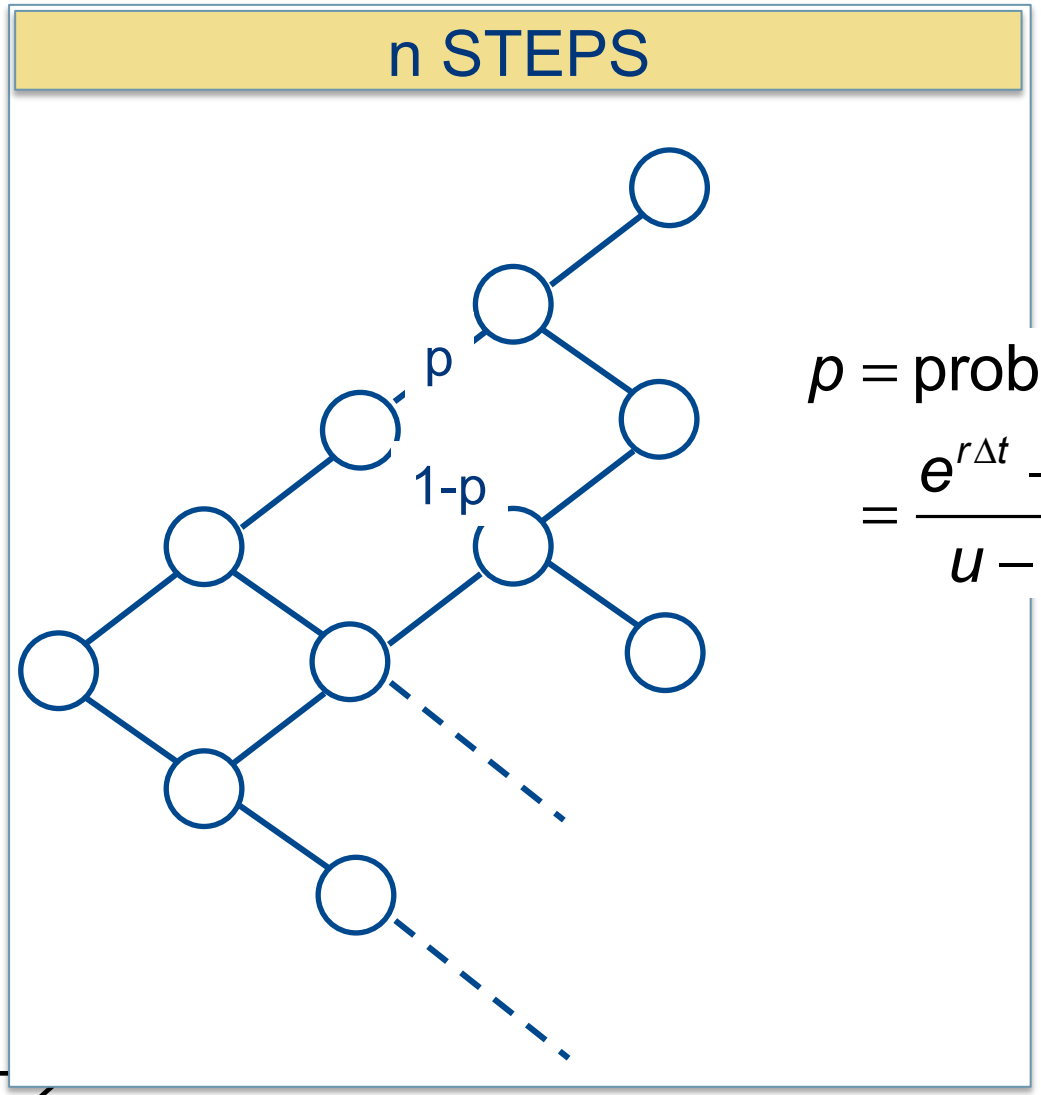
$$u = \frac{1}{d} = e^{\sigma\sqrt{\Delta t}}$$

2 STEPS



Convertible Bond Valuation

Jump-Diffusion and Binomial Trees : STEP 1



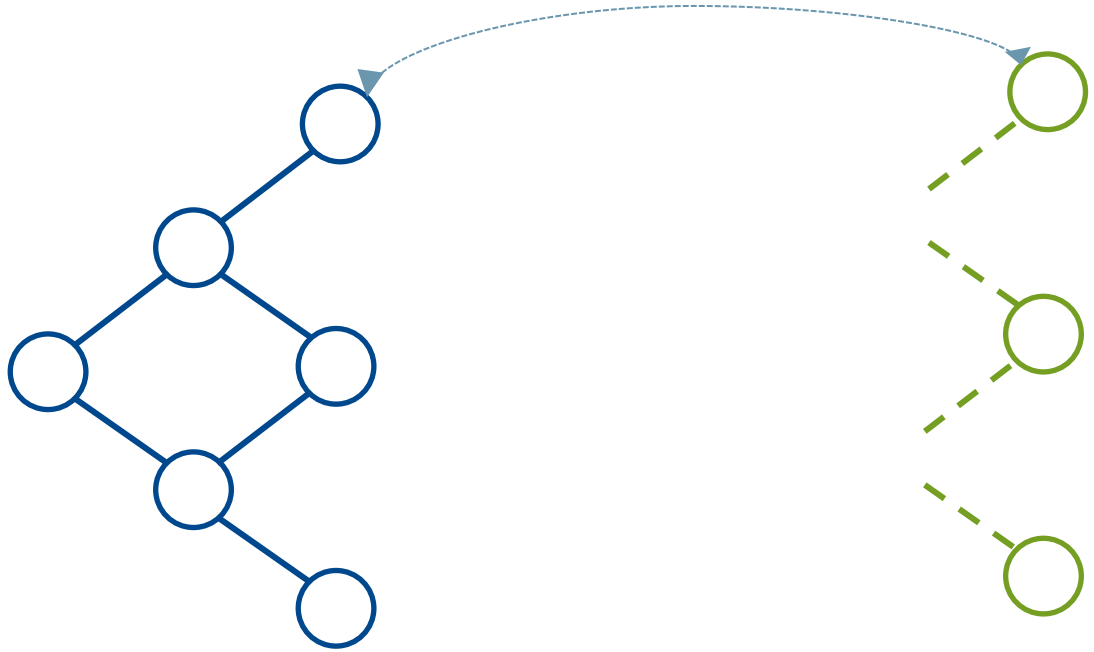
p = probability for an up move

$$= \frac{e^{r\Delta t} - d}{u - d}$$

Convertible Bond Valuation

Jump-Diffusion and Binomial Trees : STEP 2

Calculate the final payoff



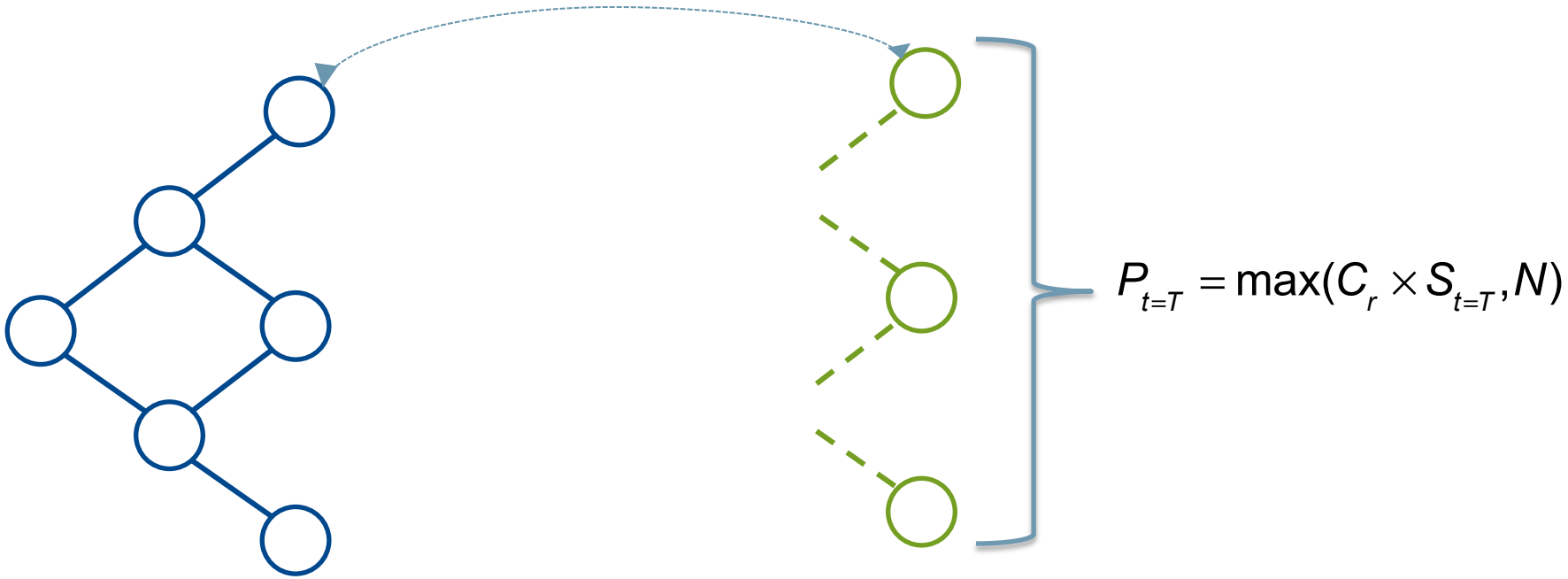
Shares (S)

Convertible (P)

Convertible Bond Valuation

Jump-Diffusion and Binomial Trees : STEP 2

Calculate the final payoff



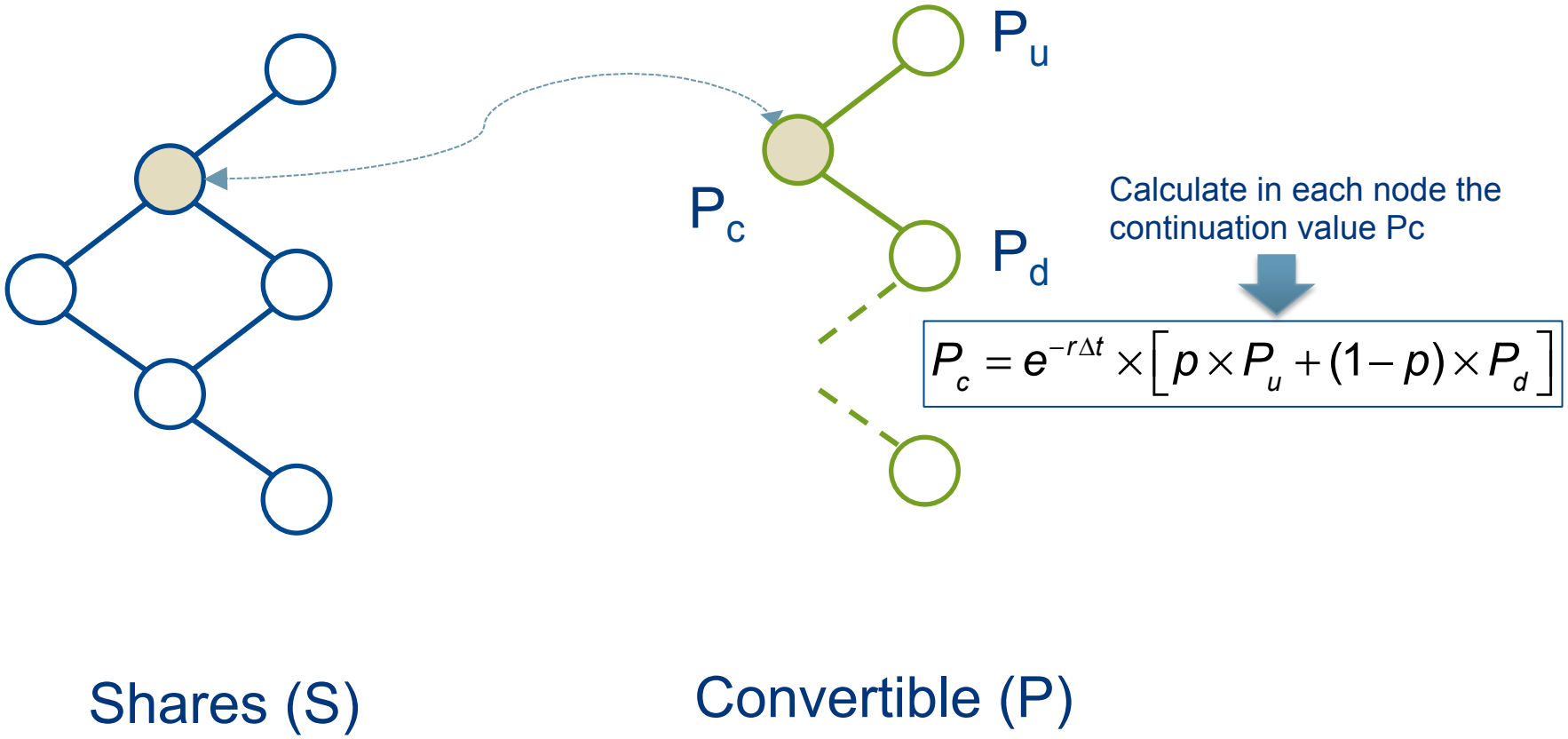
Shares (S)

