Programme-specific Section of the Curriculum for the MSc Programme in Mathematics-Economics at the Faculty of Science, University of Copenhagen 2009 (Rev. 2016)

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1 Title, affiliation and language
A shared section that applies to all BSc and MSc Programmes at the Faculty of Science is linked to this programme-specific curriculum.

1.1 Title
The MSc Programme in Mathematics-Economics leads to a Master of Science (MSc) in Mathematics-Economics with the Danish title: *Cand.scient.oecon* (*candidatus/candidata scientiarum*).

1.2 Affiliation
The programme is affiliated with the Study Board for Mathematics and Computer Science, and the students can both elect, and be elected, to this study board.

1.3 Corps of external examiners
The following corps of external examiners is used for the central parts of the MSc Programme:
- Corps of External Examiners for Mathematics (*matematik*).

1.4 Language
The language of this MSc Programme is English.

2 Academic profile
2.1 Purpose
The MSc Programme in Mathematics-Economics is a research-based interdisciplinary programme, the objective of which is to educate economists with a sound understanding of mathematics and statistics and the application of these disciplines within economic theory. Through a synthesis of the mathematical, statistical and economic fields of study, the mathematics-economist learns to handle theoretical and practical economic issues.

2.2 General programme profile
The study programme is an interdisciplinary programme offered by the Faculty of Science and the Faculty of Social Sciences with each faculty supplying a share of the compulsory courses. On the one hand, the study programme gives future economists with an interest in mathematics and statistics the opportunity to work with modern mathematical approaches and techniques. On the other hand, future mathematicians and statisticians obtain a good understanding of the areas of application of the economic subjects.

The programme's key subject areas are mathematics, statistics (including probability theory) and economics (including finance, actuarial mathematics and operations research). Moreover, computer science is included in the programme as a subject.

2.3 General structure of the programme
The MSc Programme is set at 120 ECTS credits.

There are no defined specialisations in this programme.

2.4 Career opportunities
The MSc Programme in Mathematics-Economics qualifies students for a PhD programme, and depending on the academic specialisation it may also be targeted at business functions and/or areas such as:
• Economist positions requiring good analytical skills and use of mathematics, statistics and IT.
• Work within the financial sector.
• Work within the public administration.
• Work within the consulting sector.

3 Description of competence profiles
Students following the MSc Programme acquire the knowledge, skills and competences listed below. Students will also acquire other qualifications through elective courses and other study activities.

3.1 Competence profile
On completion of the programme, an MSc in Mathematics-Economics has acquired the following:

Knowledge about:
• Selected research-active areas of economics and statistics, to a high level.
• Vector autoregressiv models, including unit root inference and co-integration.
• Economic stabilization policy with emphasis on monetary policy.
• The game-theoretic approach to industrial organization.
• Optimal stopping problems for investment and consumption in a stochastic environment.

Skills in/to:
• Read and understand economic and statistical original literature.
• Communicate economic and mathematical issues on a scientific basis.
• Account orally and in writing for inquiries into open economic issues.

Competences in/to:
• Structure a study of open economic questions, especially of an econometric or finance-related nature and divide it into smaller easily accessible challenges.
• Further develop and adapt economic models for real-life challenges.
• Conduct independent, stringent argumentation.
• Independently take responsibility for his or her own professional development and specialisation.
• Scientifically reflect on mathematical methods for analysing and resolving economic questions.

4 Admission requirements
With a Bachelor’s degree in Mathematics-Economics from the University of Copenhagen the student is granted reserved access and guaranteed a place on the MSc Programme in Mathematics-Economics if the student applies before the application deadline during the first application period after the completion of the Bachelor’s degree.

4.1 Applicants with a Bachelor’s degree in Mathematics-Economics
Applicants with a Bachelor’s degree in Mathematics-Economics from the University of Copenhagen, other Danish or Nordic universities are directly academically qualified for admission to the MSc Programme.
4.2 Applicants with a closely related Bachelor’s degree
Applicants with a Bachelor’s degree in Actuarial Mathematics or Mathematics from the University of Copenhagen, other Danish or international universities may be admitted if the programme includes:

- Subject elements in microeconomics at least 15 ECTS credits.
- Subject elements in macroeconomics at least 15 ECTS credits.
- Subject elements in finance at least 7.5 ECTS credits.
- Subject elements in statistics on a measure theoretical basis at least 15 ECTS credits.

