ACST 305 / 858

Quantitative Methods for Asset-Liability Management

Semester 2, 2009

Department of Actuarial Studies
ACST 305 / 858 Quantitative Methods for Asset-Liability Management

SECOND SEMESTER 2009

Unit convenor: Jiwook Jang
Prerequisites: ACST200(P) or ACST201(P); STAT272(P). Please consult the Unit Convenor if you do not meet any of the prerequisite requirements for the unit.

Students in this unit should read this unit outline carefully at the start of semester. It contains important information about the unit. If anything in it is unclear, please consult the unit convenor.

ABOUT THIS UNIT

Insurance companies or superannuation funds receive money from their policyholders and fund members which is invested in order to meet the future liabilities. Often, the accumulated sum is substantial and hence a well-coordinated investment strategy needs to be in place. This requires a strong understanding of the financial markets and the behaviour of the participants; knowledge of the different financial instruments available and how they are priced and being familiar with the various financial models that are used in practice.

The first two weeks of the course will cover random walk, Brownian motion, martingale, stochastic calculus and Ito’s lemma. These are essential to know to learn derivatives pricing starting week 3. We introduce the concept of forward, futures and options and their pricing. The binomial lattice model is first used as a method of valuing the European option in discrete time steps, where arbitrage-free pricing framework is explained via replicating portfolio and risk-neutral probability measure. Next, we introduce the Black-Scholes option pricing model, which values the European option in continuous time. The Greeks are introduced and dynamic hedging techniques will also be shown. American and exotic option pricing are covered in Week 5.

With the introduction of the relations among short rate, forward rate and default-free zero coupon bond price in Week 6, we cover the term structure of interest rates and examine various models that are used in practice in this area. Considering the defaultability of the companies, we also study credit risk models based on firm-value and intensity-based approach respectively.

The remaining weeks of the course will cover financial market theory and portfolio management. We introduce the various theories and models that attempt to explain the behaviour of investors in the market and how this affects the pricing of assets in the market as a whole. Various measurements of financial risk are introduced and we relate this to the mean-variance portfolio theory, where the fund manager makes a decision on which assets to include into his/her investment portfolio based on expected returns and risk.

TEACHING STAFF

The staff involved in the teaching of this unit are
Yu-Fan (Jack) Ng is a teaching administrator for this unit, who is responsible for all the administrative aspects of the unit. Administrative questions that are not covered in this unit outline should be directed to him on the Private Mail facility of the website. If the questions are of interest to everyone in the unit, the question and the reply will be posted to the Discussion Board, so you should specifically request if you want your message to remain private.

Questions about unit content should be sent to the Discussion Board of the website or raised during tutorials or lectures.

**CLASSES**

This unit will consist of 4 hours of lectures and 1 hour tutorial per week. Lectures are held at the following times:

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuesday</td>
<td>1.00 pm – 3:00 pm</td>
<td>C5CT1</td>
</tr>
<tr>
<td>Thursday</td>
<td>2:00 pm – 4:00 pm</td>
<td>C5CT1</td>
</tr>
</tbody>
</table>

One tutorial is held on every Thursday:

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thursday</td>
<td>4.00 pm – 5:00 pm</td>
<td>C5CT1</td>
</tr>
</tbody>
</table>

There is no tutorial held during Week 1 and 2.

Any alterations to the class times or locations will be advised in lectures and via the website.

**CONSULTATION HOURS**

There will be no consultation hours as questions about unit content should be initially posted on the Discussion Board of the website.

If face-to-face consultations for academic queries are required, students should contact the unit convenor via the Macquarie University e-mail system to make an appointment.