Convertible (P)

Convertible Bond Valuation

Jump-Diffusion and Binomial Trees : STEP 3

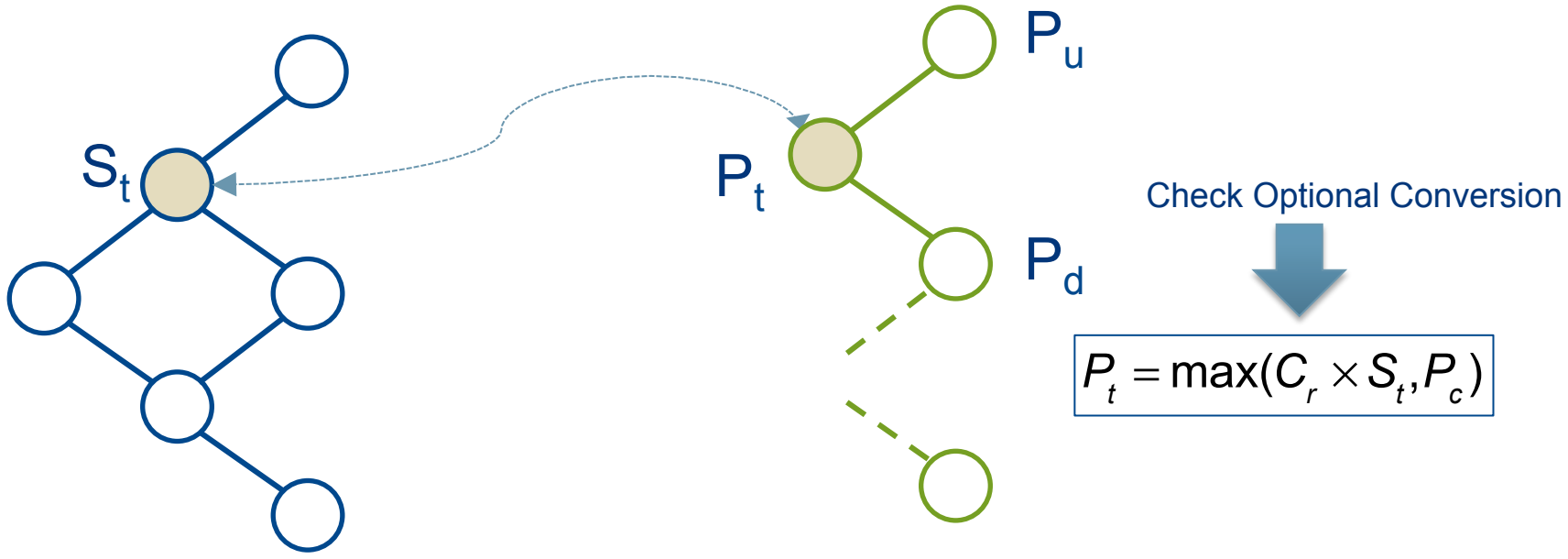
Move backwards in the tree (1)



Convertible Bond Valuation

Jump-Diffusion and Binomial Trees : STEP 3

Move backwards in the tree (2)



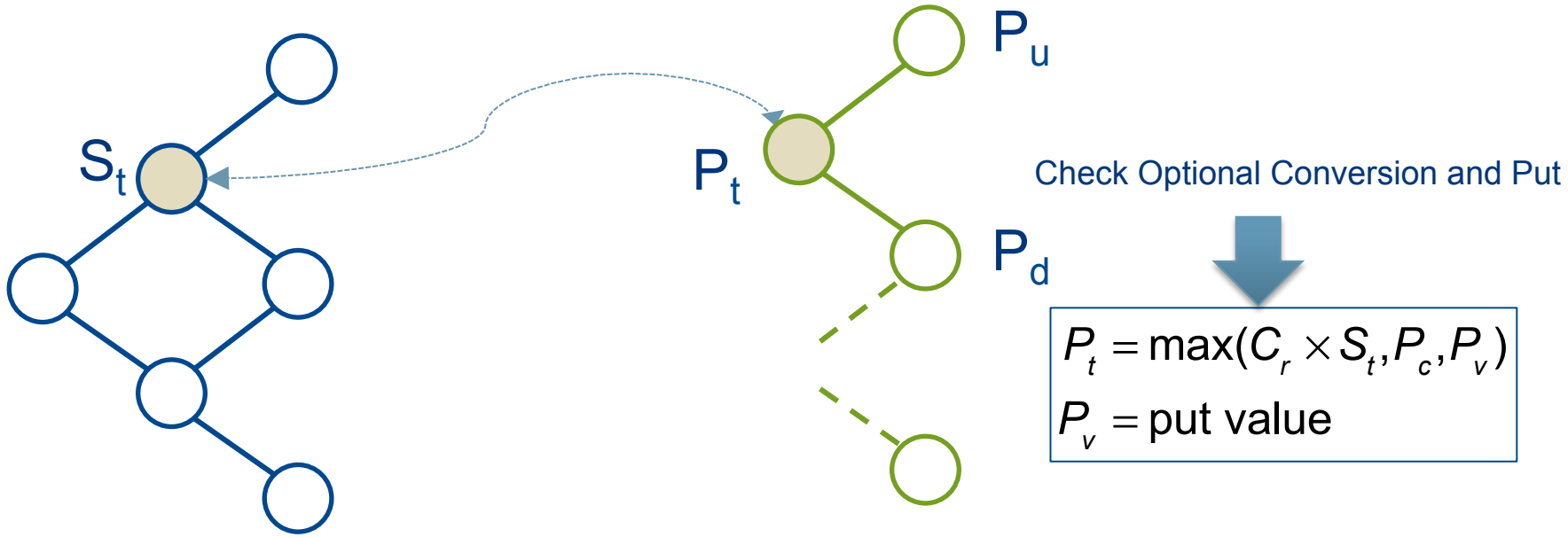
Shares (S)

Convertible (P)

Convertible Bond Valuation

Jump-Diffusion and Binomial Trees : STEP 3

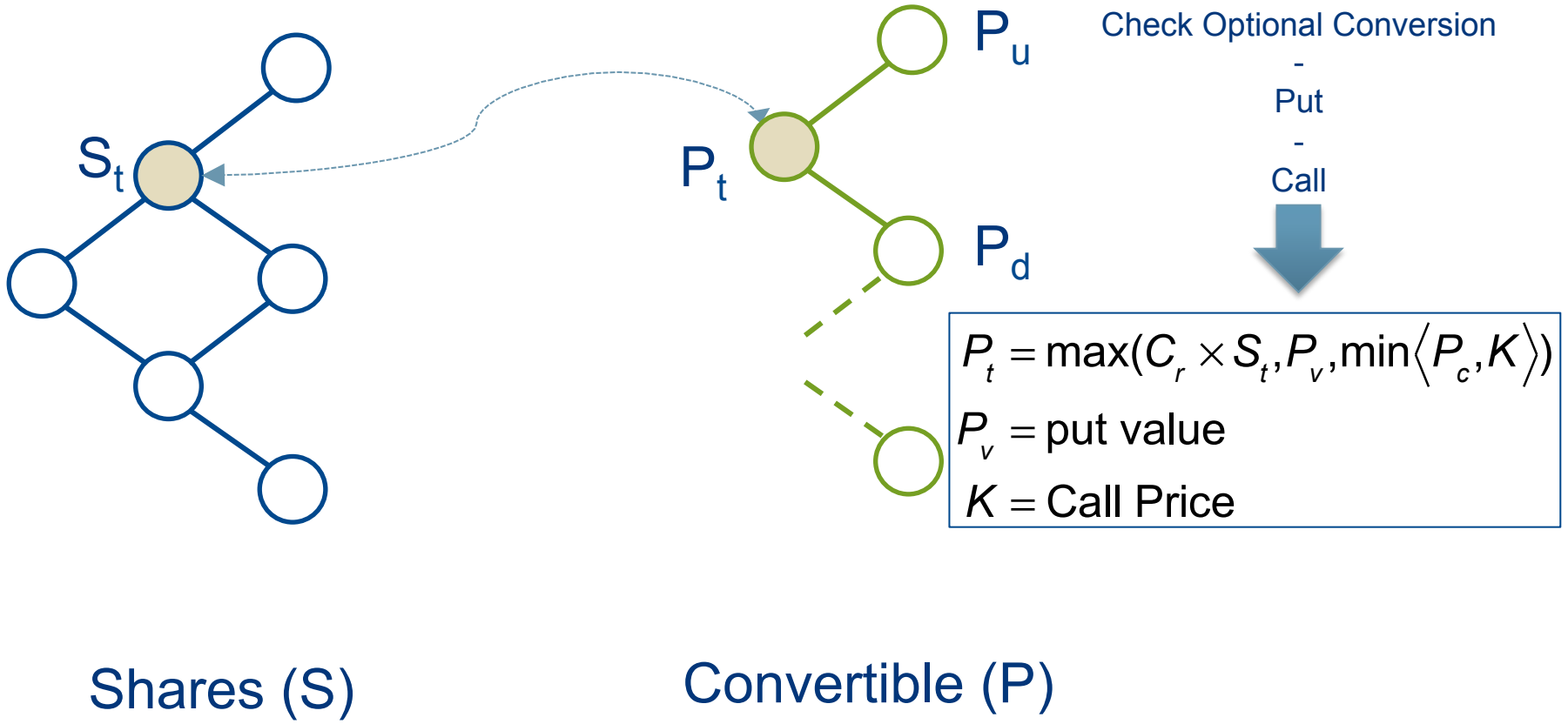
Move backwards in the tree (3)



Convertible Bond Valuation

Jump-Diffusion and Binomial Trees : STEP 3

Move backwards in the tree (4)



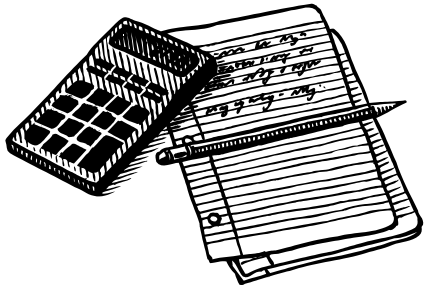
Handling Credit

Handling Credit

- The largest difference between convertible bond models is how **credit risk** and **dividends** are handled
- **Dividends** (later)
- **Credit Risk** :There are three different categories
    1. **Flat Credit Spread**
    2. **Blended Credit Spread**
        - Goldman method
        - Tsiveriotis-Fernandez
    3. **Jump-Diffusion**
- Within each category there are more differences possible
- Different models lead to different prices. This makes it hard to use the input of one CB-pricer into another one !
- We will explain the difference using tree-models

