Master Econometrics and Operations Research

Find another programme

During the first block of Econometrics and Operations Research, all students take the same compulsory theory courses. From the second block onwards, you’ll choose one of four specialisations:

- Actuarial Science
- Econometrics
- Mathematical Economics
- Operations Research

Actuarial Science

What’s it all about?

Floods, earthquakes, diseases, car accidents - the world is a risky place. In most cases, it’s hard to estimate how risky the world really is because we don’t know exactly when an area will be flooded or when we’ll need a doctor, for example. And yet in the Actuarial Sciences specialisation, you’ll learn to predict just these types of events:

- learn to estimate risks and calculate the financial consequences
- study market demand and manage return on investment, both in the short and long term
- complete some of the compulsory study material you’ll need to pursue a Dutch actuarial qualification
- be exempted from part of the actuarial qualification programme offered by the Dutch Actuarial Institute, and from part of the content of the German Deutsche Aktuarvereinigung e.V.

What you’ll actually do:

- study the financial models that form the basis of insurance and pensions
- learn to communicate your opinions and solutions professionally and clearly in order to persuade others
- break down financial problems into smaller components in order to solve them
- use a two-sided approach to look at problems, from both an asset and liability point of view
- demonstrate financial expertise in the pension and insurance sectors
Master Econometrics and Operations Research

**Student profile**

Actuarial Science is a good fit if you:

- enjoy solving economic problems
- have a background in mathematics, especially statistics
- are an analytical thinker
- work in insurance or pension funds and want higher qualification

**Econometrics**

**What’s it all about?**

Complex economic and financial issues faced by policy makers, companies and investors require rigorous and advanced data analysis. The econometrics specialisation provides you with the tools to perform such an analysis in a variety of fields. These techniques allow you to determine relationships between economic variables, to quantify the effects of policy interventions, and to predict future developments, as well as to quantify uncertainty surrounding your outcomes. Specifically, you will learn how to:

- analyse economic and financial data gathered over time
- conduct analyses for economic datasets collected over a large number of individuals or companies (possibly also over time), such as surveys
- deal with 'Big Data', where the number of variables may exceed the number of observed data
- empirically analyse financial markets

Graduates of this programme are highly sought-after by industry, banks, insurers and governmental and commercial organisations.

**What you’ll actually do:**

- learn statistical techniques for the analysis of economic and financial datasets
- study the mathematical foundations of econometric techniques
- critically assess statistical techniques and develop modifications for particular applications
- implement econometric techniques in statistical software, and apply them to economic and financial data

**Student profile**

Econometrics is a good fit if you:

- want to develop a quantitative understanding of developments in macroeconomics or microeconomics
- want to predict financial and economic developments
- have an interest in economic problem-solving
- have a background in mathematics or statistics
- want to build statistical models for Big Data
Master Econometrics and Operations Research

Mathematical Economics

What’s it all about?

Mathematical methods can be used to solve a whole range of business problems, from a company’s finances to the organisation of its people. In order to do this strategically, the Mathematical Economics track looks at theories and models that can help you make the right decisions. With a unique blend of theory and practice, you will become indispensable in making decisions about the internal and external organisation of a company and its finances.

What you’ll actually do:

- apply theoretical models to solve business problems
- make informed decisions on resources, finances and organisational structure
- learn to analyse problems quickly and assess them accurately

Student profile

Mathematical Economics is a good fit if you:

- have an interest in mathematical analysis
- have a theoretical mind
- are curious about how economic developments play out
- enjoy creating models and theories in order to solve problems

Operations Research

What’s it all about?

Operations Research is about applying technology to business situations in order to solve real problems. The track will not only give you the means to use computer programming to your advantage, but also to communicate your proposed solutions to the business decision-makers effectively.

What you’ll actually do:

- use and develop software to find optimal solutions for logistical scheduling problems
- find technical solutions to business and economic problems
- use tools like simulations and regression analysis
- have the opportunity to combine an 8-week internship with your master’s thesis

Student profile

Operations Research is a good fit if you:
are a tech-savvy person who enjoys solving problems
have an affinity for information technology
are interested in a diverse range of fields including logistics, planning, information management and telecom
have an interest in IT and technology (though this is not a programming specialisation, you can take a programming course)

Master's Programme

**Compulsory Courses**

School of Business and Economics

**Stochastic Processes**

**Full course description**

Deterministic dynamic systems are usually not well suited for modelling real world dynamics in economics, finance and business. Allowing for random components in dynamic systems leads to stochastic dynamic modelling, which is based on stochastic processes. This course covers models of stochastic processes in discrete and continuous time. This includes Markov chains, Poisson processes and Brownian motion. We introduce various tools that are very useful for deriving and understanding the asymptotic properties of modern econometric techniques. They include the functional central limit theorem and stochastic integrals. Finally, we discuss stochastic differential equations and their applications in finance and related fields, e.g. for pricing financial derivatives.