**REQUIRED AND RECOMMENDED TEXTS AND/OR MATERIALS**

The recommended textbooks for this course are:

<table>
<thead>
<tr>
<th>Title</th>
<th>Author</th>
<th>Chapters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Options, Futures and Other Derivatives (6th edition)</td>
<td>John Hull</td>
<td>Chapters 1, 2, 8, 9, 10, 11, 12, 13, 14, 17, 28, 29</td>
</tr>
<tr>
<td>An Introduction to the Mathematics of Financial Derivatives (2nd edition)</td>
<td>Salih N. Neftci</td>
<td>Chapters 2, 4, 6, 7, 9, 10, 11, 13, 14, 15, 17, 18, 19, 20, 21, 22</td>
</tr>
<tr>
<td>Interest Rate Models: An Introduction</td>
<td>Andrew J. G. Cairns</td>
<td>Chapter 11</td>
</tr>
</tbody>
</table>

The textbook by Hull includes many worked examples and exercises. You may wish to buy a copy of the Solutions Manual. Each copy of these books is available in the Reserve section of the Library.
Lecture notes can also be found from the ActEd Study Materials (subject CT8). You can purchase these notes via ASSOC at a discounted price. Information about their availability and price will be confirmed on Blackboard and in the lectures.

The advanced textbooks for this course are:

<table>
<thead>
<tr>
<th>Title</th>
<th>Author</th>
<th>Chapters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk-Neutral Valuation - Pricing and Hedging of Financial Derivatives</td>
<td>N. H. Bingham and R. Kiesel</td>
<td>Chapters 1, 4, 5, 6, 8</td>
</tr>
<tr>
<td>Quantitative Risk Management</td>
<td>Alexander J. McNeil, Rüdiger Frey and Paul Embrechts</td>
<td>Chapter 8</td>
</tr>
<tr>
<td>The Theory of Stochastic Processes</td>
<td>D. R. Cox and H. D. Miller</td>
<td>Chapters 2, 5</td>
</tr>
<tr>
<td>Introduction to Probability Models (8th edition)</td>
<td>Sheldon Ross</td>
<td>Chapter 6</td>
</tr>
</tbody>
</table>

References you will find useful for the materials covered during Weeks 11 – 13 (which will be available in the Reserve Section of the Library) are:

- Modern Portfolio Theory and Investment Analysis by Elton and Gruber,
- Investment Science by Luenberger.

UNIT WEB PAGE

Online Learning @ MQ now uses Blackboard CE6 for online units. You can access your online units from http://learn.mq.edu.au/ or via the myMQ Student Portal. Your Online Learning @ MQ username will be your standard Macquarie Student ID Number (an 8-digit number found on your Campus Card) and you should use your myMQ Student Portal password for your CE6 online units.

Answers to frequently asked questions and help with login problems are available from http://learn.mq.edu.au/ and from http://online.mq.edu.au/docs/tecinf.html. Before you use the website you should make sure that you are familiar with all of this information, including the Information Technology Security Policy and Rules and the Information Technology Usage Rules. The information also mentions a number of “plugins” that may be required. Of those listed, in this unit you will only need Acrobat Reader.

The website for this unit contains:

- Course content:
  - Unit outline. A copy of this unit outline.
  - Lecture notes and Reading lists.
  - Weekly exercises with solutions.
  - Tests and exams. Past class tests and exams with solutions.
- Discussions. A Discussions board to discuss problems with your fellow students.
- Mail. To contact the teaching administrator and for the teaching administrator to contact you.

It is your responsibility to check the website regularly to make sure that you are up-to-date with announcements and with messages sent to your Mail address.

Remember to close your browser when you have finished using the site. If you don't, another person can use the still running browser to access the website with your account.

LEARNING OBJECTIVES AND OUTCOMES
This unit aims to introduce students to Brownian motion, stochastic calculus, derivatives pricing, interest rate models, credit risk models, financial market theory and portfolio management.

In addition to the discipline-based learning objectives, all academic programs at Macquarie seek to develop students’ generic skills in a range of areas. One of the aims of this unit is that students develop their skills in the following: Critical analysis skills; Problem-solving skills; Creative thinking skills.

**TEACHING AND LEARNING STRATEGY**

The unit material is covered in the four hours of lectures each week. The tutorial is an opportunity for you to attempt questions for each section of work, or to ask questions. In addition to the tutorial, you should use the Discussion Board to ask questions or discuss concepts covered in the unit.

<table>
<thead>
<tr>
<th>Week Number</th>
<th>Week Beginning</th>
<th>Lecture Topics</th>
<th>Test</th>
<th>Tutorial</th>
<th>Lecturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3 August</td>
<td>Introduction of stochastic processes</td>
<td></td>
<td></td>
<td>JJ</td>
</tr>
<tr>
<td>2</td>
<td>10 August</td>
<td>Martingale, Introduction of stochastic calculus, Ito’s lemma.</td>
<td></td>
<td></td>
<td>JJ</td>
</tr>
<tr>
<td>3</td>
<td>17 August</td>
<td>Concept of forward, futures and option, Binomial lattice model, Arbitrage-free pricing via replicating portfolio and risk neutral probability measure.</td>
<td>Tutorial</td>
<td></td>
<td>JJ</td>
</tr>
<tr>
<td>4</td>
<td>24 August</td>
<td>Black-Scholes option pricing model, Girsanov theorem. Greeks and dynamic hedging.</td>
<td>Tutorial</td>
<td></td>
<td>JJ</td>
</tr>
<tr>
<td>5</td>
<td>31 August</td>
<td>American and exotic option pricing</td>
<td>Tutorial</td>
<td></td>
<td>JJ</td>
</tr>
<tr>
<td>6</td>
<td>7 September</td>
<td>Term structure of interest rates, Relations among short rate, forward rate and default-free zero-coupon bond.</td>
<td>Tutorial</td>
<td></td>
<td>JJ</td>
</tr>
<tr>
<td>7</td>
<td>14 September</td>
<td>Interest rate models I (Short rate models).</td>
<td>Test</td>
<td>Tutorial</td>
<td>JJ</td>
</tr>
<tr>
<td>STUDY BREAK</td>
<td>21 September</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>6 October</td>
<td>Interest rate models II (Forward rate models).</td>
<td>Tutorial</td>
<td></td>
<td>JJ</td>
</tr>
<tr>
<td>9</td>
<td>12 October</td>
<td>Credit risk models I (Firm-value model).</td>
<td>Tutorial</td>
<td></td>
<td>JJ</td>
</tr>
<tr>
<td>10</td>
<td>19 October</td>
<td>Credit risk models II (Intensity-based model).</td>
<td>Tutorial</td>
<td></td>
<td>JJ</td>
</tr>
<tr>
<td>11</td>
<td>26 October</td>
<td>Utility Theory, Mean-Variance Portfolio Theory.</td>
<td>Tutorial</td>
<td></td>
<td>JJ</td>
</tr>
<tr>
<td>12</td>
<td>2 November</td>
<td>CAPM, Measurements of Investment Risk.</td>
<td>Tutorial</td>
<td></td>
<td>JJ</td>
</tr>
<tr>
<td>13</td>
<td>9 November</td>
<td>Efficient Market Hypothesis.</td>
<td>Tutorial</td>
<td></td>
<td>JJ</td>
</tr>
</tbody>
</table>

**RELATIONSHIP BETWEEN ASSESSMENT AND LEARNING OUTCOMES**

The following table gives an indication of the relative weighting of the assessment components:

<table>
<thead>
<tr>
<th>Assessment Component</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-Semester Test</td>
<td>20%</td>
</tr>
<tr>
<td>Final Examination</td>
<td>80%</td>
</tr>
</tbody>
</table>
Mid-Semester Test

There will be one mid-semester test of ninety (90) minutes duration with five (5) minutes reading time, which covers the topics from Weeks 1 to 5. It is worth 20% of the final assessment for the unit. The test is scheduled for Tuesday 15th September 2009 and will be conducted during the lecture time (1:00pm – 3:00pm). The venue for the test will be confirmed in the lectures and posted on the discussion board on Blackboard. Please note that the mid-semester test date, time and coverage may be subject to change and that any alterations will be advised in lectures/on Blackboard.

The format of the mid-semester test will be a written paper consisting of three (3) or four (4) questions. You will answer in the spaces provided on the test paper, although a writing booklet will be distributed to you for scribbling (which is NOT collected or marked). All answers must be written in black or blue pen or a pencil (do NOT use a red pen).

When the test is marked, you will be notified to collect them from BESS (E4B106).

You should contact the unit convenor immediately (eg. prior to the test) if unexpected ill–health or other disruption affects your preparation for or performance in a class test. Applications for special consideration due to documented illness or unavoidable disruption must then be made on the “Advice of Absence or other Circumstances” form, available at http://www.reg.mq.edu.au/academic-index.htm, and submitted to the Student Enquiry Service on Level 1 of the Lincoln Building.

Exam

The final examination (3 hours with 10 minutes reading time) is worth 80% of the final assessment for the unit. The examination will cover the entire course. You will be allowed to take one A4 page into the exam (handwritten or typed and filled in on one or two sides).

The University Examination period in Second Half Year 2009 is from 18 November to 4 December.

You are expected to present yourself for examination at the time and place designated in the University Examination Timetable. The timetable will be available in Draft form approximately eight weeks before the commencement of the examinations and in Final form approximately four weeks before the commencement of the examinations. http://www.timetables.mq.edu.au/exam

The only exception to not sitting an examination at the designated time is because of documented illness or unavoidable disruption. In these circumstances you may wish to consider applying for Special Consideration. Information about unavoidable disruption and the special consideration process is available at http://www.reg.mq.edu.au/Forms/APSCon.pdf

If a Supplementary Examination is granted as a result of the Special Consideration process the examination will be scheduled after the conclusion of the official examination period. (Individual Faculties may wish to signal when the Faculties’ Supplementary Exams are normally scheduled.)

You are advised that it is Macquarie University policy not to set early examinations for individuals or groups of students. All students are expected to ensure that they are available until the end of the teaching semester, that is the final day of the official examination period.

Test and Examination Rules

Normal examination rules apply to the conduct of test and the final examination. These rules are set out under the heading “Conduct of Examinations” in the Student Information – Assessment section of the current Macquarie University Handbook of Undergraduate Studies. Students are responsible for familiarising themselves with these rules prior to the class test and the final examination.
You should ensure that your handwriting in the class test and in the final examination is legible. Sections of work that are not legible will not be marked.

Academic Senate has resolved that no mobile phones should be brought into examination rooms. Mobile phones must be switched off and sealed in closed bags during class tests.

Calculators will be allowed in the class test and the final examination but a clear indication of the steps involved in every calculation must be shown. Any machines that have a text-retrieval capacity, whether or not they have a full alphabet on the keyboard, are not allowed. Calculators may be checked at the commencement of class test and final exam, and the make/model may be recorded.

Dictionaries will not be permitted in the class test or the final examination.

**CLASS ETIQUETTE**

Mobile phones should be switched off during all lectures and tutorials. If there is an important reason for you to keep your phone on you should request to be allowed to do so before the start of the class.

Lectures commence at 5 minutes past the hour and you are expected to be punctual. You are expected to keep talking to a minimum so as not to disrupt your fellow students (and the lecturer!).

**PLAGIARISM**

The University defines plagiarism in its rules: "Plagiarism involves using the work of another person and presenting it as one's own." Plagiarism is a serious breach of the University's rules and carries significant penalties. You must read the University's practices and procedures on plagiarism. These can be found in the *Handbook of Undergraduate Studies* or on the web at: [http://www.student.mq.edu.au/plagiarism](http://www.student.mq.edu.au/plagiarism)

The policies and procedures explain what plagiarism is, how to avoid it, the procedures that will be taken in cases of suspected plagiarism, and the penalties if you are found guilty. Penalties may include a deduction of marks, failure in the unit, and/or referral to the University Discipline Committee.