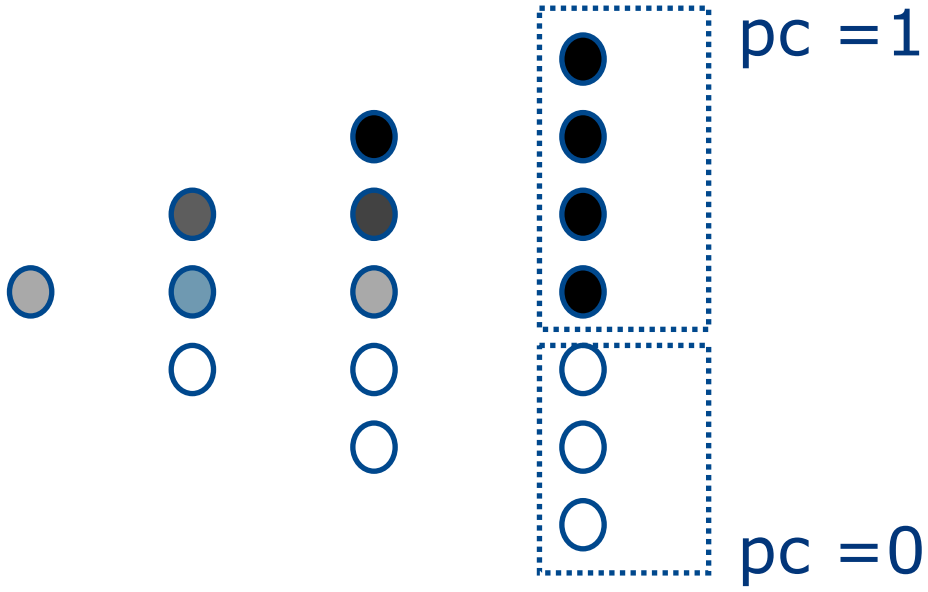
Handling Credit

- **[1] Flat Credit Spread** : “Grow riskfree , discount risky”
  - 1986 (Schwartz)
  - Risky rate = r+ credit spread
  - Converts with a high conversion probability are undervalued



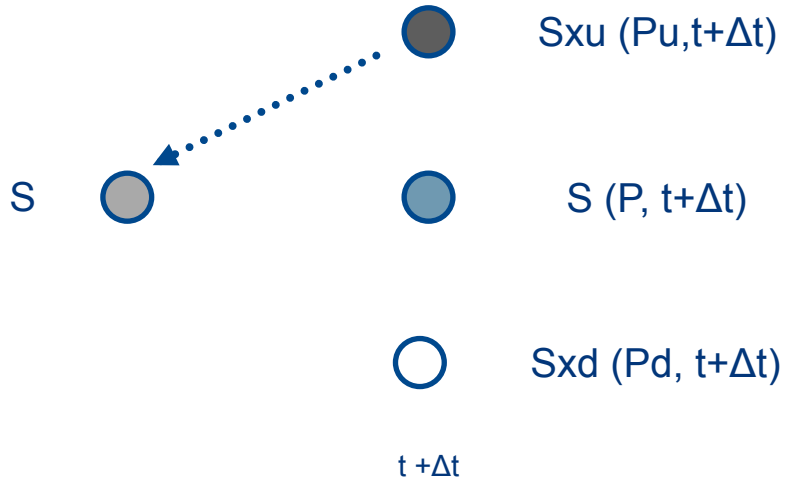
Handling Credit

- **[2] Blended Credit Spread** : “Grow riskfree , discount mixed”
  - 1994 (Goldman Sachs)
  - Credit Spread = function of conversion probability (Pc)
    - Pc=1: discount riskfree
    - Pc=0: discount risky=riskfree+ credit spread



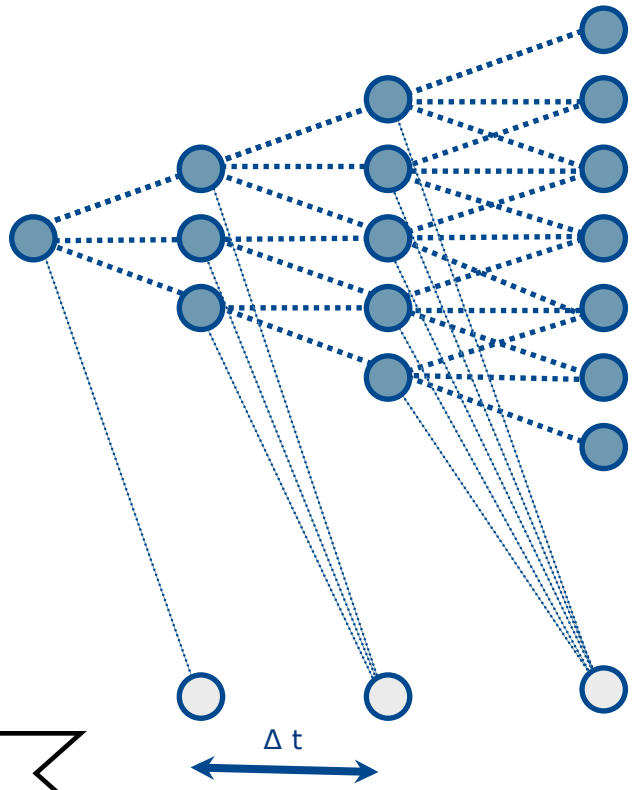
Handling Credit

- In a trinomial model where the share price S moves to three possible states :
  - Sxu with probability pu
  - S with probability p
  - Sxd with probability pd
- Discounting the happens at the blended rate (rb) , one for each node.
  - rb = pc x r + (1-pc) x (r+cs)



Handling Credit

- **[3] CDS Model** “Grow riskfree , allow default”
- The jump-difusion model being an implementation of this.



Pre-Default Layer

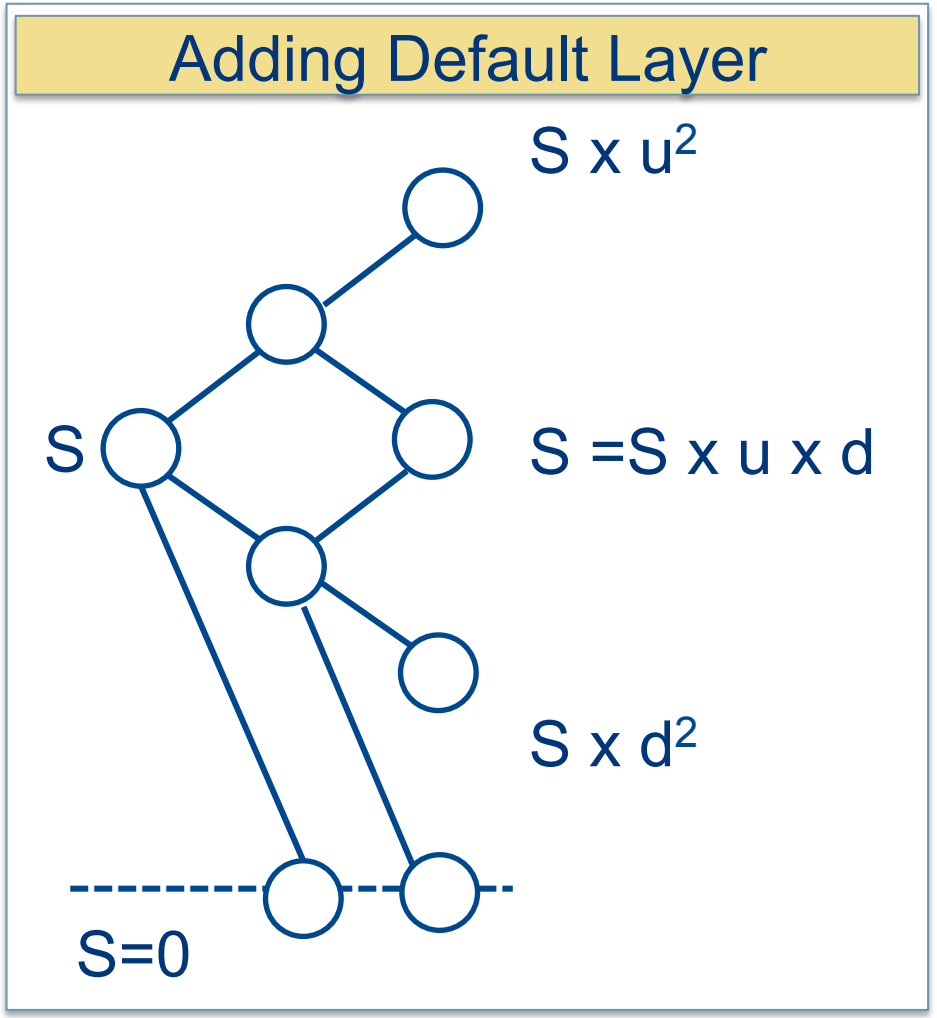
Each time step there is a probability of
1-exp(-λΔt) to jump to default

Default Layer

RISK
CONCILE

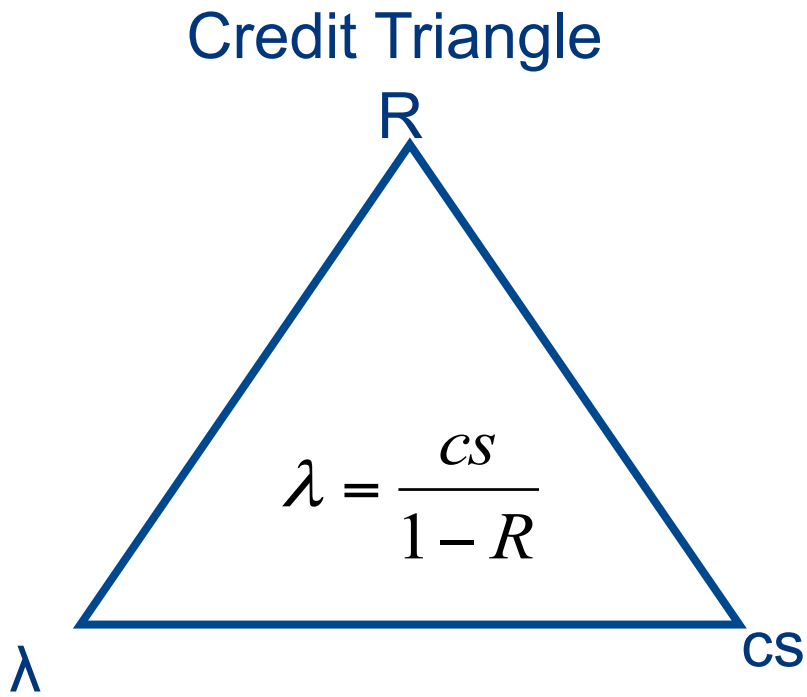
Convertible Bond Valuation

Jump-Diffusion and Binomial Trees :Adding Jumps



Handling Credit

- Link between λ and credit spread (cs)
- Link between CDS Model and Credit Spread Models



Handling Credit in Bloomberg

- **CREDIT**
  - **Flat Credit Spread (OAS)**
    - Uniform spread is added to the RISKFREE Curve
    - Black-Scholes Model
  - **Credit Spread (CDS)**
    - CDS curve or Flat CDS spread can be added
    - Jump to default data
      - Shares drop 40%
      - Recovery Rate Convertible 30%
      - Recovery Rate CDS-Bond 40%
      - Allows a 1 ½ factor model

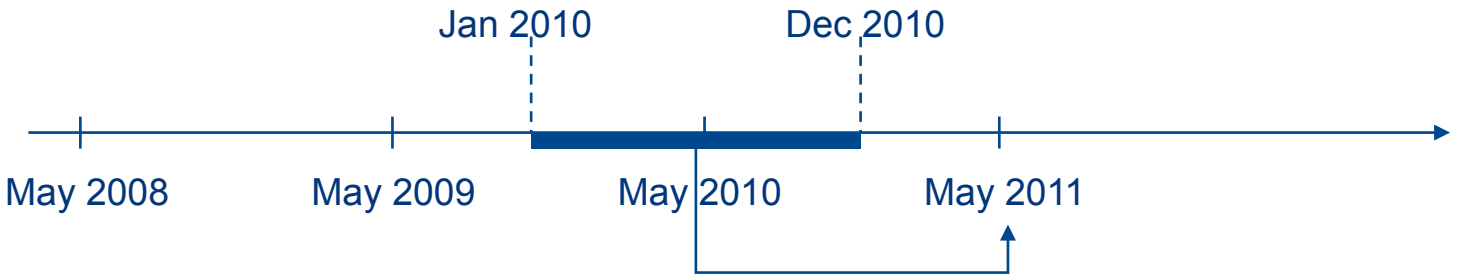
Not Everything is coverd by a model

Dividends : Timing !

- On conversion the bond holder receives shares
- Dividend Entitlement differs from issue to issue
- Example : MTU AERO ENGINES 2 ¾ 2012

  “....Shares acquired pursuant to the execution of the conversion shall be entitled to dividends (if any) from the beginning of the Financial Year in which such Shares are issued. See § 9 of the Terms and Conditions....”

- The conversion notice needs to be given **before** December 2010 if one wants to receive the dividends on May 2011



FX Exposure

Cross Currency Convertible Bonds

- The **Steinhoff 6.375% 2017** convertible is an example of a cross currency convertible

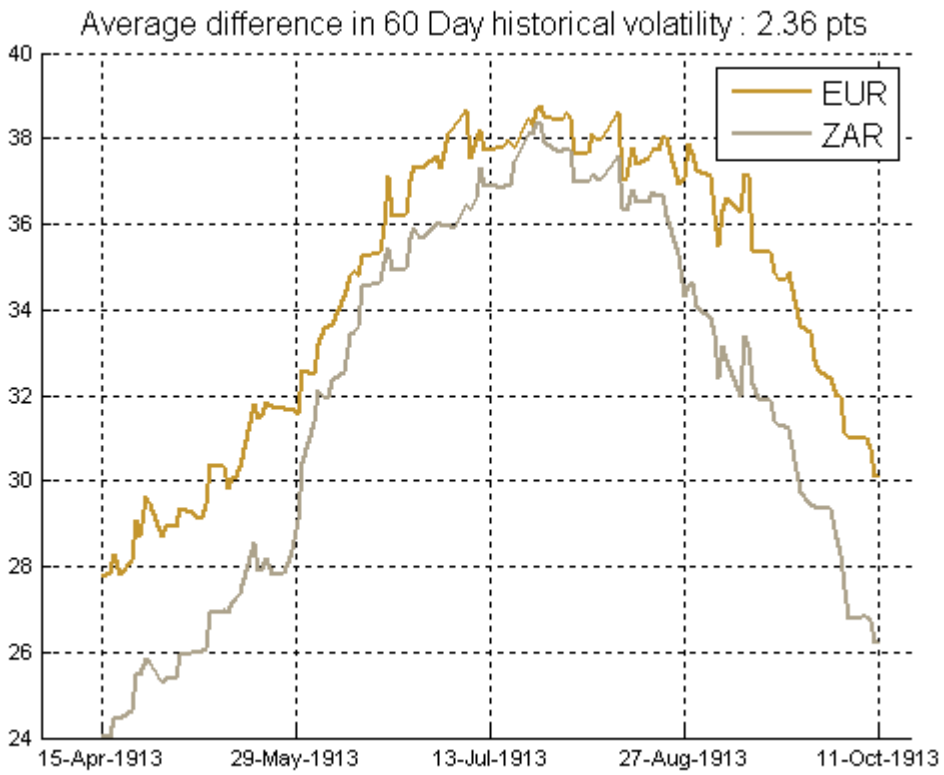
  Bond Currency (EUR) ≠ Stock Currency : ZAR

- The actual underlying asset of the convertible are **Steinhoff Shares** expressed in **EUR**
- This impacts volatility

$$\sigma_{Steinhoff,EUR} = \sqrt{\sigma^2_{Steinhoff,ZAR} + \sigma^2_{ZAREUR} + 2\rho\sigma_{Steinhoff,ZAR}\sigma_{ZAREUR}}$$

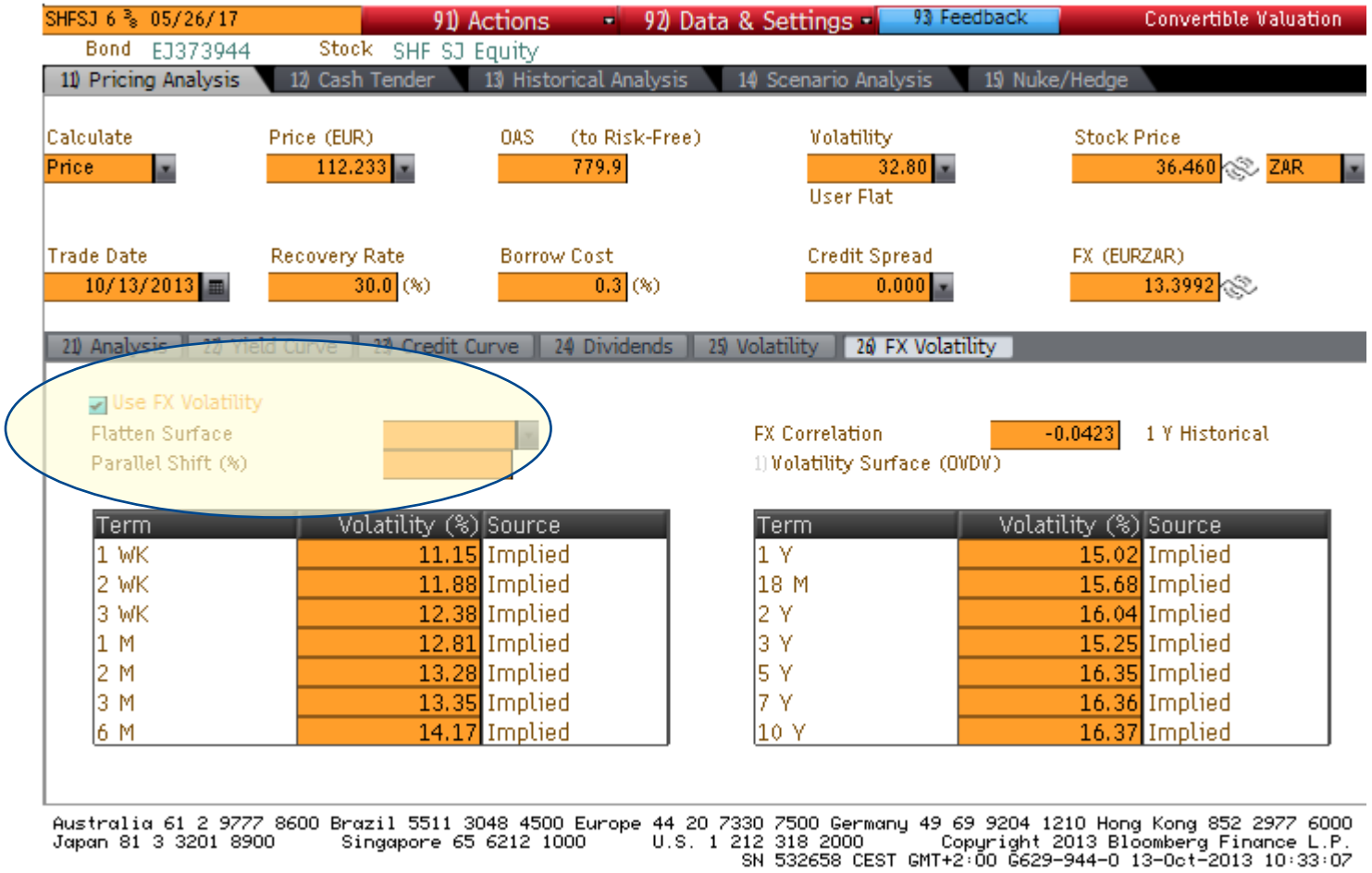
Risk Management and Trading Strategies

Cross Currency Convertible Bonds : Steinhoff 6.375% 2017



This impacts the theo price of the convertible with **1.23 bps**

Conversion Price : Cross Currency Convertibles



In Bloomberg, there is the possibility to toggle on/off The FX Volatility Impact

RISK
CONCILE

Transaction Costs

Transaction Costs

- The rebalancing of the delta-hedge introduces a transaction cost
- This transaction cost depends on
  - Brokerage Fee (k) when getting a buy or sale executed on the underlying stock
  - The frequency of the delta hedging 1/(δt)
    δt = time between two delta trades
  - Convexity (Γ)
- If the expected volatility of the stock is σ, one will be paying less than this expected volatility : σ* < σ

$$\sigma^* = \sigma\sqrt{1 - \text{sign}(\Gamma) \times A}$$

$$A = \sqrt{\frac{2}{\pi}} \times \frac{k}{\sigma\sqrt{\delta t}}$$

Transaction Costs

Transaction Costs

- **Example**
  A portfolio manager wants to invest in a convertible bond on an emerging market position. He intends to run a delta-neutral position on this convertible for a while. The bond is currently very cheaply priced and should be trading at par according to a research document. The porfolio manager expects the value of the convertible to increase and converge to a higher level. The convertible's implied volatility is 30%, the underlying stock is very illiquid and executing a trade is therefore expensive. The vega of the convertible is 0.24***. How much should the price of the bond be impacted if the target is to rebalance every week ?***

- **Data**
  - σ=30%
  - k=50bps=0.5%
  - δt = 7/365
  - Γ>0
  - Vega = 0.24

$$\sigma^* = \sigma\sqrt{1 - \text{sign}(\Gamma) \times A}$$

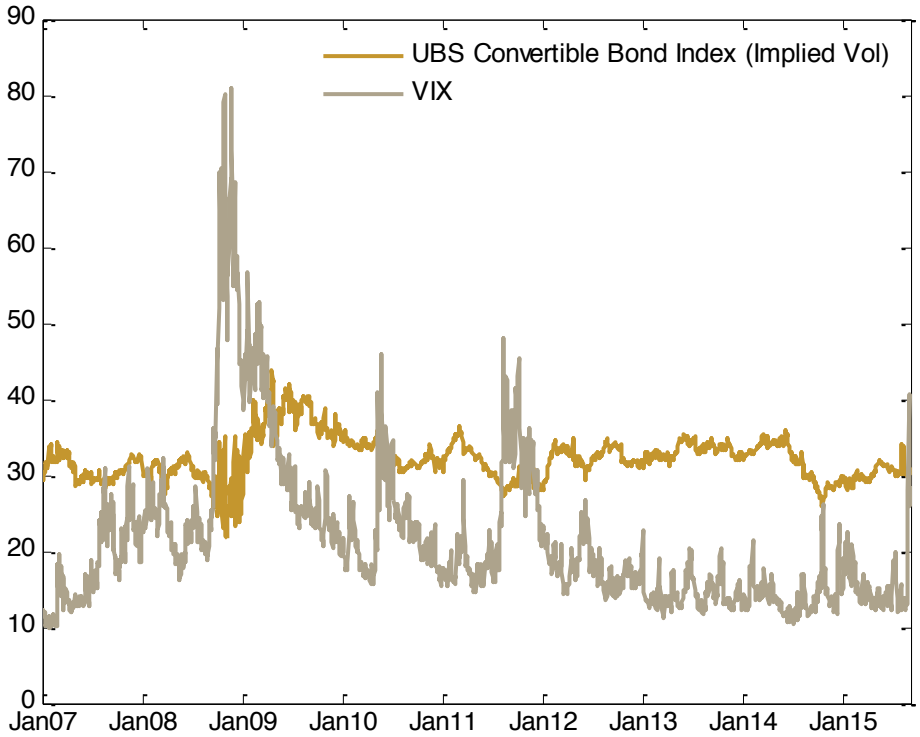
$$A = \sqrt{\frac{2}{\pi}} \times \frac{k}{\sigma\sqrt{\delta t}}$$