**Course objectives**

The purpose of the course is to introduce students to the study of stochastic processes in discrete and continuous time. Students will have learned the essentials of the subject and should be able to apply the acquired theoretical tools to problems in econometrics, economics, finance, and other fields.

**Prerequisites**

Only Master students can take Econometrics Master courses. Students require a solid background in mathematical statistics and probability theory on the level of the BSc Econometrics programme.

An advanced level of English.

**Recommended reading**

- Reader

EBC4004
Period 1
2 Sep 2019
25 Oct 2019
Game Theory and Optimisation

Full course description

Topics in optimization include duality theorems in LP, branch and bound and cutting plane algorithms in IP, and Kuhn-Tucker conditions for NLP.

Topics in game theory and economics include computation of Nash equilibrium and refinements and mechanism design.

Course objectives

This course provides a comprehensive overview of optimization techniques such as linear and integer programming, and non-linear programming, with applications in game theory and economics. Students learn optimization techniques from mathematics and operations research, and how to apply them in models from game theory and economic theory.

Prerequisites

Only Master students can take this course. Exchange students need to have obtained a BSc degree in Economics, International Business, Econometrics, or a related topic. Familiarity with the basic concepts of optimization and linear programming will be helpful. A solid basis in mathematics and calculus is also recommendable.

Recommended reading

The course will be based on chapters from standard textbooks plus additional readers.

Recommended literature for background reading:

Stochastic Processes

Full course description

Deterministic dynamic systems are usually not well suited for modelling real world dynamics in economics, finance and business. Allowing for random components in dynamic systems leads to stochastic dynamic modelling, which is based on stochastic processes. This course covers models of stochastic processes in discrete and continuous time. This includes Markov chains, Poisson processes and Brownian motion. We introduce various tools that are very useful for deriving and understanding the asymptotic properties of modern econometric techniques. They include the functional central limit theorem and stochastic integrals. Finally, we discuss stochastic differential equations and their applications in finance and related fields, e.g. for pricing financial derivatives.

Course objectives

The purpose of the course is to introduce students to the study of stochastic processes in discrete and continuous time. Students will have learned the essentials of the subject and should be able to apply the acquired theoretical tools to problems in econometrics, economics, finance, and other fields.
Prerequisites

Only Master students can take Econometrics Master courses. Students require a solid background in mathematical statistics and probability theory on the level of the BSc Econometrics programme. An advanced level of English.

Recommended reading

- Reader

EBC4004
Period 1
2 Sep 2019
25 Oct 2019
Print course description
ECTS credits: 6.5
Instruction language: English
Coordinator:
  - M.B. Eichler

Teaching methods:
PBL, Assignment(s), Lecture(s)
Assessment methods:
Written exam, Participation
School of Business and Economics

Time Series Methods and Dynamic Econometrics

Full course description

The emphasis of this course will be on studying in depth methods and techniques for the analysis of (nonstationary) economic and financial time series. We will cover and discuss issues related to:
- dynamic econometric modelling
- modelling nonstationary processes
- asymptotic theory for dependent and integrated processes
- unit roots (representation, tests, properties), cointegration and VECMs.
Empirical applications as well as simulation experiments will also be considered to provide students with practical experience in analyzing economic and business time series.

Course objectives

The objectives of this course are:
- to provide students with an understanding/intuition of the concepts of modern time series methods that are used in econometrics.
- introduce the student to fundamental methodological issues in dynamic econometric modelling
Master Econometrics and Operations Research
(nonstationarity, nonstandard asymptotic theory).
- to provide students with some experience in analyzing univariate and multivariate time series from economics or business.

**Prerequisites**

Econometric methods (EBC2111), Stochastic Processes (EBC4004).

Exchange students need to have a solid background in econometric methods, probability theory, mathematical statistics, and some knowledge in stochastic processes (some familiarity with Brownian Motion theory is important). Exchange students need to have obtained a Bachelor degree and an advanced level in mathematics and probability and statistics.

An advanced level of English.

**Recommended reading**

The main textbook used in this course will be:

You might also want to consult the following book:

The first book is mathematically very concise, while the second book is more narrative of nature. Students often perceive the two books as complementary.

**Life Insurance I**

**Full course description**

1. Pricing by Replication: Role of the actuary; Basic idea fair value; Bonds; Forward rates; Duration; Inflation.
2. Equity Options: Unit linked insurance; Intro to option theory; Equity derivatives; With-profit
Master Econometrics and Operations Research

policies.

5. Time-Consistent and Market-Consistent Pricing: Two-step pricing operator; Pricing in continuous time.
6. Interest Rate Risk: Interest rate swaps; Swaptions; Minimum return guarantees.
7. Applications: Market-consistent embedded value; Solvency II; IFRS 17.