**UNIVERSITY POLICY ON GRADING**

Macquarie University uses the grades HD, D, Cr, P, PC and F for grading the achievements of students in units of study. The meaning of each symbol is explained in the Bachelor Degree Rules in the current Macquarie University Handbook of Undergraduate Studies. Your final result will include one of these grades plus a standardised numerical grade (SNG).

The numerical marks resulting from assessment of your work in this unit will be used as an initial indicator of the quality of your learning and understanding. The use of these numerical marks is, however, only a starting point in determining the appropriate grade. In particular, note that the SNG ranges mentioned in the Handbook of Undergraduate Studies are not the raw marks. To obtain a grade you must satisfy the qualitative definition of that grade. Once your grade has been determined, you are allocated an SNG indicating your approximate position amongst students assigned that grade.

Academic Senate has a set of guidelines on the distribution of grades across the range from fail to high distinction. It is important that you realise that the policy does not require that a minimum number of students are to be failed in any unit. In fact it does something like the opposite, in requiring examiners to explain their actions if more than 20% of students fail in a unit. For an explanation of the policy see [http://senate.mq.edu.au/rules/Guidelines2003.doc](http://senate.mq.edu.au/rules/Guidelines2003.doc) or [http://senate.mq.edu.au/rules/detailedguidelines.doc](http://senate.mq.edu.au/rules/detailedguidelines.doc).
EXEMPTIONS

The unit ACST 305/858 corresponds to the professional subject CT8. You require a Credit grade or higher to receive the exemption.

ELECTRONIC COMMUNICATION AND YOUR STUDENT FILE

Every business keeps a record of its correspondence with its customers. The University is no exception and it maintains a file for every student. Staff are required to ensure that copies of all correspondence with you are added to your file. Historically, “correspondence” meant letters, but nowadays it also includes electronic communication such as email. Staff have some discretion here and might not file copies of trivial emails, but it is difficult to define precise boundaries here, so it is safer to assume that any email you send to a staff member will be added to your file.

Some people regard email as more ephemeral than a letter and thus tend to take less care with issues such as clarity of expression, grammar and spelling. Before sending an email to a staff member, a good question to ask yourself is: “If a member of staff is reviewing my student file prior to writing a reference for me, and they see a copy of this email, would that staff member gain a favourable impression of my level of communication skills?”

In this context, email includes communications you send to staff with the mail tool in the unit's web site. It does not normally include postings you make to the discussion area. However, in those very rare cases where a student makes an inappropriate posting to the discussion area, a copy of the posting would be added to that student’s file.

INSTITUTE OF ACTUARIES OF AUSTRALIA

There are advantages to joining the Institute of Actuaries of Australia as a student. Please refer to http://www.actuaries.asn.au/AboutTheInstitute/Membership for information.

STUDENT SUPPORT SERVICES

Macquarie University provides a range of Academic Student Support Services. Details of these services can be accessed at http://www.student.mq.edu.au.

BESS. The (Faculty of) Business and Economics Student Services (BESS) is located in room E4B106 and offers photocopying facilities, reading areas and reference material.

ACSTINFO. This ACSTINFO site is used to distribute information to all students majoring in actuarial studies. The information supplied may include administrative information and job advertisements. You will retain access to this site during the vacation following the end of this semester. It is to your advantage to ensure you read information on this web site regularly. You should not assume that information posted there will also be repeated in lectures. When you first access the site, please read the section labelled “How to use this site”. This contains useful information that will help you determine when there is new information on the site that you should read.

FEEDBACK

I would welcome your feedback on any aspect of the unit.

If you see that something could be improved, let me know your ideas and if I agree that your ideas are good I will make changes. You can give me feedback in lectures or by posting to the website (anonymously if need be).
I hope not to see any feedback in the end-of-semester unit evaluations that I haven’t heard about already and therefore had the opportunity to respond to. Please get involved in making this unit as useful and rewarding as possible.

Jiwook Jang
30 July 2009