

ST909-15 Applications of Stochastic Calculus in Finance

26/27

Department

Statistics

Level

Taught Postgraduate Level

Module leader

Jonathan Warren

Credit value

15

Module duration

9 weeks

Assessment

Multiple

Study location

University of Warwick main campus, Coventry

Description

Introductory description

This module is available for students on a course where it is a listed option and as an Unusual Option to students who have completed the prerequisite modules.

Pre-requisites

- ST401 Stochastic Methods in Finance; OR ST908 Stochastic Calculus for Finance (MSMF students)

[Module web page](#)

Module aims

To give a thorough understanding of how stochastic calculus is used in continuous time finance.
To develop an in-depth understanding of models used for various asset classes.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Option Pricing and Hedging in Continuous Time

- Pricing Europeans via equivalent martingale measures, numeraire, fundamental valuation formula, arbitrage and admissible strategies
- Pricing Europeans via PDEs (brief review)
- Completeness for the Black Scholes economy
- Implied volatility, market implied distributions, Dupire
- Stochastic volatility and incomplete markets
- Pricing a vanilla swaption, Black's formula for a PVBP-digital swaption
- Multicurrency Economy
- Black-Scholes economy with dividends
- Economy with possibility of default CVA, DVA of a vanilla swap

Applications across Asset classes

Interest Rates: Term Structure Models

- Short rate models. Introduction to main examples, implementation of Hull-White
- Market Models (Brace, Gatarek and Musiela approach), specification in terminal and spot measure
- Pricing callable interest rate derivatives with market models, drift approximation and separability, implementation via Longstaff-Schartz
- Greeks via Monte Carlo for market models, pathwise method, likelihood ratio method.
- Markov-functional models
- Practical issues in choice of model for various exotics, Bermudan swaptions
- Calibration: global versus local
- Stochastic volatility models, SABR

Credit

- Description of main credit derivative products: CDS, First-to-default swaps, CDOs
- Extension of integration by parts, Ito's formula, Doleans exponential to cover jumps
- Martingale characterization of single jump processes, Girsanov's Theorem
- State variable, default and enlarged filtrations
- Filtration switching formula
- Intensity-correlation versus default-events correlation
- Conditional Jump Diffusion approach to modelling of default correlation

FX

- Stochastic local volatility models, calibration,
- Gyongy's Theorem
- Barrier options

Time permitting:

- Equity

- Dividends
- Volatility as an asset class, variance swaps, volatility derivatives
- Heston model

Learning outcomes

By the end of the module, students should be able to:

- Demonstrate understanding of the conceptual framework for the pricing and hedging of derivatives using EMMs and be able to apply it in a range of models of financial markets.
- Demonstrate in-depth knowledge of some models, including for interest rate term structures, credit risk and stochastic volatility.
- Be able to use techniques and concepts from stochastic analysis, such as the Markov property, Ito's formula and changes of measure to study models of financial markets.
- Show some awareness of how models are used in practice: their interpretation and implementation.
- Be able to communicate mathematical results about financial models clearly and precisely.

Indicative reading list

[Reading lists can be found in Talis](#)

Subject specific skills

Demonstrate understanding of the conceptual framework for the pricing and hedging of derivatives using EMMs and be able to apply it in a range of models of financial markets.

Demonstrate in-depth knowledge of some models, including for interest rate term structures, credit risk and stochastic volatility.

Be able to use techniques and concepts from stochastic analysis, such as the Markov property, Ito's formula and changes of measure to study models of financial markets.

Show some awareness of how models are used in practice: their interpretation and implementation.

Be able to communicate mathematical results about financial models clearly and precisely.

Transferable skills

TBC

Study

Study time

Type	Required
Lectures	27 sessions of 1 hour (18%)
Tutorials	9 sessions of 1 hour (6%)
Private study	109 hours (73%)
Assessment	5 hours (3%)
Total	150 hours

Private study description

Weekly revision of lecture notes and materials, wider reading, practice exercises and preparing for examination.

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Students can register for this module without taking any assessment.

Assessment group D6

	Weighting	Study time	Eligible for self-certification
Class Test 1	7%		No
A class test taken during the term covering a range of material from the module.			
Class Test 2	8%		No
A class test taken during the term covering a range of material from the module.			
Seminar problem discussion	5%	5 hours	No
Students discuss and present solutions to problems in class.			
Centrally-timetabled examination (On-campus)	80%		No
The examination paper will contain four questions, of which the best marks of THREE questions will be used to calculate your grade.			

- Answerbook Pink (12 page)

Assessment group R4

	Weighting	Study time	Eligible for self-certification
Locally Timetabled Examination - Resit	100%		No

Feedback on assessment

Feedback on class tests will be returned after 4 weeks, following each test.

Solutions and cohort level feedback will be returned for the examinations.

Examination scripts are retained for the external examiners and will not be returned to you.

[Past exam papers for ST909](#)

Availability

Courses

This module is Core for:

- Year 1 of TIBS-N3G1 Postgraduate Taught Financial Mathematics

This module is Optional for:

- Year 1 of TSTA-G4P1 Postgraduate Taught Statistics
- Year 4 of USTA-G300 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics

This module is Option list A for:

- Year 1 of TSTA-G4P1 Postgraduate Taught Statistics
- Year 5 of USTA-G301 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics (with Intercalated
- Year 4 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
- Year 5 of USTA-G1G4 Undergraduate Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)

This module is Option list B for:

- TSTA-G4P1 Postgraduate Taught Statistics
 - Year 1 of G40B Statistics with Data Science (Taught)
 - Year 1 of G40A Statistics with Probability (Taught)
- Year 5 of USTA-G301 Undergraduate Master of Mathematics, Operational Research, Statistics and Economics (with Intercalated

This module is Option list D for:

- Year 5 of USTA-G301 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics (with Intercalated

This module is Option list E for:

- Year 5 of USTA-G301 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics (with Intercalated

This module is Option list F for:

- Year 4 of USTA-G300 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics