

# O1 Course Package

## Advanced Topics

### O1/A3 Syllabus IP1 - Unibo

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## Change History

Version	Date	Author(s)	Changes
0.1	December 30, 2014	Rossella Agliardi	Preliminary version for the first IP1 announcement
0.2	March 31, 2015	Rossella Agliardi, Umberto Cherubini	Draft version including prerequisites, required readings, course content and an outline of the case-study.
0.3	April 30, 2015	Rossella Agliardi, Umberto Cherubini	Structure updated to incorporate the partners' feedbacks; a timetable is added showing how IP1 is organized.
0.4	May 27, 2015	Rossella Agliardi, Umberto	Final draft

## Disclaimer

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## 1. Course information

“Advanced Topics in Quantitative Methods in Finance” is designed as a pilot intensive programme that is offered in two weeks (5-18 July 2015) within the International Project **INTQUANT** (Creating an International Semester for Master Programmes in Quantitative Finance), Funding Scheme: Erasmus+ Strategic Partnerships (Key Action 2), involving four partner universities (University of Applied Sciences bfi Vienna, University of Bologna, University of Economics in Katowice and University of Iasi).

This specialized course will be organized in cooperation with Unipol Financial Group S.p.a. and will be taught as a combination of lectures and tutorials offered by the local teachers, seminars on some frontier issues by some local academics and distinguished guest experts, additional reading materials, class discussions, and a significant portion of work in teams on an assigned case study that is chosen in cooperation with the local industry partner.

A successful accomplishment of the course is worthy 6 ECTS that can be acknowledged within the Master programme of each partner University.

The IP venue is the main building of the (former) Faculty of Economics, piazza Scaravilli, 2, Bologna. Most lectures will be held in room 5. Some laboratories will be made available for the activities within the working teams.

## 2. Learning outcomes

### 2.1 General learning outcomes

At the end of this course, students are able to:

- Demonstrate an in-depth understanding of some quantitative models and methods in finance and apply academic knowledge in a practical finance and risk management context;
- Summarise case findings in a team report, present and defend them in a clear and effective way;
- Assess critically both theirs' and other teams' case reports during the presentation and solutions phase;
- Work in an individual and/or international team environment and develop the ability to formulate and defend your point of view in a constructive manner;
- Use intercultural creativity to achieve an agreed outcome;
- Understand how culture affects the work in international teams;
- Select appropriate communication tools for international teams.

### 2.2 Specific learning outcomes

At the end of this course, students are able to:

- Understand some advanced methods for modeling the term structure of interest rates;
- analyse the most relevant changes triggered by the financial crisis and the effect on derivative pricing and adjustments for credit/liquidity risk;
- become aware of some new phenomena and methodologies;
- build a stress test scenario for the risk analysis of asset and liabilities of financial institutions and insurance companies, by working on a specific case-study.

### 3. Prerequisites and co-requisites

Participating students will have to prepare themselves prior to attending the two-week onsite phase of the course. Students should have a notion of the basic definitions of interest rates (short rate and forward rate dynamics, market examples), coupon bonds, yield, yield-to-maturity, term structure, swaps, caps and floors.

A good knowledge of some general concepts in finance, such as arbitrage pricing and martingale methods, is needed as well.

### 4. Recommended or required readings

The following textbooks are recommended for the offsite preparation before the attendance phase. For an introduction (or review) on interest rate models the following text is recommended:

D. Filipovic, Term-structure models: a graduate course, Springer Verlag , 2009 [also available online]

The written exam to assess the offsite individual preparation is mainly based on the textbook above.

A more advanced book emphasizing the calibration issues that can be useful for the research work is:

D. Brigo and F. Mercurio, Interest rate models—theory and practice, Springer Verlag, Berlin, 2001 or 2006 (2nd edition)

A rigorous presentation of martingale methods in finance can be found in:

M. Musiela and M. Rutkowski, Martingale methods in financial modelling, Springer Verlag, 2005

Further readings (scientific articles, professional reports, working papers) will be handed out during the onsite phase.

## 5. Course contents

The aim of this IP is to study and implement some advanced methods for modeling the term structure of interest rates, with their impact for stress testing in financial and insurance institutions in view.

The credit crunch crisis started in the second half of 2007 has triggered, among many consequences, some regime changes in the interest rate markets, such as the explosion of the basis spreads between interest rate instruments (e.g. swaps) characterized by different underlying rate tenors (e.g. 6-months vs 3 months), and the divergence between deposit and Eonia based rates, or between FRA contracts and the corresponding forward rates implied by consecutive deposits.

These frictions have induced a richer micro-term structure and a sort of segmentation of the interest rate market into sub-areas, characterized by different internal dynamics, liquidity and credit risk premia, thus demanding a general rethinking about the methodology used to price and hedge interest rate derivatives, namely those financial instruments whose price depends on the present value of future interest rate-linked cash-flows.

The recent developments of the crisis have furthermore raised a new challenge of interest rates that are bound to remain close to the zero level for a very long time. This scenario, that is also called “Japanese scenario” in the current market jargon, represents one of the main new problems faced by the regulators of both finance and insurance markets.

The course aims at providing (or reviewing) the definitions and quotation mechanism of the main interest rates in the market and of interest rate derivatives. Students will learn how to construct zero and forward curves, how to work with some short rate interest models. One main focus will be the analysis of the most relevant changes

triggered by the financial crisis and the effect on derivative pricing and adjustments for credit/liquidity risk. Collateralized contracts will be touched upon.

Possibly, some new topics such as the double-curve framework for basic interest rate sensitive asset pricing will be tackled upon as well. The tools will then be used to build a stress test scenario for the risk analysis of asset and liabilities of financial institutions and insurance companies.