- **Solution**
  - σ*=28.52%
  - Price impact = 0.24 x (30-28.52)=**35bps**
  - **Adjust Fair Value = 100-0.35=99.65%**

Convertible ≠ Listed Option

Volatility Hedging

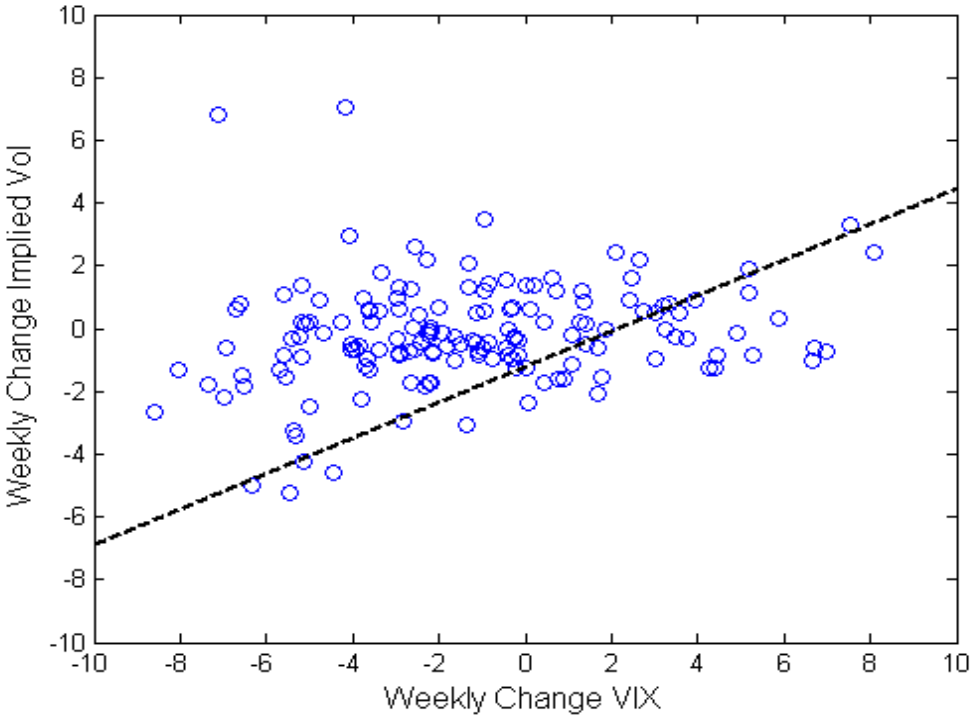
- Not all the convertible bonds have listed options trading on their underlying shares
- Even if this would be the case, there would be a mismatch in **Maturity** and **Strike**
- Hedging with a VIX- futures overlay is not without risk :



Risk Management and Trading Strategies

Volatility Hedging

- Period **2008-2011**
- Out of the 183 Weekly observations, there were
  - 34 Observations where the VIX increased but the implied vol decreased
  - 45 Observations where the VIX decreased and the implied vol increased
  - This accounts for **43%** of the weeks.



Takeover Protection

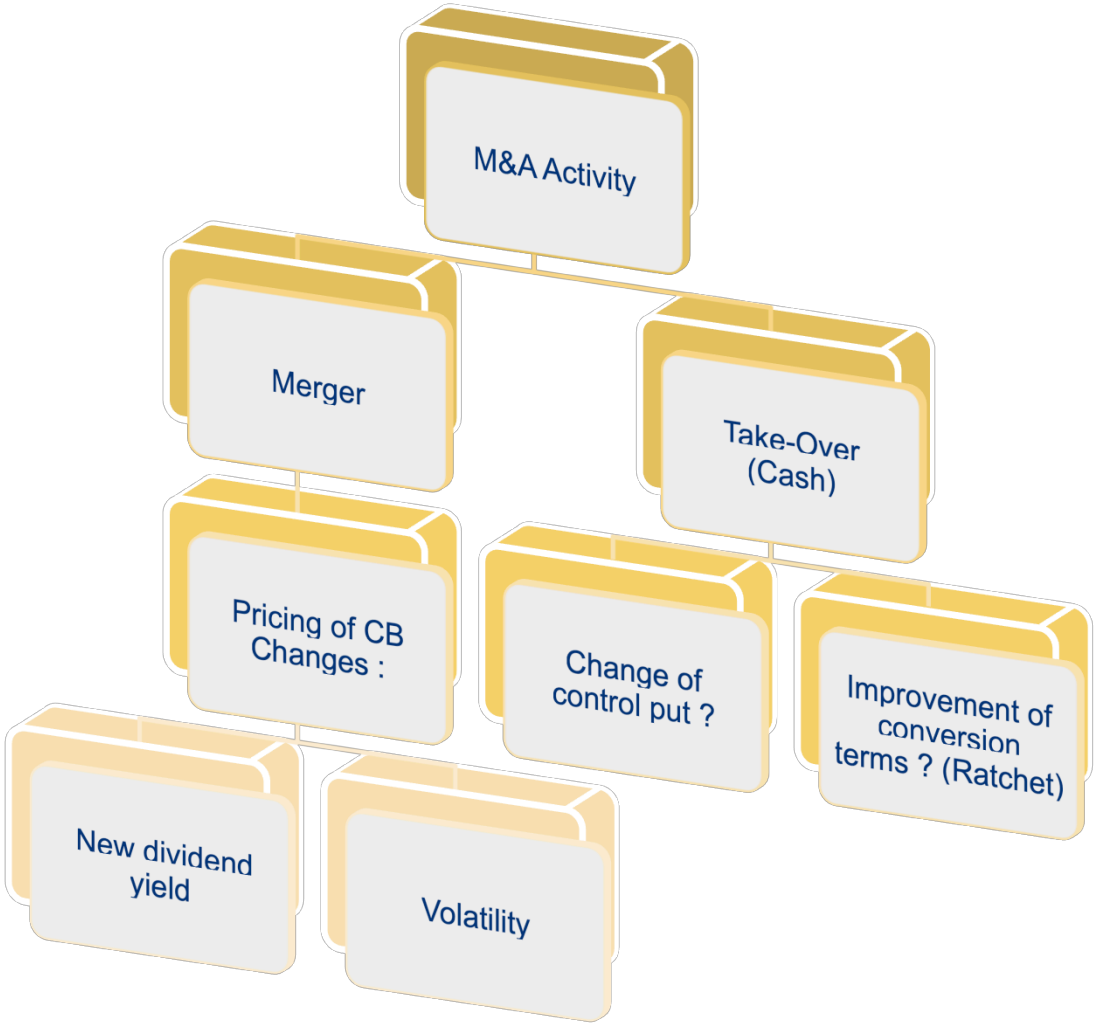
Ratchets

Two mechanisms in case of a take over

- **Change of control put**
  - The investor sells back the bond to the issuer (probably at par)
  - When the take-over materializes
- **Ratchet**
  - Increase of the conversion ratio accoring to
    - (Ratchet) table
    - (Ratchet) formula
  - Compensates the investor for a loss of the premium.

Takeover Protection

Dealing with Take over and mergers



Takeover Protection

Change of Control Put

"....If we undergo a "fundamental change" (as defined in this prospectus supplement under "Description of notes—Fundamental change permits holders to require us to repurchase notes"), subject to certain conditions, you will have the right, at your option, to require us to repurchase for cash all or any portion of your notes such that the principal amount of each of your notes that remains outstanding equals $2,000 or an integral multiple of $1,000 in excess thereof. The fundamental change repurchase price will equal 100% of the principal amount of the notes to be repurchased, plus accrued and unpaid interest to, but excluding, the fundamental change repurchase date...."

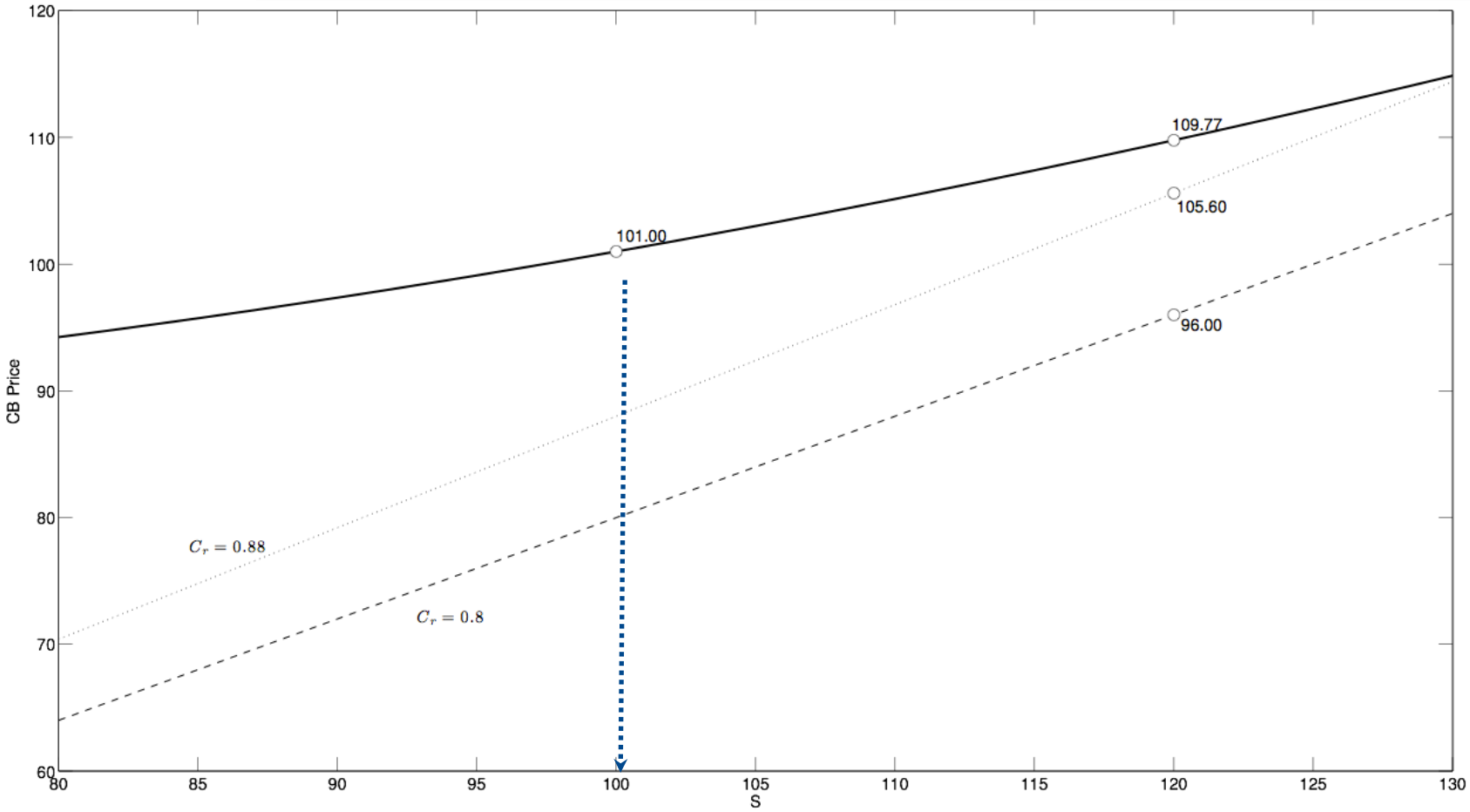
Takeover Protection

Ratchets

- Improving the conversion terms in case of a take-over
- Different outcome
  - Long Only
  - Convertible Bond Arbitrage
- Let's start with a practical example: S convertible bond with conversion ratio = 0.8

