

Università Commerciale Luigi Bocconi

MSc. Finance/CLEFIN 2017/2018 Edition

Advanced Quantitative Methods for Asset Pricing and Structuring

May 2018 Exam for Attending Students

Time Allowed: 60 minutes

Family Name (Surname)	First Name	Student Number (Matr.)

Please answer all questions by choosing the most appropriate alternative(s) and/or by writing your answers in the spaces provided. You need to carefully justify and show your work in the case of "open" questions. There is only one correct answer(s) for each of the multiple choice questions. Correct answers not selected and questions that have been left blank will receive zero points. Only answers explicitly reported in the appropriate box will be considered. No other answers or indications pointing to potential answers will be taken into consideration. In the case of "open" questions, the maximum number of points is indicated.

Question 1. Which of the following statements about CDS calibration is TRUE?

(A) Default frequency and payment frequency are input which can be chosen arbitrarily

 \blacksquare (B) The breakeven spread with premium accrued has to be less than that without premium accrued

□ (C) For deterministic intensity models, the O'Kane Turnbull formula is a good approximation

(D) For deterministic intensity models, the survival probability can become negative

Question 2. Which of the following statements about AT1P structural models is TRUE?

(A) Default is represented by an exogenous process

- (B) The barrier is stochastic
- \blacksquare (C) If the asset volatility increases, the value of the barrier decreases
- (D) The survival probability can oscillate

Question 3. Which of the following statements about counterparty risk is TRUE?

(A) It is affected by the counterparty volatility, the contract volatility and the correlation between them

(B) Counterparty exposure at any future time is given by the market value of the portfolio of derivative positions with that counterparty

(C) DVA depends on the positive part of the market value of the derivative positions with the counterparty

☑ (D) Exposure at default is stochastic

Question 4. Which of the following statements about jump processes is TRUE?

☑ (A) Time inhomogeneous Poisson processes are increasing unit-size jump process, whose increments are independent but no longer identically distributed

(B) Time homogeneous Poisson processes are increasing unit-size jump process, whose increments are independent but no longer identically distributed

C) Time homogeneous Poisson processes accounts for the term structure of credit spreads

(D) Time inhomogeneous Poisson processes accounts for the volatility of credit spreads

Question 5.

Given a term structure of CDS with the following maturities T = 1,3,5,7,10, write the survival probabilities in a piece-wise constant intensity model.

Answer.

See O'Kane Turnbull, pag 14.

Question 6. The matrix below shows the pair-wise correlations between returns on three different stocks. For simplicity, assume the stocks are characterized by the same volatility and that they do not pay any dividends. Which of the proposed combinations of stocks will allow the highest coupon to be paid out by a Reverse Convertible certificate written on a "worst of" basket of **two only of these three stocks** to be used as its underlying basket?

	Univeler	Trotter	Brambo
Univeler	1		
Trotter	0.7	1	
Brambo	0.2	0.5	1

 \blacksquare (A) Brambo and Univeler followed by Brambo and Trotter

- (B) Trotter and Univeler, followed by Brambo and Trotter
- C) Brambo and Unilever, followed by Univeler and Trotter
- (D) Trotter and Brambo

Debriefing

A is the correct answer. Correct answer is A. In case of a Reverse Convertible we sell an ATM put option, therefore, when the "worst of" feature is present the lower the correlation, the more expensive the put option, the higher amount we can spend for the coupon. Indeed, with the "worst of" feature, the lowest the correlation, the highest the probability that at least one of the two underlying will touch the barrier.

Question 7. Markus, a structurer at Dutch Robobank, on every Monday produces a newsletter to show to the sales team a number of alternative Bonus Cap certificates, that could be immediately issued (their selling price will be \in 100). A portion of his latest newsletter, concerning potential Bonus Caps on Fiat, is copied below. In the second column of the table, Markus has reported the Bonus Amount (equal to the Cap Amount). Which of the following statements is the MOST LIKELY?