In particular, a significant portion of the IP will be devoted to team-work on an assigned case study that is chosen in cooperation with the local industry partner (Unipol). The task of the team-work will be to build up a synthetic portfolio, the larger part consisting of bonds (about 80%), both fixed-income and variable-income bonds, mainly government bonds, stocks and some interest rate derivatives (swaps and caps). Students are expected to compute the MtoM-value of this portfolio, by using the assigned market data. Preliminary computation includes: Yields and forward-rates curves and calibration of the stochastic model introduced in the onsite classes.

## 6. Learning activities and teaching methods

### 6.1. Onsite phase

The course will start with an introduction to the required theoretical background on the financial problem and the quantitative methodologies needed to work out the case-study.

This introduction will be given by the local academic lecturer(s) in the form of lectures and tutorials.

An overview of the following topics will be presented:

- Definitions and quotation mechanism of the main interest rates in the market
- Short rate interest models (in particular, Vasicek model)
- Interest rate derivatives

- VaR and expected shortfall
- Stress testing (definition and methodologies)

The specific content of the preliminary part will be adjusted depending on the assessment of the participants' individual offsite preparation.

As a preliminary tool, an introduction to Matlab programming will be offered as well.

Then, an introduction to a business case will be given, supplied by the representative of the local industry partner (Unipol Financial Group). Additional coaching will also be provided by the local industry representative together with the lecturers. Students will be given the opportunity to collect background information on the company and also ask specific questions about the case.

The onsite phase will also include

- A lab class on the calibration of a named model to Caps and Floors prices and to Swaptions;
- Some specialized seminars on some hot topics in finance, among which:
  - an analysis of the most relevant changes triggered by the financial crisis and the effect on derivative pricing and adjustments for credit/liquidity risk;
  - the role of stress testing design as a quantitative risk management tool and regulatory issues;
  - new frameworks for basic interest rate sensitive asset pricing: pricing and hedging interest rate derivatives decoupling forwarding and discounting yield curves.

A significant part of the onsite presence will consist in team working. Five international teams, each consisting of four students from different countries, will work on an assigned problem related to the case-study under consideration. Each team will have to provide their own set of solutions in a case report. They will present their report as a preliminary version on Friday of the second week of the IP.

## 6.2 Follow-up

Students will submit the case report two weeks after the onsite course completion. The report will be evaluated at the host university and the grade will be communicated by e-mail to each member of the team.

## 7. Assessment methods and criteria

Students are assessed based on the quality of their group work, their clarity of speech and ideas and quality of argument.

The assessment methods is based on the evaluation of a **written test** for the offsite individual preparation (based on pre-assigned required readings), a **case study report** and **its presentation**, a **written case study report** to be delivered two weeks after the termination of the onsite phase.

The following weights are attributed to each (onsite) assessment phase:

25% to the written test;

50% team report on the case study;

25% presentation of the case study.

The grade attributed to the team report can be modified (up to 50%) depending on the quality of the written report.

Additional information on the assessment method will be discussed during the first onsite lecture.

In order to pass this IP course, a student must achieve a score of at least 50%.

## 8. ECTS credits and workload

Two models of course organization and ECTS distribution have been agreed among the partners. This IP follows **Model 2**, that is, 2 ECTS credits are allocated for the first phase of pre-reading/offsite preparation, 3 ECTS credits for the second phase of presence and onsite preparation, and 1 ECTS credit for the follow-up phase scheduled two weeks after the course completion onsite.

## 9. Plan of activities

Week	Date	Room	Topics	Assignment	References
1	6/7/2015 9-12 15-18	Aula 5	Registration. General information. Assessment of offsite preparation. Introduction to Matlab	Exam on individual offsite preparation. Lecture (compulsory attendance)	D. Filipovic, Term-structure models: a graduate course, Springer Verlag, 2009
1	7/7/15 10-13 15-18	Aula 5 Laboratorio informatico	Overview of the basic financial tools Financial modeling using Matlab	Lecture and lab class (compulsory attendance)	J.C. Hull, Risk management and financial institutions, 2012 (Ch. 9). Additional literature will be handed out.
1	8/7/15 9-13	Aula 5 and Laboratorio Informatico	Vasicek short-rate model	Lecture and lab class (compulsory attendance)	D. Brigo and F. Mercurio, Interest rate models— theory and practice, Springer Verlag, 2001 (§3.2.1) M. Musiela and M. Rutkowski, Martingale methods in financial modelling, Springer Verlag.
1	8/7/15 14-16	Aula 5	Stress-testing techniques	Lecture (compulsory attendance)	U. Cherubini, G. Della Lunga, Stress-testing techniques and VaR measures: a unified approach. Rivista di Matematica per le Scienze Economiche e sociali (1999), 22, 77-99
1	8/7/2015 16-19	Aula 5	Presentation of the case study by Unipol's representative	Participation to the presentation of the case study and discussion	To be provided by Unipol
1	9/7/15	Aula 5	Teams are formed. Preliminary work on the case study.	Discussion.	
1	10/7/15	Aula 5 and Laboratorio Informatico	Case-study	Discussion and contact with the instructors.	
2	13/7/15	Aula 5	Case-study	Team work	
2	14/1/00	Laboratorio Ranzani	Case-study	Team work. Discussion and contact with the instructors.	
2	15/7/15	Laboratorio Ranzani	Case-study	Team work.	
2	16/7/15	Laboratorio Ranzani	Case-study	Team work	
2	17/7/15	Aula 5	Case-study	Presentation of the team work by the individual teams.	