Study-load and grading:
* Study-load = 6.5 ECTS (= 182 study-hours).
* The course takes 7 weeks, with 4 contact hours every week plus mandatory homework assignments every week.
* Students work in groups of max. 3 students on the homework assignments. Each post-discussion two groups present their solution to the tutorial group, which will then be discussed by the tutorial group.
* Please note that the homework assignments are based on real-life cases. This means that the assignments are relatively unstructured. This also means that there is usually not a unique "correct" solution for the assignment. It is therefore important that students can motivate and defend the choices they have made to obtain their solution. Discussing the pro's and con's of different solutions will be an important aspect of the post-discussion.
* Average grade for all homework-presentations in the post-discussion counts for 50% of final grade. Final written exam counts for 50% of final grade.

Course objectives

In this course we aim to teach students the basic principles of pricing life-insurance and pension contract and basic principles of measuring value creation on a market-consistent basis (Market-Consistent Embedded Value).

The underlying principle for this course is the notion that the market-consistent value of a life-insurance or pension contract is based on the market-value of the Replicating Portfolio plus an “add-on” for the remaining (unhedgeable) portions of the risk that are not covered by the Replicating Portfolio.

Prerequisites

Bachelor Level Econometrics and Operations Research, including preparatory courses Actuarial Sciences.

Recommended reading

To be announced.

EBC4119
Period 2
28 Oct 2019
20 Dec 2019
Print course description
ECTS credits:
Life Insurance II

Full course description

The course provides students with statistical models that are useful in life insurance (many of these models are also used in other fields that are concerned with future lifetimes of individuals or groups such as biostatistics, epidemiology or public health planning). We first discuss methods to model mortality rates for a larger group or an entire population. A particular focus is on the Lee-Carter model and its extensions. We also learn how to estimate these models. Afterwards we turn to models that are appropriate to model the future lifetime of individuals. A focus will be on models that can incorporate covariates such as parametric regression models, the Cox model and the accelerated failure time model. We also address the multiple decrement model. Subsequently, we discuss how these models can be used to set premiums for life insurance products. In the last part of the course we introduce a model that allows to calculate premiums for insurances that may provide benefits depending on the current status of the insured. As part of the course students will also apply the methods introduced to real data.

Course objectives

To become acquainted with statistical models that can be used in life insurance.

Prerequisites


Recommended reading

Research articles, the slides of the course.
Mathematical Finance

Full course description

The aim of the course is to provide students with an appreciation and understanding of the main ideas and concepts of mathematical finance. The core of mathematical finance concerns questions of pricing and hedging of financial derivatives such as options whose value depend on that of an underlying risky asset. We will discuss the general principles of continuous-time financial markets where the investor can buy and sell $d+1$ assets. As a special case we will consider the Black-Scholes model for a financial market. We will further point out the link between the no-arbitrage condition and certain probability measures, the so called equivalent martingale measures. In complete markets as well as in incomplete markets these measures allow to price financial derivatives in an arbitrage-free way. Moreover, we will consider probabilistic models for bond markets and apply the theory of equivalent martingale measures to the pricing of fixed income securities. Finally, we will address the issue of estimating the parameters of the probabilistic models from historical data.

Course objectives

The principal aim of this course is to provide students with an appreciation and understanding of how the application of mathematics, particularly stochastic mathematics, to the field of finance may be used to illuminate this field and model its randomness, resulting in greater understanding and quantification of investment returns and security prices.

Prerequisites

Students should have knowledge of stochastic processes, in particular Brownian motion, geometric Brownian motion and the underlying stochastic differential equations. Moreover, students should be familiar with the Ito integral and the Ito formula. Knowledge of the Girsanov transformation is helpful, but not required.

Recommended reading


ECTS credits: 6.5
Instruction language: English
Game Theory and Optimisation

Full course description

Topics in optimization include duality theorems in LP, branch and bound and cutting plane algorithms in IP, and Kuhn-Tucker conditions for NLP.

Topics in game theory and economics include computation of Nash equilibrium and refinements and mechanism design.

Course objectives

This course provides a comprehensive overview of optimization techniques such as linear and integer programming, and non-linear programming, with applications in game theory and economics. Students learn optimization techniques from mathematics and operations research, and how to apply them in models from game theory and economic theory.

Prerequisites

Only Master students can take this course. Exchange students need to have obtained a BSc degree in Economics, International Business, Econometrics, or a related topic. Familiarity with the basic concepts of optimization and linear programming will be helpful. A solid basis in mathematics and calculus is also recommendable.

Recommended reading

The course will be based on chapters from standard textbooks plus additional readers.

Recommended literature for background reading :

Deterministic dynamic systems are usually not well suited for modelling real world dynamics in economics, finance and business. Allowing for random components in dynamic systems leads to stochastic dynamic modelling, which is based on stochastic processes. This course covers models of stochastic processes in discrete and continuous time. This includes Markov chains, Poisson processes and Brownian motion. We introduce various tools that are very useful for deriving and understanding the asymptotic properties of modern econometric techniques. They include the functional central limit theorem and stochastic integrals. Finally, we discuss stochastic differential equations and their applications in finance and related fields, e.g. for pricing financial derivatives.