4.3 Applicants with a related Bachelor’s degree
Applicants with a Bachelor’s degree in economics, physics, computer science or chemistry from the University of Copenhagen or other Danish or international universities may also be admitted if their programme includes the following elements:

- Subject elements in mathematical analysis at least 22.5 ECTS credits.
- Subject elements in linear algebra at least 7.5 ECTS credits.
- Subject elements in microeconomics at least 15 ECTS credits.
- Subject elements in macroeconomics at least 15 ECTS credits.
- Subject elements in finance at least 7.5 ECTS credits.
- Subject elements in statistics on a measure theoretical basis at least 15 ECTS credits.

4.4 Other applicants
The Faculty may also admit applicants who, after an individual academic assessment, are deemed to possess educational qualifications equivalent to those required in Subclauses 4.1-3.

4.5 Language requirements
4.5.1 Applicants from Nordic universities
Applicants with a Bachelor’s degree from Nordic universities must as a minimum document English language qualifications comparable to a Danish upper secondary school English B level.

4.5.2 Non-Nordic applicants
Applicants with a non-Nordic Bachelor’s degree must be able to document English proficiency corresponding to an IELTS test score of minimum 6.5 or a TOEFL test score of minimum 83 (Internet-based).

5 Prioritisation of applicants
If the number of qualified applicants to the programme exceeds the number of places available, applicants will be prioritised as follows:

1) Applicants with a Bachelor’s degree in Mathematics-Economics from the University of Copenhagen seeking admission by way of direct extension of their completed BSc programme.
2) Other applicants with a Bachelor’s degree in Mathematics-Economics.
3) Applicants with a Bachelor’s degree in Mathematics or Actuarial Mathematics from the University of Copenhagen.
4) Other applicants.

Applicants are then prioritised according to their total number of ECTS credits within the relevant academic fields and the grades obtained.
6 Structure of the programme
The compulsory subject elements, restricted elective subject elements and the thesis constitute
the central parts of the programme (Section 21 of the Ministerial Order on Bachelor and
Master’s Programmes (Candidatus) at Universities).

6.1 Programme components
The programme is set at 120 ECTS credits and consists of the following:
- Compulsory subject elements, 30 ECTS credits.
- Restricted elective subject elements, 45 ECTS credits.
- Elective subject elements, 15 ECTS credits.
- Thesis, 30 ECTS credits.

6.1.1 Compulsory subject elements
All of the following subject elements are to be covered (30 ECTS credits):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject Description</th>
<th>Block</th>
<th>ECTS Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMAA05025U</td>
<td>Econometrics 2: Statistical Analysis of Econometric Time Series</td>
<td>StatØ2</td>
<td>Block 1</td>
</tr>
<tr>
<td>NMAK10018U</td>
<td>Macroeconomics 3 – Business Cycles and Monetary Policy</td>
<td>MakØk3</td>
<td>Block 2</td>
</tr>
<tr>
<td>NMAK11020U</td>
<td>Microeconomics 3 – Industrial Organization</td>
<td>MikØk3</td>
<td>Block 3</td>
</tr>
<tr>
<td>NMAA09045U</td>
<td>Finance 2: Dynamic Portfolio Choice</td>
<td>Fin2</td>
<td>Block 4</td>
</tr>
</tbody>
</table>