Takeover Protection

Ratchets

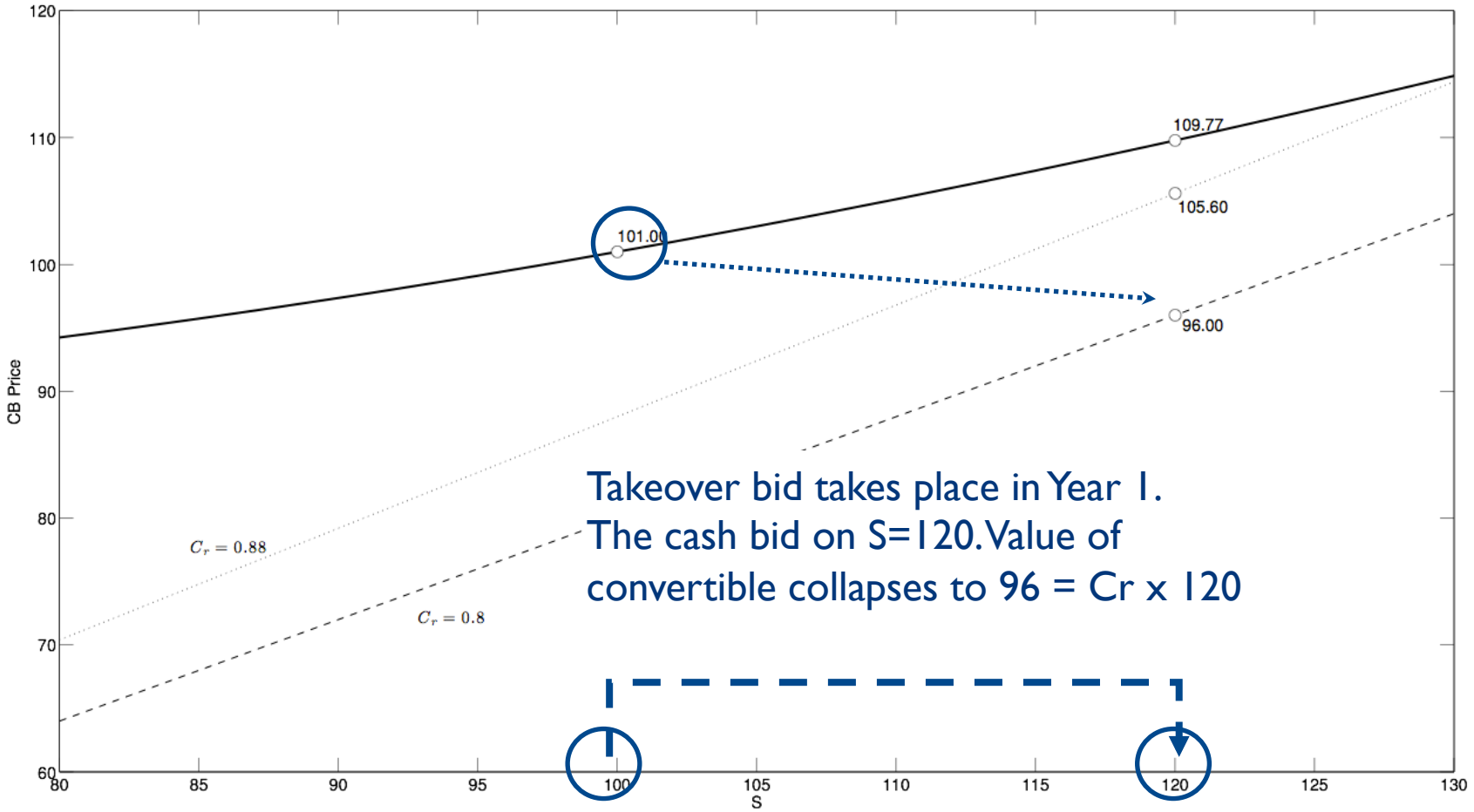


Share Price (S) = 100

Convertible trades @ 101

Takeover Protection

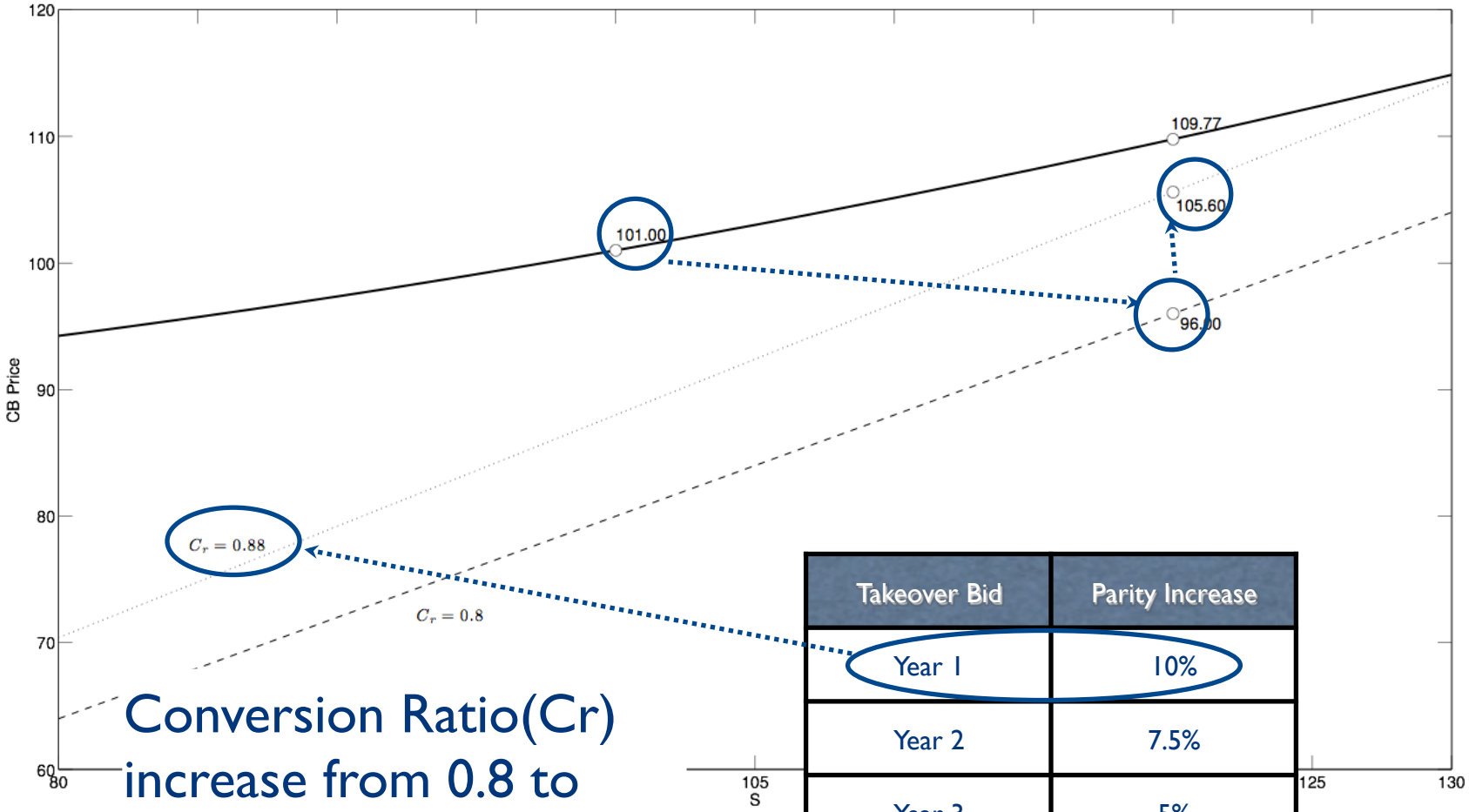
Ratchets



RISK
CONCILE

Takeover Protection

Ratchets



Conversion Ratio(Cr) increase from 0.8 to 0.88 (+10%)

Takeover Bid	Parity Increase
Year 1	10%
Year 2	7.5%
Year 3	5%
Year 4	2.5%
Year 5	0%

RISK
CONCILE

Takeover Protection

Ratchets

- To make up for the lost premium, the bond might have (in the prospectus) two possible mechanisms:
  - Ratchet Table
  - Ratchet Formula

Takeover Protection

Ratchets : Ratchet Formula

- General Formula

$$CP^* = \frac{CP}{1 + \text{Initial Premium} \times \frac{\Delta T1}{\Delta T2}}$$

$$\Delta T1 = \text{Maturity Date - TakeOverDate}$$

$$\Delta T2 = \text{Maturity Date - Issue Date}$$

- If the annoucement happens close to the expiration date, there will be hardly any impact
- Ratchet clauses can be combined with a change of control put

INVA 2.125% 2023

If we experience a "fundamental change," as defined herein, each holder may require us to purchase for cash all or a portion of such holders' notes at a redemption price equal to 100% of the principal amount of the notes to be redeemed, plus accrued and unpaid interest to but excluding the repurchase date. In addition, we will in some circumstances increase the conversion rate of the notes with a make-whole premium for conversions in connection with certain fundamental changes.

INVA 2.125% 2023

	14.921	17.788	19.773	21.346	24.903	28.461	35.576	42.692	56.922	71.153
01/24/13	16.439	12.3986	10.4444	9.2209	7.1605	5.7403	3.9478	2.8858	1.7148	1.1187
01/15/14	16.439	12.3986	10.4444	9.1825	7.0617	5.6162	3.816	2.7667	1.6282	1.0618
01/15/15	16.439	12.3986	10.4217	9.1004	6.9146	5.4441	3.6454	2.6172	1.5224	0.9889
01/15/16	16.439	12.3986	10.3434	8.9673	6.7116	5.2182	3.4295	2.4331	1.3959	0.9068
01/15/17	16.439	12.3986	10.1811	8.746	6.4242	4.9152	3.1567	2.2082	1.2525	0.8105
01/15/18	16.439	12.3794	9.8917	8.3941	6.015	4.5076	2.8066	1.927	1.083	0.6995
01/15/19	16.439	12.0066	9.3932	7.8426	5.4304	3.9526	2.3625	1.5864	0.8902	0.5768
01/15/20	16.439	11.3488	8.6083	7.0142	4.6142	3.2172	1.8172	1.1918	0.6754	0.4438
01/15/21	16.439	10.2943	7.416	5.7971	3.4877	2.2592	1.1751	0.7657	0.453	0.305
01/15/22	16.439	8.6275	5.5496	3.9373	1.9122	1.0562	0.5085	0.3598	0.2313	0.1594
01/15/23	16.439	5.6353	0	0	0	0	0	0	0	0

Max Conversion Ratio = 50.581 + 16.439 = 67.02

Appendix
American Monte Carlo

American Monte Carlo for Convertibles

- The value of the derivative security can be defined as a risk neutral expectation of a discounted payoff.