Course objectives

The purpose of the course is to introduce students to the study of stochastic processes in discrete and continuous time. Students will have learned the essentials of the subject and should be able to apply the acquired theoretical tools to problems in econometrics, economics, finance, and other fields.

Prerequisites

Only Master students can take Econometrics Master courses. Students require a solid background in mathematical statistics and probability theory on the level of the BSc Econometrics programme.

An advanced level of English.
Recommended reading

- Reader

EBC4004
Period 1
2 Sep 2019
25 Oct 2019
Print course description
ECTS credits:
6.5
Instruction language:
English
Coordinator:
- M.B. Eichler

Teaching methods:
PBL, Assignment(s), Lecture(s)
Assessment methods:
Written exam, Participation
School of Business and Economics

Econometric Methods for Cross-sectional and Panel Data

Full course description

The main topics of the course are (1) unobserved effects models for panel data, (2) probit and logit models for discrete choice, (3) tobit and related censored regression models, (4) models dealing with sample selectivity, and (5) the estimation of average treatment effects (a.k.a. policy impact evaluation). Dynamic extensions of the models are considered when feasible. Estimation and testing methods are applied in a number of empirical assignments and their properties are investigated.

Course objectives

- Thorough understanding of the most frequently used econometric models and methods for the analysis of panel data, categorical choice and limited dependent variables.
- Some practice in the application of the methods, the interpretation of the models, and the evaluation of inferences.
- The experience of conducting a theoretical, experimental and/or empirical investigation of the methods.

Prerequisites

- Calculus, matrix algebra, probability, mathematical statistics, asymptotic theory, linear statistical models.
- Familiarity with statistical software like Stata and Gauss, Matlab, or R.
- Econometric methods at the level of Greene (2008) or Davidson & MacKinnon (2004), ideally as in courses Econometric Methods I (EBC2111), and Econometric Methods II (EBC2120).
The course is intended for students in the Econometrics Master programme as well as others with a comparable background and motivation. FLUENCY IN MATRIX ALGEBRA AND IN ASYMPTOTIC THEORY is necessary.

An advanced level of English.

**Recommended reading**


These references will be supplemented with a reading list of journal articles and book chapters.

**EBC4006**  
Period 4  
3 Feb 2020  
3 Apr 2020  
[Print course description](#)  
ECTS credits:  
6.5  
Instruction language:  
English  
Coordinator:  
- D.P.I. de Crombrugghe

Teaching methods:  
Presentation(s), Lecture(s), Assignment(s), Work in subgroups, Paper(s), Research, Skills  
Assessment methods:  
Final paper, Participation, Written exam, Presentation  
School of Business and Economics

**Time Series Methods and Dynamic Econometrics**

**Full course description**

The emphasis of this course will be on studying in depth methods and techniques for the analysis of (nonstationary) economic and financial time series. We will cover and discuss issues related to:  
- dynamic econometric modelling  
- modelling nonstationary processes  
- asymptotic theory for dependent and integrated processes  
- unit roots (representation, tests, properties), cointegration and VECMs.  
Empirical applications as well as simulation experiments will also be considered to provide students with practical experience in analyzing economic and business time series.

**Course objectives**

The objectives of this course are:
Master Econometrics and Operations Research
- to provide students with an understanding/intuition of the concepts of modern time series methods that are used in econometrics.
- introduce the student to fundamental methodological issues in dynamic econometric modelling (nonstationarity, nonstandard asymptotic theory).
- to provide students with some experience in analyzing univariate and multivariate time series from economics or business.

Prerequisites

Econometric methods (EBC2111), Stochastic Processes (EBC4004).

Exchange students need to have a solid background in econometric methods, probability theory, mathematical statistics, and some knowledge in stochastic processes (some familiarity with Brownian Motion theory is important). Exchange students need to have obtained a Bachelor degree and an advanced level in mathematics and probability and statistics.

An advanced level of English.

Recommended reading

The main textbook used in this course will be:

You might also want to consult the following book:

The first book is mathematically very concise, while the second book is more narrative of nature. Students often perceive the two books as complementary.

EBC4008
Period 2
28 Oct 2019
20 Dec 2019
Print course description
ECTS credits:
6.5
Instruction language:
English
Coordinator:
- I. Wilms

Teaching methods:
PBL, Presentation(s), Lecture(s), Work in subgroups
Assessment methods:
Written exam, Participation, Final paper
School of Business and Economics

Empirical Analysis of Financial Markets
In this course we consider in depth the fluctuations of stock prices. The purpose of the course is to provide you with an overview of recent empirical research in asset pricing and portfolio management. How are theoretical models of asset pricing being tested in practice? What are the strengths and weaknesses of various methodologies? What kind of statistical techniques are used?