6.1.2 Restricted elective subject elements
45 ECTS credits are to be covered as subject elements from the following list:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject Description</th>
<th>Block</th>
<th>ECTS Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMAA09044U</td>
<td>Operations Research 2: Advanced Operations Research (OR2)</td>
<td></td>
<td>Block 1</td>
</tr>
<tr>
<td>NMAK11003U</td>
<td>Advanced Probability Theory 1 (VidSand1)</td>
<td></td>
<td>Block 1</td>
</tr>
<tr>
<td>NMAA05117U</td>
<td>Stochastic Processes in Non-Life Insurance (SkadeStok)</td>
<td></td>
<td>Block 1</td>
</tr>
<tr>
<td>NMAK16004U</td>
<td>Computational Finance (AAM)</td>
<td></td>
<td>Block 1</td>
</tr>
<tr>
<td>NMAA05115U</td>
<td>Stochastic Processes in Life Insurance (LivStok)</td>
<td></td>
<td>Block 1</td>
</tr>
<tr>
<td>NMAK16005U</td>
<td>Computational Statistics</td>
<td></td>
<td>Block 1</td>
</tr>
<tr>
<td>NMAK15013U</td>
<td>Functional Data Analysis*</td>
<td></td>
<td>Block 1</td>
</tr>
<tr>
<td>NMAK15011U</td>
<td>Control Theory in Finance and Insurance (AAM)*</td>
<td></td>
<td>Block 1</td>
</tr>
<tr>
<td>NMAK16009U</td>
<td>Gams and modelling</td>
<td></td>
<td>Block 2</td>
</tr>
<tr>
<td>NMAK16019U</td>
<td>Survival Analysis</td>
<td></td>
<td>Block 2</td>
</tr>
<tr>
<td>NMAA11011U</td>
<td>Advanced Probability Theory 2 (VidSand2)</td>
<td></td>
<td>Block 2</td>
</tr>
<tr>
<td>NMAA05113U</td>
<td>Continuous Time Finance (FinKont)</td>
<td></td>
<td>Block 2</td>
</tr>
<tr>
<td>NMAK13005U</td>
<td>Introduction to Extreme Value Theory (IntroExtremValue)</td>
<td></td>
<td>Block 2</td>
</tr>
<tr>
<td>NMAK10020U</td>
<td>Quantitative Risk Management (QRM)</td>
<td></td>
<td>Block 2</td>
</tr>
<tr>
<td>NMAK10012U</td>
<td>Optimization and Convexity (OK)*</td>
<td></td>
<td>Block 2</td>
</tr>
<tr>
<td>NMAK15020U</td>
<td>Statistical Computing*</td>
<td></td>
<td>Block 2</td>
</tr>
<tr>
<td>NMAK15024U</td>
<td>Topics in Financial Risk Management (AAM)*</td>
<td></td>
<td>Block 2</td>
</tr>
<tr>
<td>AØKA08128U</td>
<td>Advanced Industrial Organizations</td>
<td>Autumn</td>
<td>7.5 ECTS credits</td>
</tr>
<tr>
<td>AØKA08012U</td>
<td>Corporate finance and incentives</td>
<td>Autumn</td>
<td>7.5 ECTS credits</td>
</tr>
<tr>
<td>AØKK08202U</td>
<td>Corporate finance theory</td>
<td>Autumn</td>
<td>7.5 ECTS credits</td>
</tr>
<tr>
<td>AØKA08216U</td>
<td>Financial econometrics A</td>
<td>Autumn</td>
<td>7.5 ECTS credits</td>
</tr>
<tr>
<td>AØKA08079U</td>
<td>Health economics</td>
<td>Autumn</td>
<td>7.5 ECTS credits</td>
</tr>
<tr>
<td>AØKA08070U</td>
<td>Multivariat analyse og kategoriserede data</td>
<td>Autumn</td>
<td>7.5 ECTS credits</td>
</tr>
<tr>
<td>AØKA08208U</td>
<td>Praktisk tidsrækkeanalyse</td>
<td>Autumn</td>
<td>7.5 ECTS credits</td>
</tr>
<tr>
<td>AØKA08036U</td>
<td>Årsregnskab og regnskabsanalyse</td>
<td>Autumn</td>
<td>7.5 ECTS credits</td>
</tr>
</tbody>
</table>
• **NMAK15004U** Advanced Operations Research: Stochastic Programming | Block 3 | 7.5 ECTS credits
• **NMAK11022U** Regression (Reg) | Block 3 | 7.5 ECTS credits
• **NMAK14013U** Modelling Dependence in Discrete Time | Block 3 | 7.5 ECTS credits
• **NMAK15010U** Continuous Time Finance 2 (FinKont2) | Block 3 | 7.5 ECTS credits
• **NMAK15001U** Operations Research 3: Hierarchical optimization and equilibrium | Block 4 | 7.5 ECTS credits
• **NMAK16006U** Consumption-Investment-Insurance problems | Block 4 | 7.5 ECTS credits
• **NMAK14028U** Project in Statistics | Block 4 | 7.5 ECTS credits
• **NMAK14022U** Statistics for non-linear time series models (AAM)* | Block 4 | 7.5 ECTS credits
• **AØKA08088U** Advanced Development Economics - Micro Aspects | Spring | 7.5 ECTS credits
• **AØKA08069U** Economics of Banking | Spring | 7.5 ECTS credits
• **AØKA08204U** Fixed Income Derivatives: Risk Management and Financial Institutions | Spring | 7.5 ECTS credits
• **AØKA08020U** Industrial Organization | Spring | 7.5 ECTS credits
• **AØKA08021U** International Economics | Spring | 7.5 ECTS credits
• **AØKK08094U** Miljø-, ressource- og klimaøkonomi | Spring | 7.5 ECTS credits
• **AØKK08095U** Pricing Financial Assets | Spring | 7.5 ECTS credits
• **AØKA08186U** Programmering og statistik med SAS | Spring | 7.5 ECTS credits
• **AØKA08073U** Regnskabsanalyse og aktievurdering | Spring | 7.5 ECTS credits
• **AØKA08077U** Stikprøveteorì | Spring | 7.5 ECTS credits
• **AØKA08091U** Økonomiske prognoser i praksis | Spring | 7.5 ECTS credits

*The courses are discontinued. See course specific changes in the interim arrangements.