Barrier / Tenor	1 year
60%, American	117
70%, American	120
60%, European	115
70%, European	112

 \Box (A) Markus has obviously done a mistake: indeed, we would expect the Bonus (Cap) Amount of a certificate with American Barrier to be lower than that of a certificate with European Barrier, all else being equal

(B) Markus has obviously done a mistake: indeed, we would expect the Bonus (Cap) Amount of a certificate with American Barrier to be equal than that of a certificate with European Barrier, all else being equal

 \Box (C) Markus has obviously done a mistake: indeed, we would expect the Bonus (Cap) Amount of a certificate to become higher when we lower the barrier, all else being equal \Box (D) Markus has obviously done a mistake: indeed, we would expect the Bonus (Cap) Amount of a certificate to become lower when we lower the barrier, all else being equal

Debriefing

Correct answer is D (see slide below)

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		PRODUCT SUMMARY	
ld.	0f5b9ab5-03a7-4375-9257- d72d65aec792	ld:	5e7fb7e2-ccc5-4c7b-8b91- a4bd42b25c8a
Pricing Date:	April 19, 2018 - 10:04 AM	Pricing Date:	April 19, 2018 - 10:02 AM
Product Type:	Barrier Reverse Convertible (BRC)	Product Type:	Barrier Reverse Convertible (BRC)
Underlying/s:	INTESA SANPAOLO Compute initial delta and vega	Underlying/s:	INTESA SANPAOLO Compute initial delta and vega
Legal Entity:	Leonteq Securities AG, Zurich	Legal Entity:	Leonteq Securities AG, Zurich
Frequency:	Annually	Frequency:	Annually
Date Convention:	European	Date Convention:	European
Quanto:	No	Quanto:	No
Life Cycle		Life Cycle	
Initial Fixing Date:	19 aprile 2018	Initial Fixing Date:	19 aprile 2018
Issue Date:	30 aprile 2018	Issue Date:	30 aprile 2018
Final Fixing Date:	23 aprile 2019	Final Fixing Date:	23 aprile 2019
Redemption Date:	30 aprile 2019	Redemption Date:	30 aprile 2019
Parameters		Parameters	
Barrier:	80% (American)	Barrier:	70% (American)
Strike Level:	100%	Strike Level:	100%
Indicative Coupon :	6,83% p.a. (6,827% per period)	Indicative Coupon :	3,97% p.a. (3,969% per period)

*Barrier Reverse Convertible is the Swiss version of the Bonus Cap (Bonus Amount = Coupon) An Introduction to Structured Financial Products 11

Question 8. Which of the following statements is the MOST LIKELY?

(A) A Turbo certificate implies a leverage that is function of the level of the underlying, given a fixed strike

(B)The major drawback of a Fixed Leverage Certificate is the "compounding effect"

(C) A Fixed Leverage certificate is characterized by a constant leverage ratio

 \blacksquare (D)All of the above statements are correct

Debriefing

Correct answer is D. A Turbo certificate has a dynamic leverage that is a function of the underlying, given a fixed strike (leverage ratio is given by ratio between the underlying value and the strike). In the case of a Leverage certificate the strike is adjusted every day such that the leverage ratio is constant. A Leverage certificate shows the so called "compounding effect".

Question 9. Kirilo, a senior structurer at PJ Dorman Bank, has been asked to structure an equity protection certificate on the FTSE MIB (with full capital protection and a tenor of 3 years). Unfortunately, as the relevant ZCB costs \in 98 and a 3-year ATM call option on the FTSE MIB is worth \in 6, it is not possible to offer an unlimited one-to-one participation rate to the positive performance of FTSE MIB.

• What is the maximum participation rate that the product can offer, given an initial selling price of \in 100 and why?

• Draw the payoff of an alternative product that offers a 100% participation rate to the positive performance of the FTSE MIB, but up to a certain cap (assume it to be equal to 20%). Discuss how this product can be replicated. Also discuss the sign of the vega *at issuance* of this structure.

Debriefing:



You have only 2 euro to spend and therefore the maximum participation to the appreciation of the underlying that can be offered is 2/6 (33%) because you can buy 1/3 of the ATM call option.