Statistical methods in empirical asset pricing have evolved into a separate field called financial econometrics. These techniques are specifically designed to answer typical questions in finance. Examples are models of risk that look at how risk is measured, how it evolves over time, and how risks in different stocks are related. It also considers probabilities of crashes, bankruptcies and defaults, and statistical tests for the performance of trading strategies.

A more recent development are prediction models that build on insights from machine learning and advances in big data methodologies. These techniques seem to uncover new patterns in stock prices. From an investment perspective it is important to assess whether such new facts will remain or will be arbitrated away as soon as large investors start trading to exploit these patterns. In the course we will review and discuss interpretations of new techniques and empirical findings.

A second aim of the course is to let you gain some experience in doing empirical research. An important aspect of the course is learning about the characteristics of stock returns by doing a small research project. The research projects are concerned with predictability of stock returns and the profitability of various trading strategies based on (seeming) anomalies. At the end of the course you should be able to make your own assessment about events on financial markets. Are reported superior returns pure chance, statistical illusion, a reward for risk or really an anomaly?

**Course objectives**

The purpose of the course is to provide students with an overview of empirical methods and stylised facts that will enable them to make their own assessment of events on financial markets.

**Prerequisites**

Knowledge of basics of asset pricing and portfolio management, and linear regression models. Exchange students need to have obtained a Bachelor degree in economics or business administration, and sufficient quantitative background. Exchange students need to major in finance in their master.

An advanced level of English.

**Recommended reading**

- recent research papers
- recent journal articles

EBC4010
Period 5
6 Apr 2020
5 Jun 2020

[Print course description](#)
Game Theory and Optimisation

Full course description

Topics in optimization include duality theorems in LP, branch and bound and cutting plane algorithms in IP, and Kuhn-Tucker conditions for NLP.

Topics in game theory and economics include computation of Nash equilibrium and refinements and mechanism design.

Course objectives

This course provides a comprehensive overview of optimization techniques such as linear and integer programming, and non-linear programming, with applications in game theory and economics. Students learn optimization techniques from mathematics and operations research, and how to apply them in models from game theory and economic theory.

Prerequisites

Only Master students can take this course. Exchange students need to have obtained a BSc degree in Economics, International Business, Econometrics, or a related topic. Familiarity with the basic concepts of optimization and linear programming will be helpful. A solid basis in mathematics and calculus is also recommendable.

Recommended reading

The course will be based on chapters from standard textbooks plus additional readers.

Recommended literature for background reading:

Deterministic dynamic systems are usually not well suited for modelling real world dynamics in economics, finance and business. Allowing for random components in dynamic systems leads to stochastic dynamic modelling, which is based on stochastic processes. This course covers models of stochastic processes in discrete and continuous time. This includes Markov chains, Poisson processes and Brownian motion. We introduce various tools that are very useful for deriving and understanding the asymptotic properties of modern econometric techniques. They include the functional central limit theorem and stochastic integrals. Finally, we discuss stochastic differential equations and their applications in finance and related fields, e.g. for pricing financial derivatives.

**Course objectives**

The purpose of the course is to introduce students to the study of stochastic processes in discrete and continuous time. Students will have learned the essentials of the subject and should be able to apply the acquired theoretical tools to problems in econometrics, economics, finance, and other fields.
Prerequisites

Only Master students can take Econometrics Master courses. Students require a solid background in mathematical statistics and probability theory on the level of the BSc Econometrics programme.

An advanced level of English.

Recommended reading

- Reader

Social Choice Theory

Full course description

In collective decision-making (e.g., elections) the rules and procedures used to arrive at a decision may have a considerable impact on the final result. Different rules may lead to different decisions. In this course such rules are studied. In particular, desirable properties like Pareto-optimality and non-manipulability are investigated.

Some topics are:

- voting schemes for two alternatives, theorem of May;
- voting schemes for more than two alternatives, score rules, veto rules;
- Condorcet winners, dictatorial rules, anonymity, neutrality, positive association, impossibility theorems of Arrow, Gibbard and Satterthwaite;
- location problems;
- strategy-proof division;
- implementation.
Course objectives

In this course the student will learn to formally analyse collective decision rules w.r.t. various aspects such as anonymity, Pareto-optimality, neutrality, and strategy-proofness.

Prerequisites

A mathematic level comparable to a BSc Econometrics & Operations Research meets the prerequisites.

Exchange students need to have obtained a Bachelor degree and an advanced level in mathematics.

An advanced level of English.

Recommended reading

Lecture notes.

EBC4005
Period 2
28 Oct 2019
20 Dec 2019
Print course description
ECTS credits:
6.5
Instruction language:
English
Coordinator:

- A.J.A. Storcken

Teaching methods:
PBL, Lecture(s)
Assessment methods:
Written exam
School of Business and Economics

Industrial Economics

Full course description

Every week of this course consists of one theory lecture and one exercise session. During the exercise session we will discuss some exercises about the theory of that week. These exercise sessions will be highly interactive, as students will be asked to explain an exercise, or a part of it, to their fellow students on the whiteboard.