### 6.1.3 Elective subject elements
15 ECTS credits are to be covered as elective subjects.

BSc subject elements corresponding to 15 ECTS credits may be included in the MSc Programme.

Projects outside the course scope may be included in the elective section of the programme with up to 15 ECTS credits. The regulations are described in Appendix 5 to the shared section of the curriculum.

Projects in practice may be included in the elective section of the programme with up to 15 ECTS credits. The regulations are described in Appendix 4 to the shared section of the curriculum.

### 6.1.4 Thesis
The MSc Programme in Mathematics-Economics includes a thesis corresponding to 30 ECTS credits, as described in Appendix 2 to the shared curriculum. The thesis must be written within the academic scope of the programme.

The principal supervisor can be from the Department of Economics, the Faculty of Social Science.

### 6.1.5 Academic mobility
Academic mobility requires that the student follows the rules and regulations regarding pre-approval and credit transfer.
The academic mobility in the MSc Programme in Mathematics-Economics is placed in block 1+2 of the 2nd year. This means that the curriculum makes it possible to follow subject elements outside the Faculty of Science.

In addition the student has the possibility to arrange similar academic mobility in other parts of the programme.

7 Exemptions
In exceptional circumstances, the study board may grant exemptions from the rules in the curriculum specified solely by the Faculty of Science.

8 Commencement etc.
8.1 Validity
This subject specific section of the curriculum applies to all students enrolled in the programme – see however Appendix 2.

8.2 Transfer
Students enrolled on previous curricula may be transferred to the new one as per the applicable transfer regulations or according to an individual credit transfer by the study board.

8.3 Amendment
The curriculum may be amended once a year so that any changes come into effect at the beginning of the academic year. Amendments must be proposed by the study board and approved by the Dean.

Notification about amendments that tighten the admission requirements for the programme will be published online at www.science.ku.dk one year before they come into effect.

If amendments are made to this curriculum, an interim arrangement may be added if necessary to allow students to complete their MSc Programme according to the amended curriculum.
### Appendix 1 Tables

#### Table for students admitted to the programme in September (summer):

**Table - MSc Programme in Mathematics-Economics**

<table>
<thead>
<tr>
<th>Year</th>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
<th>Block 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
</tr>
<tr>
<td>2nd</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Thesis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td>Elective</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Table for students admitted to the programme in February (winter):

**Table - MSc Programme in Mathematics-Economics**

<table>
<thead>
<tr>
<th>Year</th>
<th>Block 3</th>
<th>Block 4</th>
<th>Block 1</th>
<th>Block 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
</tr>
<tr>
<td>2nd</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Thesis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td>Elective</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*This table is only relevant for students who begin the MSc Programme in February (block 3).*
Appendix 2 Interim arrangements

The Shared Section of the BSc and MSc Curricula for Study Programmes applies to all students.

The interim arrangements below only consist of parts where the current curriculum differs from the rules and regulations that were previously valid. Therefore, if information about relevant rules and regulations are missing, it can be found in the curriculum above.

1 General changes valid for students admitted in the academic year 2015/2016

Students admitted to the MSc Programme in the academic year 2015/16 must finish the programme with the original curriculum structure under which they were admitted.

Restricted elective subject elements

30 ECTS credits are to be covered by subject elements from the list in the curriculum above, and by courses from the following list:

- NMAK15013U Functional Data Analysis Discontinued* 7.5 ECTS credits
- NMAK15011U Control Theory in Finance and Insurance Discontinued* 7.5 ECTS credits
- NMAK10012U Optimization and Convexity (OK) Discontinued* 7.5 ECTS credits
- NMAK15020U Statistical Computing Discontinued* 7.5 ECTS credits
- NMAK15024U Topics in Financial Risk Management Discontinued* 7.5 ECTS credits
- NMAK14022U Statistics For Non-Linear Time Series Models Discontinued* 7.5 ECTS credits
- AØKA08055U Contract Theory and the Economics of organization Discontinued* 7.5 ECTS credits
- AØKK08206U Financial Frictions, Liquidity and the Business Cycle Discontinued* 7.5 ECTS credits
- AØKA08102U Financial Markets Discontinued* 7.5 ECTS credits

* See course specific changes below.

2 General changes valid for students admitted in the academic year 2014/2015 or earlier

Students admitted to the MSc Programme in the academic year 2014/15 or earlier must finish the programme with the original curriculum structure under which they were admitted.

