



## Course and Examination Fact Sheet: Autumn Semester 2015

### 10,388: Advanced topics in pricing and hedging of equity derivatives

ECTS credits: 4

#### Overview examination/s

(binding regulations see below)

Decentral - Doctoral examination with individual examination time (70%)

Decentral - Group examination paper (all given the same grades) (30%)

#### Attached courses

Timetable -- Language -- Lecturer

[10,388,1.00 Advanced topics in pricing and hedging of equity derivatives](#) -- English -- [Fengler Matthias](#)

#### Course information

##### Course prerequisites

Fundamental knowledge in stochastic calculus, good knowledge of the Black Scholes Model, and financial statistics and econometrics.

##### Course content

The class will approach the problem of pricing and hedging of equity derivatives from the phenomenological perspective of the Black-Scholes implied volatility surface (IVS). In the first part, I will first review the recent theoretical developments on IVS asymptotics both in strike and expiry dimension and discuss no-arbitrage relationships. This will be followed by a variety of modeling techniques of the IVS ranging from parametric approximate and constructive methods, to non and semiparametric techniques (smoothing splines, semiparametric factor models). In the second part, I will cover the theory of local volatility and derive the Dupire formula. The class concludes with stochastic volatility models and the homogeneity issue of option pricing.

##### Course structure

1. Introduction: the BS model
2. The implied volatility surface: asymptotics
3. The implied volatility surface: no-arbitrage constraints
4. Parametric models for the implied volatility surface
5. Interpolation & smoothing techniques for call prices
6. Introduction to smoothing splines and nonparametric regression
7. Smoothing splines under no arbitrage principles
8. Local Volatility and Dupire formula
9. Homogeneity: hedging under the smile
10. Stochastic volatility

##### Course literature

###### Books:

Björk (2004), Arbitrage Theory in Continuous Time, Oxford University Press

(Excellent treatment of general no-arbitrage theory)

Lipton (2001), Mathematical Methods For Foreign Exchange: A Financial Engineer's Approach

(Good, but somewhat outdated treatment on PDE approaches of LV and SV models)

Fengler (2005), Semiparametric Modeling of Implied Volatility, Springer-Verlag

Ekstrand (2011), Financial Derivatives Modeling, Springer-Verlag

Gatheral (2006), The volatility surface, Wiley Finance



(Specific IV views on the modeling problem)

## **Specific readings for topics:**

### 2. The implied volatility surface: asymptotics

Fengler (2011), Option data and modeling BSM implied volatility, Handbook of Computational Finance

Lee, R. W. (2004). The moment formula for implied volatility at extreme strikes, Mathematical Finance 14(3): 469–480

Tehranchi, M. (2009). Asymptotics of implied volatility far from maturity, Journal of Applied Probability 46(3): 629–650.

Tehranchi, M. (2010). Implied volatility: long maturity behavior, in R. Cont (ed.), Encyclopedia of Quantitative Finance, John Wiley & Sons. Forthcoming.

### 3. The implied volatility surface: no-arbitrage constraints

Carr, P. and Madan, D. B. (2005). A note on sufficient conditions for no arbitrage, Finance Research Letters 2: 125–130.

Kahalé, N. (2004). An arbitrage-free interpolation of volatilities, RISK 17(5): 102–106.

Fengler, M. R. (2009). Arbitrage-free smoothing of the implied volatility surface, Quantitative Finance 9(4): 417–428

### 5. Interpolation techniques for call prices

Kahalé, N. (2004). An arbitrage-free interpolation of volatilities, RISK 17(5): 102–106.

### 6. Introduction to smoothing splines and nonparametric regression

Green & Silverman (1994), Nonparametric regression and generalized linear models, Chapter 1-2

Härdel, Müller, Sperlich, Werwartz (2004) Nonparametric and Semiparametric Models, Springer-Verlag

### 7. Smoothing under no arbitrage principles

Ait-Sahalia, Y. and Duarte, J. (2003). Nonparametric option pricing under shape restrictions, Journal of Econometrics 116: 9–47.

Ait-Sahalia, Y. and Lo, A. (1998). Nonparametric estimation of state-price densities implicit in financial asset prices, Journal of Finance 53: 499–548.

Fengler, M. R. (2009). Arbitrage-free smoothing of the implied volatility surface, Quantitative Finance 9(4): 417–428

### 8. Local Volatility and Dupire formula

Ayache, E., Henrotte, P., Nassar, S. and Wang, X. (2004). Can anyone solve the smile problem?, Wilmott magazine (Jan.): 78–96.

Andersen, L. B. G. and Brotherton-Ratcliffe, R. (1997). The equity option volatility smile: An implicit finite-difference approach, Journal of Computational Finance 1(2): 5–37.