Some topics that we will discuss are: Static and dynamic models of quantity and price competition, horizontal and vertical product differentiation, price discrimination, asymmetric information, signaling by prices and advertising, cartels, and models of strategic entry.
Course objectives

The aim of this course is to guide the students through some of the most important models in Industrial Economics. In this area we investigate the behavior of firms, both in monopolistic and oligopolistic markets. In oligopolistic markets we study small numbers of firms that compete with each other by choosing quantities, prices, product characteristics, or marketing strategies. We often use game theory to investigate such competition models. This is natural since in these settings firms must reason about the decisions of other firms before deciding about their own strategy. Hence, such competition models can be seen as games between firms. In this course we will not only analyze the various models game theoretically, but will also discuss the findings in these models from an intuitive economic point of view. A good conceptual understanding and economic intuition is considered very important.

Prerequisites

A good understanding of micro economics, and a basic knowledge of game theory.

Recommended reading


Equilibrium Theory and Financial Markets

Full course description

After introducing the necessary mathematical preliminaries and extending our knowledge on selected ingredients from consumer theory, the course focuses on general equilibrium models with complete markets, in particular classical exchange and production economies. Central concepts to be studied are the competitive equilibrium and the core. Next, the model is extended to include time...
and uncertainty, and the strong assumption of complete markets is relaxed. This makes it possible to incorporate financial markets in a satisfactory way. We study the relationships between equilibrium and arbitrage opportunities, and the valuation of financial securities. The well-known CAPM is a special case of the model studied. A rigorous derivation of the CAPM is provided.

**Course objectives**

- Learn about the notion of competition in a setting with many households, firms, and commodities.
- Understand the notions of competitive equilibrium, the first and second fundamental welfare theorem, and the core.
- Understand the role of financial markets in reshuffling income across time and states of the world.
- Learn about the consequences of market incompleteness.
- Understand the Capital Asset Pricing Model.

**Prerequisites**

Intermediate microeconomics course, e.g. Microeconomics, or Information, Markets and Organisation. Exchange students need to have obtained a Bachelor degree with a major in Economics or Econometrics and have an advanced level in mathematics.

An advanced level of English.

**Recommended reading**


EBC4009
Period 5
6 Apr 2020
5 Jun 2020
Print course description
ECTS credits:
6.5
Instruction language:
English
Coordinator:

- A. Predtetchinski

Teaching methods:
PBL, Assignment(s)
Assessment methods:
Written exam
School of Business and Economics
Game Theory and Optimisation

Full course description

Topics in optimization include duality theorems in LP, branch and bound and cutting plane algorithms in IP, and Kuhn-Tucker conditions for NLP.

Topics in game theory and economics include computation of Nash equilibrium and refinements and mechanism design.

Course objectives

This course provides a comprehensive overview of optimization techniques such as linear and integer programming, and non-linear programming, with applications in game theory and economics. Students learn optimization techniques from mathematics and operations research, and how to apply them in models from game theory and economic theory.

Prerequisites

Only Master students can take this course. Exchange students need to have obtained a BSc degree in Economics, International Business, Econometrics, or a related topic. Familiarity with the basic concepts of optimization and linear programming will be helpful. A solid basis in mathematics and calculus is also recommendable.

Recommended reading

The course will be based on chapters from standard textbooks plus additional readers.

Recommended literature for background reading:


EBC4188
Period 1
2 Sep 2019
25 Oct 2019
Print course description
ECTS credits:
Deterministic dynamic systems are usually not well suited for modelling real world dynamics in economics, finance and business. Allowing for random components in dynamic systems leads to stochastic dynamic modelling, which is based on stochastic processes. This course covers models of stochastic processes in discrete and continuous time. This includes Markov chains, Poisson processes and Brownian motion. We introduce various tools that are very useful for deriving and understanding the asymptotic properties of modern econometric techniques. They include the functional central limit theorem and stochastic integrals. Finally, we discuss stochastic differential equations and their applications in finance and related fields, e.g. for pricing financial derivatives.

The purpose of the course is to introduce students to the study of stochastic processes in discrete and continuous time. Students will have learned the essentials of the subject and should be able to apply the acquired theoretical tools to problems in econometrics, economics, finance, and other fields.

Only Master students can take Econometrics Master courses. Students require a solid background in mathematical statistics and probability theory on the level of the BSc Econometrics programme.

An advanced level of English.


Recommended reading
Algorithms and Optimisation

Full course description

This course is devoted to mathematical models and solution methods for hard optimization problems. First, we study the theory of computational complexity, including the concept of P versus NP. In particular, we prove that some problems are computationally intractable. Given the complexity insights, solving such problems is a challenge. Therefore, we study the design and analysis of exponential time exact algorithms as well as polynomial time approximation algorithms and approximation scheme. The course is open ended in the sense that some topics can be chosen according to student interests. Classical problems that will be covered are, among others, scheduling, colouring, set covering, and packing. Equipped algorithm design skills will be used to solve challenging problems from Project Euler (projecteuler.net) throughout the entire course.