$$P = e^{-rT} E\left[P_T\right]$$

or

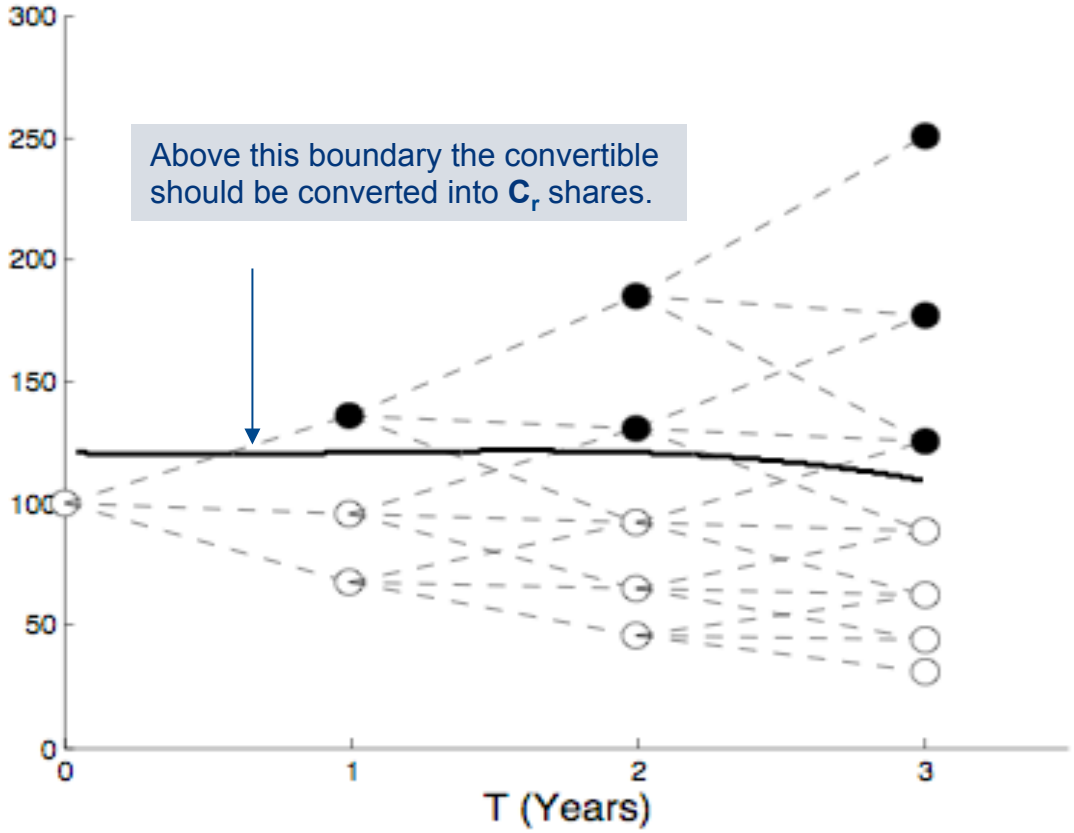
$$P = e^{-rT} \int_0^{\infty} f(S) P(S) dS$$

- **Procedure**

1. Generate N random prices S_i with i=1,...n at maturity T.
2. Calculate for each S_i the corresponding payoff P_i using the appropriate payoff function $P_{\{t=T\}}$. For derivatives where the final payoff $P_{\{t=T\}}$ depends on a set of m share prices observed at intermediate dates t_k with k=1,...m, will need a slightly different approach. In this step the final payoff $P_{\{t=T\}}$ is now calculated based on a payoff function $P_{\{t=T\}}(S_1,...S_m)$ where all the intermediate price observations intervene.
3. Discount each of the P_i at the risk free rate r from T to the valuation date of the option. This gives a discounted payoff $P_{i,0}$.
4. Take the average of these discounted values $P_{i,0}$. to obtain the Monte Carlo estimate.

American Monte Carlo for Convertibles

- Convertibles bonds have an expected life < T
- The moment the convertible is converted, called or put is the stopping time τ
- This forms the exercise boundary b(S,t)
- Can be visualized in a tree model :



$P^* > P^c$
with
$P^* = C_r S$
and
P^c = Continuation Value

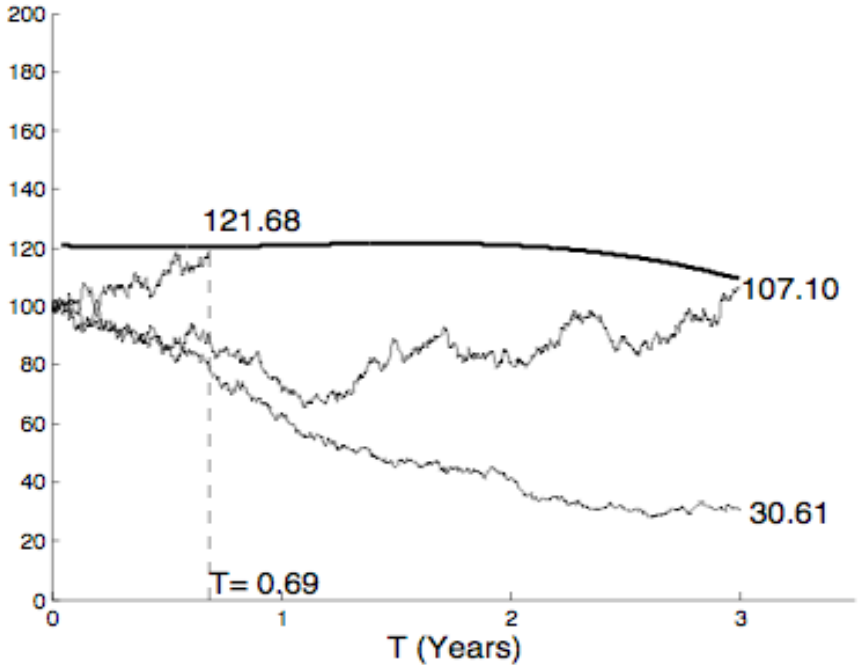
American Monte Carlo for Convertibles

- C_r = 1
- T = 3 yr
- DivYld = 5%
- Interest Rate = 3%
- Volatility (σ) = 20%
- Face Value = 100
- S = 100
- No Call
- No Put

American Monte Carlo for Convertibles

- 3 Random walks are simulated
- Suppose we know the exercise boundary above which the convertible will be converted into shares
  - **Path 1**
    - At t=0.69 year the share price path crosses the boundary where S = 121.68
    - The cash flow at this point is $121.68
    - Present Value = **119.19**
  - **Path 2**
    - No early conversion
    - Final conversion with S=107.10
    - Present Value = **97.88**
  - **Path 3**
    - No early conversion
    - Final conversion value < FV
    - S ends at 30.31.
    - The final cash flow = 100
    - Present Value = **91.39**

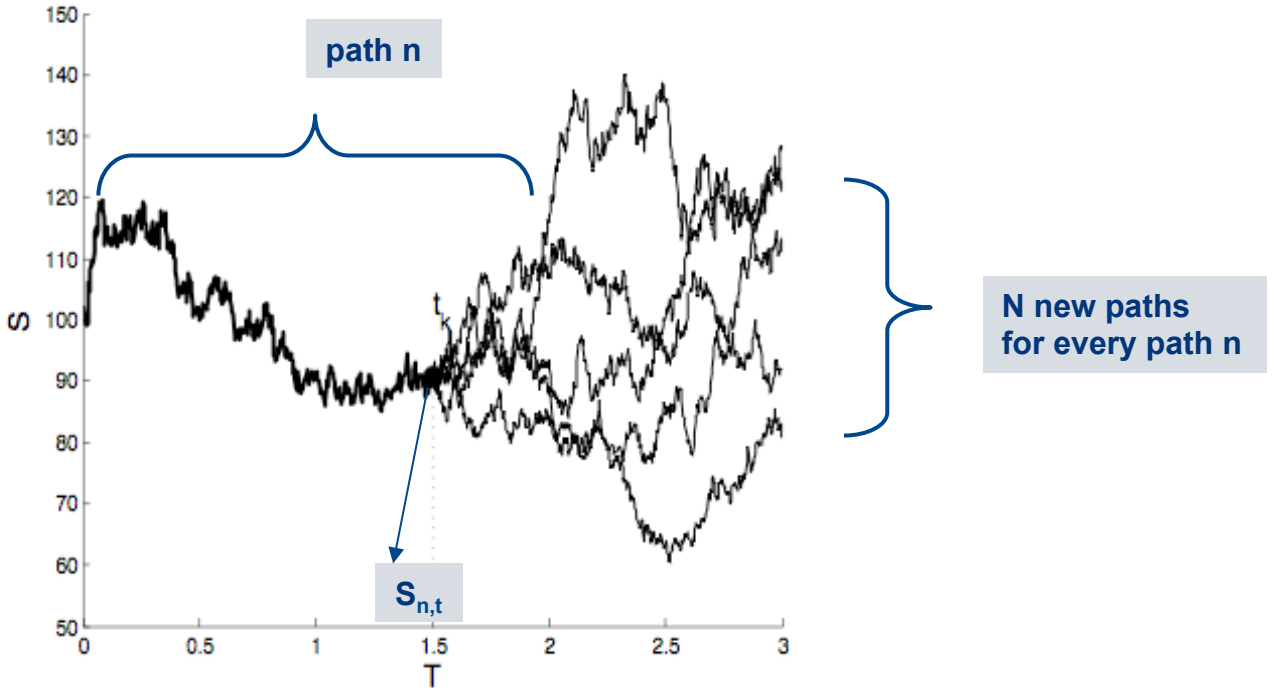
$$P = \frac{1}{3}(119.19 + 97.88 + 91.39) = 102.82$$



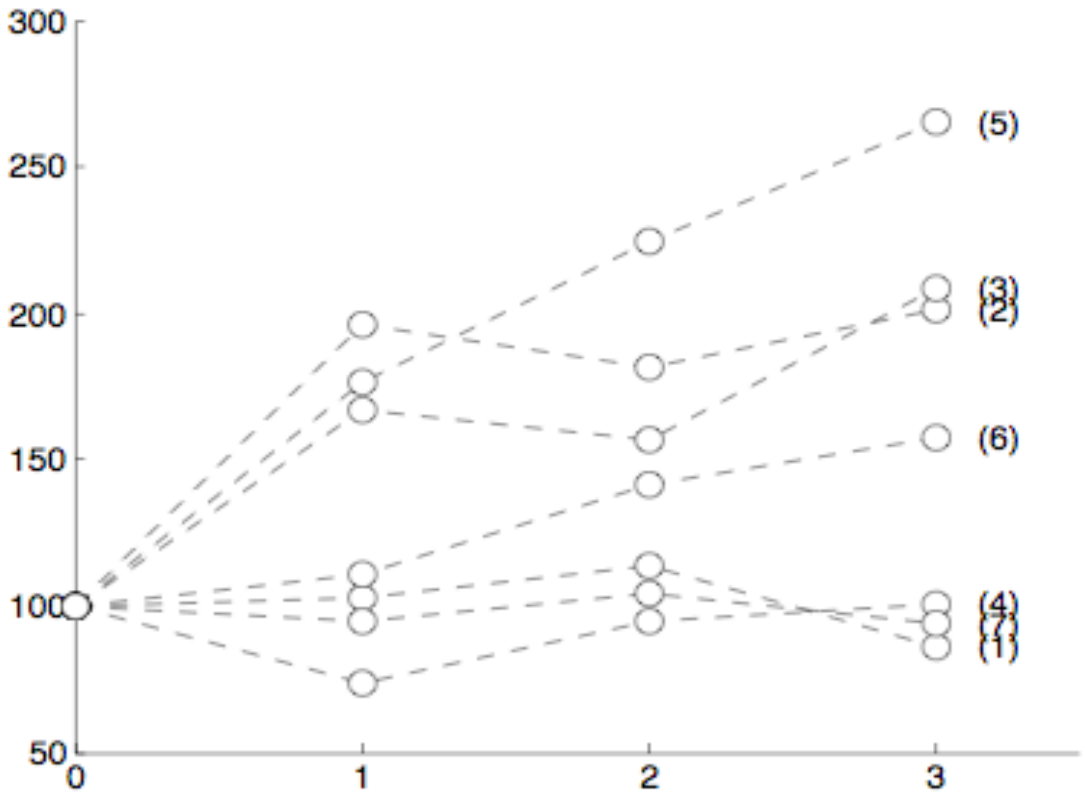
RISK
CONCILE

American Monte Carlo Technique

- We have no knowledge of the exercise boundary
- At each point $S_{n,t}$ of path n where the convertible could be converted we calculate
  - **Exercise value** (P^*) = C_r x S
  - **Continuation Value** (P^c)
    This continuation value is the value of a convertible bond starting at $S_{n,t}$.
- Explosive in calculation time, if we apply Monte Carlo again.