Britten-Jones, M. and Neuberger, A. J. (2000). Option prices, implied price processes, and stochastic volatility, Journal of Finance 55(2): 839–866.

Derman, E. and Kani, I. (1994a). Riding on a smile, RISK 7(2): 32–39.

Dumas, B., Fleming, J. and Whaley, R. E. (1998). Implied volatility functions: Empirical tests, Journal of Finance 80(6): 2059–2106.

Dupire, B. (1994). Pricing with a smile, RISK 7(1): 18–20.

### 9. Homogeneity: hedging under the smile

Alexander, C. and Nogueira, L. M. (2007). Model-free hedge ratios and scale-invariant models, Journal of Banking and Finance 31(6): 1839–1861.

Bates, D. S. (2005). Hedging the smirk, Finance Research Letters 2(4): 195–200.

### 10. Stochastic volatility

Heston, S. (1993). A closed-form solution for options with stochastic volatility with applications to bond and currency options, Review of Financial Studies 6: 327–343.

Hagan, P., Kumar, D., Lesniewski, A. and Woodward, D. (2002). Managing smile risk, Wilmott magazine 1: 84–108.

## Additional course information

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## Examination information

### Examination sub part/s

#### 1. Examination sub part (1/2)

##### Examination time and form

Decentral - Doctoral examination with individual examination time (70%)

##### Remark

Exam is 20 minutes

##### Examination-aid rule



## Extended Closed Book

The use of aids is limited; any additional aids permitted are **exhaustively** listed under "Supplementary aids". Basically, the following is applicable:

- At such examinations, all the pocket calculators of the Texas Instruments **TI-30** series and bilingual dictionaries without hand-written notes are admissible. Any other pocket calculator models and any electronic dictionaries are inadmissible.
- In addition, any type of communication, as well as any electronic devices that can be programmed and are capable of communication such as notebooks, tablets, PDAs, mobile telephones and others, are inadmissible.
- Students are themselves responsible for the procurement of examination aids.

## Supplementary aids

I may provide copies of the lecture notes.

## Examination languages

Question language: English

Answer language: English

## 2. Examination sub part (2/2)

### Examination time and form

Decentral - Group examination paper (all given the same grades) (30%)

### Remark

Homeworks to be solved in groups with 2-3 students

### Examination-aid rule

Term papers

- Term papers must be written without anyone else's help and in accordance with the known quotation standards, and they must contain a declaration of authorship.
- The documentation of sources (quotations, bibliography) has to be done throughout and consistently in accordance with the APA or MLA standards. The indications of the sources of information taken over verbatim or in paraphrase (quotations) must be integrated into the text in accordance with the precepts of the applicable quotation standard, while informative and bibliographical notes must be added as footnotes (recommendations and standards can be found, for example, in METZGER, C. (2013), *Lern- und Arbeitsstrategien* (11th ed., 3rd printing). Aarau: Sauerländer).
- For any work written at the HSG, the indication of the page numbers both according to the MLA and the APA standard is never optional.
- Where there are no page numbers in sources, precise references must be provided in a different way: titles of chapters or sections, section numbers, acts, scenes, verses, etc.
- For papers in law, the legal standard is recommended (by way of example, cf. FORSTMOSER, P., OGOREK R. et SCHINDLER B. (2014, *Juristisches Arbeiten: Eine Anleitung für Studierende* (5. Auflage), Zürich: Schulthess, or the recommendations of the Law School).

## Supplementary aids

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## Examination languages

Question language: English

Answer language: English

## Examination content

1. Introduction: the BS model
2. The implied volatility surface: asymptotics
3. The implied volatility surface: no-arbitrage constraints
4. Parametric models for the implied volatility surface
5. Interpolation & smoothing techniques for call prices
6. Introduction to smoothing splines and nonparametric regression
7. Smoothing splines under no arbitrage principles



8. Local Volatility and Dupire formula
9. Homogeneity: hedging under the smile
10. Stochastic volatility

## Examination relevant literature

Lecture notes and "course literature"

### Please note

We would like to point out to you that this fact sheet has absolute priority over other information such as StudyNet, faculty members' personal databases, information provided in lectures, etc.

When will the fact sheets become binding?

- Information about courses and examination time (central/decentral and grading form): from the start of the bidding process on 20 August 2015
- Information about decentral examinations (examination-aid rule, examination content, examination relevant literature): after the 4th semester week on 12 October 2015
- Information about central examinations (examination-aid rule, examination content, examination relevant literature): from the start of the enrolment period for the examinations on 02 November 2015

Please look at the fact sheet once more after these deadlines have expired.