Course objectives

Ability to analyse the complexity of optimization problems, and ability to design fast algorithms providing good-quality solutions for hard optimization problems.

Prerequisites

Students need to have obtained a Bachelor degree in Econometrics, Operations Research, Mathematics, or Computer Science. Knowledge in optimization (Linear Programming) and basic graph theory is highly recommended. Familiarity with basic algorithms and the analysis of algorithms (runtime complexity) is certainly helpful. C++ (or Java/Python/Basic) Programming skills are also prerequisites as there will be many practical programming cases. An advanced level of English.

Recommended reading

"Algorithms" by Dasgupta, Papadimitriou and Vazirani (Mc Graw-Hill). Selected chapters from several books on combinatorial optimization.
Modelling and Solver Technology

Full course description

This course is devoted to mathematical modelling of hard optimisation problems. We focus on integer programming techniques to solve these optimisation problems. During this course techniques as branch and bound, cutting planes and column generation will be discussed as well as the theory needed to understand these techniques. Furthermore, partially by using LP and ILP solvers, some of these techniques will be implemented.

Course objectives

After this course, the student is able to model (hard) optimisation problems as mathematical programs and knows several techniques to solve these problems. Moreover, the student can use general purpose software tools to solve these problems.

Prerequisites

Linear programming (including the simplex method), duality, basics in integer programming, combinatorial optimisation, graph theory, C++, Java (or some other programming language). Exchange students need to have obtained a Bachelor degree and an advanced level in mathematics. An advanced level of English

Recommended reading

- Selected papers.
- Lecture notes.
Full course description

This course is devoted to mathematical models and solution methods in logistics and telecommunication. Based on recent articles from scientific journals, we review classical as well as new optimisation models from problem domains such as facility location, vehicle routing, personnel scheduling, network design, traffic network analysis, railway planning, optical telecom networks, frequency planning for GSM-networks, and site location in UMTS. These problems are analysed with respect to solvability, complexity, and approximability. In particular, exact and approximation algorithms as well as heuristic techniques for these problem are studied. Students will learn how techniques learned from the courses "Algorithms and Optimisation" and "Modelling and Solver Technology" are applied to real world problems, and how these techniques can be refined in order to address specific problem structures.

Course objectives

Students learn how to apply general techniques from mathematical programming and combinatorial optimisation to specific classes of problems as well as to real-life applications in these areas. This includes the mathematical analysis of approximation algorithms and heuristics for these applications. Students will learn how to read state-of-the-art research articles, to understand the technical details, and to give presentations on the subjects.

Prerequisites

Students have to be familiar with the subjects of the Master courses "Algorithms and Optimisation" and "Modelling and Solver Technology" from the Master programme Econometrics and Operations Research. This includes at least basic algebra, linear programming, problems and techniques from combinatorial optimisation and complexity theory. Programming abilities in C++ and CPLEX.
Recommended reading

Recent research articles and lecture notes will be provided.

EBC4187
Period 5
6 Apr 2020
5 Jun 2020
Print course description
ECTS credits:
6.5
Coordinator:

- A. Berger

Teaching methods:
PBL, Paper(s), Assignment(s), Presentation(s), Lecture(s), Work in subgroups, Research
Assessment methods:
Participation, Attendance, Presentation, Assignment
School of Business and Economics

Game Theory and Optimisation

Full course description

Topics in optimization include duality theorems in LP, branch and bound and cutting plane
algorithms in IP, and Kuhn-Tucker conditions for NLP.

Topics in game theory and economics include computation of Nash equilibrium and refinements and
mechanism design.

Course objectives

This course provides a comprehensive overview of optimization techniques such as linear and
integer programming, and non-linear programming, with applications in game theory and
economics. Students learn optimization techniques from mathematics and operations research, and
how to apply them in models from game theory and economic theory.

Prerequisites

Only Master students can take this course. Exchange students need to have obtained a BSc degree
in Economics, International Business, Econometrics, or a related topic. Familiarity with the basic
concepts of optimization and linear programming will be helpful. A solid basis in mathematics and
calculus is also recommendable.
**Recommended reading**

The course will be based on chapters from standard textbooks plus additional readers.

Recommended literature for background reading:


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EBC4188
Period 1
2 Sep 2019
25 Oct 2019

**Print course description**

ECTS credits:
6.5

Coordinators:

- A.J. Vermeulen
- M. Staudigl

Teaching methods:
PBL, Lecture(s)

Assessment methods:
Written exam

**Skills**

School of Business and Economics

**Topics in Computational Econometrics**

**Full course description**

The students use a statistical and matrix programming language (Gauss or R for example) software to implement computationally intensive econometric techniques. The focus will be on programming and using advanced techniques not readily available in standard statistical or optimisation packages. These techniques may for example include simulation based methods (bootstrap, Monte Carlo, indirect inference).