Structure of the programme

For students admitted to the MSc programme in the academic year 2014/15 or earlier the programme consists of the following:

- Compulsory subject elements, 30 ECTS credits.
- Restricted elective subject elements, 30 ECTS credits.
- Elective subject elements, 30 ECTS credits.
- Thesis, 30 ECTS credits.

Restricted elective subject elements

30 ECTS credits are to be covered by subject elements from the following list:

- NMAA05113U Continuous Time Finance (FinKont) Block 1 7.5 ECTS credits
- NMAA09044U Operations Research 2: Advanced Operations Research (OR2) Block 1 7.5 ECTS credits
- Courses with the abbreviation “Continuous Time Finance 2 (FinKont2)” Up to 30 ECTS credits
- Other courses held by Department of Mathematics and Department of Economics on MSc level Up to 30 ECTS credits
- Projects outside the course scope with the principal supervisor from the Department of Mathematical Science or the Department of Economics Up to 15 ECTS credits
Thesis
The thesis may either be carried out as a full-time project at the end of the study programme or concurrently with other subject elements. However, the thesis must conclude the programme.

Competence profile
On completion of the programme, an MSc in Mathematics-Economics enrolled in 2014/2015 or earlier has acquired the following:
Knowledge about:
• Selected research-active areas of economics and statistics, to a high level.
Skills in/to:
• Read and understand economic and statistical original literature.
• Communicate economic and mathematical issues on a scientific basis.
• Account orally and in writing for inquiries into open economic issues.
Competences in/to:
• Structure a study of open economic questions, especially of an econometric or finance-related nature and divide it into smaller easily accessible challenges.
• Further develop and adapt economic models for real-life challenges.
• Conduct independent, stringent argumentation.
• Independently take responsibility for his or her own professional development and specialisation.
• Scientifically reflect on mathematical methods for analysing and resolving economic questions.

3 Course specific changes

<table>
<thead>
<tr>
<th>Discontinued course</th>
<th>Interim arrangement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Data Analysis (NMAK15013U), 7.5 ECTS credits</td>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier.</td>
</tr>
<tr>
<td></td>
<td>The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
</tr>
<tr>
<td>Control Theory in Finance and Insurance (AAM) (NMAK15011U), 7.5 ECTS credits</td>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier.</td>
</tr>
<tr>
<td></td>
<td>The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
</tr>
<tr>
<td>Optimization and Convexity (OK) (NMAK10012U), 7.5 ECTS credits</td>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier.</td>
</tr>
<tr>
<td></td>
<td>The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
</tr>
<tr>
<td>Statistical Computing (NMAK15020U), 7.5 ECTS credits</td>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier.</td>
</tr>
<tr>
<td></td>
<td>The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
</tr>
<tr>
<td></td>
<td>The course is equivalent to Computational Statistics (NMAK16005U), 7.5 ECTS credits.</td>
</tr>
<tr>
<td>Statistics for non-linear time series</td>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier.</td>
</tr>
<tr>
<td></td>
<td>The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
</tr>
<tr>
<td>Course Title</td>
<td>Credits</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>models (AAM) (NMAK14022U), 7.5 ECTS credits</td>
<td></td>
</tr>
<tr>
<td>Topics in Financial Risk Management (AAM) (NMAK15024U), 7.5 ECTS credits</td>
<td></td>
</tr>
<tr>
<td>Contract Theory and the Economics of organization (AØKA08055U), 7.5 ECTS credits.</td>
<td></td>
</tr>
<tr>
<td>Financial Frictions, Liquidity and the Business Cycle (AØKA08055U), 7.5 ECTS credits.</td>
<td></td>
</tr>
<tr>
<td>Financial Markets (AØKA08102U), 7.5 ECTS credits.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 3 Description of objectives for the thesis

After completing the thesis, the student should have:

Knowledge about:
- Scientific problems within the study programme’s subject areas.
- A suitable combination of methodologies/theories based on international research for use in his/her work with the problem formulation.
- Theories/models on the basis of an organised value system and with a high degree of independence.

Skills in/to:
- Apply and critically evaluate theories/methodologies, including their applicability and limitations.
- Assess the extent to which the production and interpretation of findings/material depend on the theory/methodology chosen and the delimitation chosen.
- Discuss academic issues arising from the thesis.
- Draw conclusions in a clear and academic manner in relation to the problem formulation and, more generally, considering the topic and the subject area.
- Discuss and communicate the academic and social significance, if any, of the thesis based on ethical principles.

Competences in/to:
- Initiate and perform academic work in a research context.
- Solve complex problems and carry out development assignments in a work context.