American Monte Carlo Technique



0	1	2	3
100.00	102.89	114.05	86.04
100.00	196.49	181.21	200.98
100.00	167.15	156.66	208.60
100.00	73.36	94.93	100.58
100.00	176.26	224.46	265.28
100.00	111.08	141.68	157.44
100.00	94.88	104.26	94.26

- 7 paths
- 2 intermediate conversion dates t=1 and t=2

RISK
CONCILE

American Monte Carlo Technique

t=3

- Cash flows at the final maturity date determine the value of the convertible at the final date.
- 7 paths :
  - 5 conversions into shares
  - 2 redemptions at par
- These cash flows need to be rolled back to the previous point t=2.

3	
100.00	Redemption
200.98	Conversion
208.60	Conversion
100.58	Conversion
265.28	Conversion
157.44	Conversion
100.00	Redemption

t=2

American Monte Carlo Technique

t=3

CashFlow Matrix

Path	1	2	3
1			100.00
2			200.98
3			208.60
4			100.58
5			265.28
6			157.44
7			100.00

American Monte Carlo Technique

t=2

- In each of the 7 paths we need to check if the convertible should be converted.
- Conversion if
  Exercise Value > Continuation Value
  P*>Pc
- **Step 1**
  Determine continuation values where conversion is not possible
- **Step 2**
  Obtain other continuation values through a regression
- **Step 3**
  Calculate the value of the convertible P in all paths and move on...

Path	S	P^*	P^c	P
1	114.05	114.05		
2	181.21	181.21		
3	156.66	156.66		
4	94.93	94.93		
5	224.46	224.46		
6	141.68	141.68		
7	104.26	104.26		

American Monte Carlo Technique

t=2

- **Step 1**
  - Path 4 corresponds to a share price of 94.93 for t=2.
  - The convertible will not be exercised at this point
  - The value of the convertible (P) in this point is equal to the present value of the convertible along the same path in the previous node at t=3
  - This value
    - P = 94.91 x exp(-0.03)
    - P = 97.61

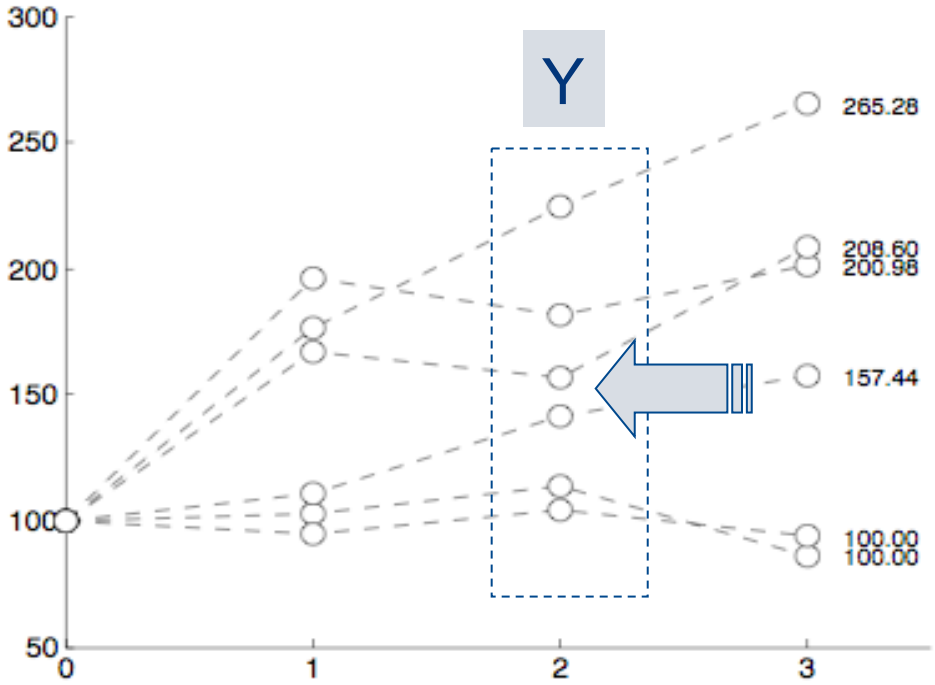
Path	S	P^*	P^c	P
1	114.05	114.05		
2	181.21	181.21		
3	156.66	156.66		
4	94.93	94.93	97.61	97.61
5	224.46	224.46		
6	141.68	141.68		
7	104.26	104.26		

American Monte Carlo Technique

t=2

- **Step 2**
  - In the remaining points t∈{1,2,3,5,6,7}, the continuation value needs to be calculated.
  - A first step is to calculate the present value **Y** of cash flows paid out at t=3 in the nodes t=2.
  - The values of Y are **not** the continuation values

Path	S	Y
1	114.05	97.04
2	181.21	195.04
3	156.66	202.43
5	224.46	257.44
6	141.68	152.79
7	104.26	97.04



RISK
CONCILE

American Monte Carlo Technique

t=2

- **Step 2**
  - Longstaff and Schwartz have proven that the continuation value P^c can be written as :
  - $P^c=a+bS+cS^2+dS^3$ (*)
  - The coefficients a,b,c and d are obtained using a regression against **Y**

Coefficient	Value
a	-474.8802
b	9.0848
c	-0.0436
d	0.0001

  - Using the results of this regression we can calculate the values of the P^c in each of the paths where conversion could be possible. For example in the first path where S=114.05, we find P^c **= 110.66**
  - This calculation is to be done for path 1,2,3,5,6 and 7

Path	S	P*	Pc	P
1	114.05	114.05	**110.66**	
2	181.21	181.21	**207.08**	
3	156.66	156.66	**180.31**	
4	94.93	94.93	97.61	97.61
5	224.46	224.46	**255.87**	
6	141.68	141.68	**160.47**	
7	104.26	104.26	**87.39**	

RISK CONCILE

(*) This is only one of the possible choices of basis functions.

American Monte Carlo Technique

t=2

- **Step 3**
  - Compare P^* and P^c and determine the value of the convertible P in each of the paths at time t=2
  - In t=2, there are two paths where the convertible will be converted into shares
  - This conversion will generate an intermediate cash flow at t=2

Path	S	P*	Pc	P	Action
1	114.05	114.05	110.66	114.05	Convert
2	181.21	181.21	207.08	207.08	
3	156.66	156.66	180.31	180.31	
4	94.93	94.93	97.61	97.61	
5	224.46	224.46	255.87	255.87	
6	141.68	141.68	160.47	160.47	
7	104.26	104.26	87.39	104.26	Convert

American Monte Carlo Technique

t=2

CashFlow Matrix

Path	1	2	3
1		114.05	
2			200.98
3			208.60
4		97.61	
5			265.28
6			157.44
7		104.26	

American Monte Carlo Technique

t=1

- **Step 1**
  - There are in t=1, two points where conversion is suboptimal : path 4 and 7.
  - The continuation value ($\mathbf{P^c}$) in these nodes is equal to the present value of the subsequent cash flows:
    - 94.73 = exp(-0.03) x 97.61
    - 101.18 = exp(-0.03) x 104.26
- **Step 2**
  - Calculate in the nodes 1,2,3,5 and 6 the present value if the subsequent cash flows : **Y**

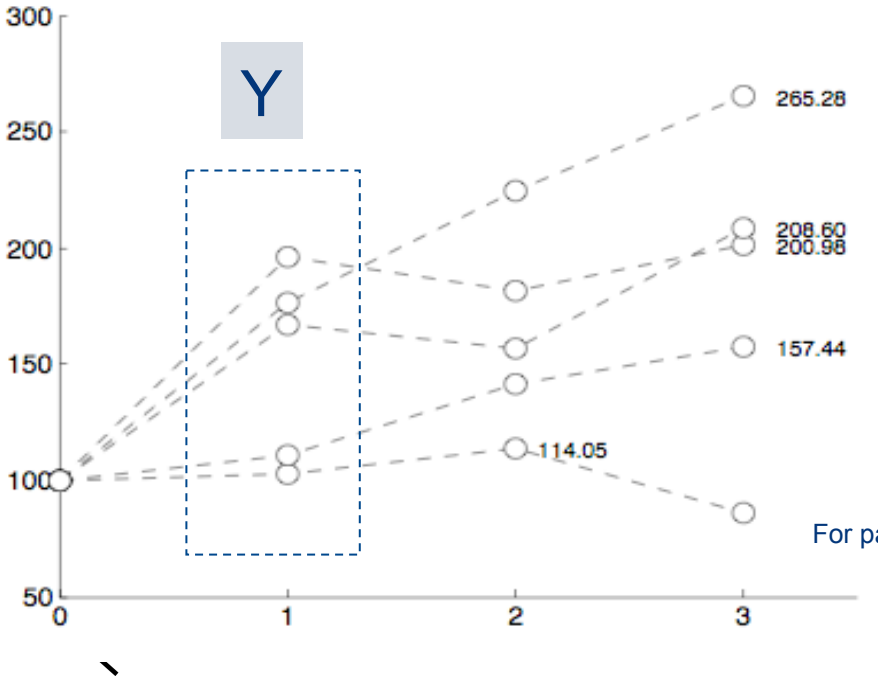
Path	S	P*	Pc	P
1	102.89	102.89		
2	196.49	196.49		
3	167.15	167.15		
4	73.36	73.36	94.73	94.73
5	176.26	176.26		
6	111.08	111.08		
7	94.88	94.88	101.18	101.18

American Monte Carlo Technique

t=1

- **Step 2**
  Calculation of Y

Path	S	Y
1	102.89	110.68
2	196.49	189.26
3	167.15	196.44
5	176.26	249.81
6	111.08	148.26



Y= Present value of the cash flows paid out at maturity

For path 1: Y= Present value of the cash flow paid out at t=2

American Monte Carlo Technique

t=1

- **Step 2**
  - Through a regression of Y vs [1 S S^2 S^3] the continuation value can be calculated:
  - **$P^c=a+bS+cS^2+dS^3$**

Coefficient	Value
a	-54.9230
b	-0.7007
c	0.0375
d	-0.0001

  - Calculate the continuation values using the formula for path 1,2,3,5 and 6

Path	S	P*	Pc	P
1	102.89	102.89	117.71	
2	196.49	196.49	194.61	
3	167.15	167.15	222.78	
4	73.36	73.36	94.73	94.73
5	176.26	176.26	221.03	
6	111.08	111.08	138.33	
7	94.88	94.88	101.18	101.18

American Monte Carlo Technique

t=1

- Step 3
  - Compare P* and Pc and determine the value of the convertible in every node of the paths at time t=1.

Path	S	P*	Pc	P	
1	102.89	102.89	117.71	117.71	
2	196.49	196.49	194.61	196.49	Convert
3	167.15	167.15	222.78	222.78	
4	73.36	73.36	94.73	94.73	
5	176.26	176.26	221.03	221.03	
6	111.08	111.08	138.33	138.33	
7	94.88	94.88	101.18	101.18	

  - There is only one node where the convertible will be converted into shares at t=2

American Monte Carlo Technique

t=1

CashFlow Matrix

Path	1	2	3
1		114.05	
2	196.49		
3			208.60
4	94.73		
5			265.28
6			157.44
7	101.18		

American Monte Carlo Technique

t=0

- This is the **final step**
- The value of the convertible is equal to the expected present value of the converts in t=1
- Price of the convertible = **152.16**

- **More Precision:**
  - Increase nbr of paths
  - Increase nbr of points where the early conversion is checked.