Question 10. The basic intuition and results of a liquidity model based on stochastic holding periods are:

(A) Due to changing market liquidity conditions, desks operate along a "calendar time" that may strongly differ from their operational time and this will affect the profits and losses (P&L) from managing their portfolios; as a result, mixing portfolio return scenarios under random stochastic holding periods creates mixtures of distributions for the portfolio P&L, allowing for time-varying means and variances in predicted performances

□ (B) Due to changing market liquidity conditions, desks operate along an "operational time" that may strongly differ from calendar time and this will affect the profits and losses (P&L) from managing their portfolios; however, as partially applied by regulators, the point of the resulting models can be effectively captured by simply stretching the holding period to calculate market VaR and ES to exceed one day, for instance to ten business days instead of one

 \checkmark (C) Due to changing market liquidity conditions, desks operate along an "operational time" that may strongly differ from calendar time and this will affect the profits and losses (P&L) from managing their portfolios; as a result, mixing portfolio return scenarios under random stochastic holding periods creates mixtures of distributions for the portfolio P&L, allowing for skewness, heavy tails and extreme scenarios in predicted performances

□ (D) Due to changing market liquidity conditions, desks operate along an "operational time" that may strongly differ from calendar time and this will affect the profits and losses (P&L) from managing their portfolios; as a result, through weighted sums of portfolio return scenarios under random stochastic holding periods creates mixtures of distributions for the portfolio P&L, allowing for conditional heteroskedastic effects that however will be of a symmetric type

Question 11. With reference to the Monte Carlo approximation of the Vega of a structure with strike K, time-to-maturity τ , which of the following statements is the MOST LIKELY? (A) The formula to be applied is

$$\nu \equiv \lim_{h \to 0} \frac{O(S_t + h, \sigma_t; K, \tau) - O(S_t - h, \sigma_t; K, \tau)}{2h}$$

where $O(S_t, \sigma_t; K, \tau)$ is the structure price from some stochastic volatility model with initial price S_t . However, the measurement error of the two prices at $\sigma_t + h$ and $\sigma_t - h$ can be large for Monte Carlo simulations and result in an error of O(1/(hN))

(B) The formula to be applied is

$$\nu \equiv \lim_{h \to 0} \frac{O(\sigma_{t} + h, S_{t}; K, \tau) - O(\sigma_{t} - h, S_{t}; K, \tau)}{2h}$$

where $O(S_t, \sigma_t; K, \tau)$ is the structure price from Black Scholes model with constant volatility σ_t and $\sigma_t > h$. However, the measurement error of the two prices at $\sigma_t + h$ and $\sigma_t - h$ can be large for Monte Carlo simulations and result in an error of $O(h/(N^{1/2}))$

 \Box (C) It is impossible to approximate the Vega of a structure using Monte Carlo, because these can be just applied to the calculation of the delta of an option or basket of options

 \blacksquare (D) The formula to be applied is

$$v \equiv \lim_{h \to 0} \frac{O(\sigma_t + h, S_t; K, \tau) - O(\sigma_t - h, S_t; K, \tau)}{2h}$$

where $O(S_t, \sigma_t; K, \tau)$ is the structure price from some stochastic volatility model with initial volatility σ_t and $\sigma_t > h$. However, the measurement error of the two prices at $\sigma_t + h$ and $\sigma_t - h$ can be large for Monte Carlo simulations and result in an error of $O(1/(hN^{1/2}))$

Question 12. In an expected power utility portfolio maximization problem (with coefficient of relative risk aversion $\gamma > 1$) in which the asset menu includes a risky asset, cash, and a derivative structure with generic payoff that depends on both the variance and the price of the underlying asset, which of the following statements is the MOST LIKELY?

 \checkmark (A) The optimal demand of the derivative is non-zero if and only markets are incomplete, which means that the structure will be traded as a way to hedge volatility risk, and empirically turns out to depend on the sign and the size of the volatility risk premium; however, because any derivative with payoff that has non-zero Vega may complete the markets, its ex- ante economic value does not specifically depend on its payoff function

□ (B) The optimal demand of the derivative is non-zero if and only markets are complete, which means that the structure will be traded as a way to statically diversify risk, and empirically turns out to depend on the sign and the size of the equity risk premium; however, because any derivative with payoff that has non-zero Vega may complete the markets, its ex-ante economic value does not specifically depend on its payoff function

(C) The optimal demand of the derivative has one static and one dynamic, hedging component; while the former is always non-zero, the latter is non-zero if and only markets are incomplete, which means that the structure is traded as a way to hedge volatility risk

(D) The optimal demand of the derivative is non-zero if and only markets are

incomplete, which means that the structure is traded as a way to hedge volatility risk, and empirically turns out to depend on the sign and the size of the volatility risk premium; as we would expect, the ex-ante economic value of the derivative will depend on its payoff function