**Course objectives**

Students will work with an advanced statistical and matrix programming language in order to solve advanced problems in econometrics.
Prerequisites

- Courses from periods 1 and 2 from the Master in Econometrics.
- Restricted to econometrics students or students from the MSc. Research master programs.

Recommended reading

A selection of (survey) articles on the specific econometric techniques used and manuals on the statistical software used (all will be distributed via the course website).

EBS4007
Period 3
6 Jan 2020
31 Jan 2020
Print course description
ECTS credits:
4.0
Instruction language:
English
Coordinator:
- S.J.M. Smeekes

Teaching methods:
Lecture(s), Assignment(s), Work in subgroups
Assessment methods:
Final paper
School of Business and Economics

Operations Research Software

Full course description

During this course, we introduce discrete event simulation. The students need to implement a discrete event simulation tool for a practical problem and be able to analyse the outcome of the simulations.

Course objectives

After this skill, the student knows what discrete event simulation is and can implement it in a programming language.

Prerequisites

- Basic knowledge of Operations Research and Combinatorial Optimisation, programming skills.
- An advanced level of English.
Topics in Computational Actuarial Methods

Full course description

The goal of the course is to become familiar with computer based methods useful in actuarial science and financial engineering. The focus of the course will be on Monte Carlo Methods and the Bootstrap. After a general introduction to Monte Carlo Methods we will study variance reducing techniques such as importance sampling and control variates in more detail. To see how these techniques work in practice we will discuss how they can be used in actuarial applications like the calculation of risk measures. Similar, we will first give a general introduction to the Bootstrap. Next, we apply the Bootstrap to actuarial problems like estimation of Value-at-Risk or constructing confidence intervals for the number of claims made per year.

Course objectives

To provide an understanding of mathematical models useful in actuarial science and their implementation.

Prerequisites


Recommended reading

Research articles and slides of the course.
In collective decision-making (e.g., elections) the rules and procedures used to arrive at a decision may have a considerable impact on the final result. Different rules may lead to different decisions. In this course such rules are studied. In particular, desirable properties like Pareto-optimality and non-manipulability are investigated.

Some topics are:

- voting schemes for two alternatives, theorem of May;
- voting schemes for more than two alternatives, score rules, veto rules;
- Condorcet winners, dictatorial rules, anonymity, neutrality, positive association, impossibility theorems of Arrow, Gibbard and Satterthwaite;
- location problems;
- strategy-proof division;
- implementation.

Course objectives

In this course the student will learn to formally analyse collective decision rules w.r.t. various aspects such as anonymity, Pareto-optimality, neutrality, and strategy-proofness.

Prerequisites

A mathematic level comparable to a BSc Econometrics & Operations Research meets the prerequisites.
Exchange students need to have obtained a Bachelor degree and an advanced level in mathematics. An advanced level of English.

**Recommended reading**

Lecture notes.

EBC4005  
Period 2  
28 Oct 2019  
20 Dec 2019  
[Print course description](#)

ECTS credits: 6.5

Instruction language: English

Coordinator:
- A.J.A. Storcken

Teaching methods: PBL, Lecture(s)

Assessment methods: Written exam

School of Business and Economics

**Econometric Methods for Cross-sectional and Panel Data**

**Full course description**

The main topics of the course are (1) unobserved effects models for panel data, (2) probit and logit models for discrete choice, (3) tobit and related censored regression models, (4) models dealing with sample selectivity, and (5) the estimation of average treatment effects (a.k.a. policy impact evaluation). Dynamic extensions of the models are considered when feasible. Estimation and testing methods are applied in a number of empirical assignments and their properties are investigated.

**Course objectives**

- Thorough understanding of the most frequently used econometric models and methods for the analysis of panel data, categorical choice and limited dependent variables.
- Some practice in the application of the methods, the interpretation of the models, and the evaluation of inferences.
- The experience of conducting a theoretical, experimental and/or empirical investigation of the methods.

**Prerequisites**

- Calculus, matrix algebra, probability, mathematical statistics, asymptotic theory, linear statistical models.
Master Econometrics and Operations Research

- Familiarity with statistical software like Stata and Gauss, Matlab, or R.
- Econometric methods at the level of Greene (2008) or Davidson & MacKinnon (2004), ideally as in courses Econometric Methods I (EBC2111), and Econometric Methods II (EBC2120).

The course is intended for students in the Econometrics Master programme as well as others with a comparable background and motivation. FLUENCY IN MATRIX ALGEBRA AND IN ASYMPTOTIC THEORY is necessary.

An advanced level of English.

**Recommended reading**


These references will be supplemented with a reading list of journal articles and book chapters.

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**ECTS credits:**
6.5

**Instruction language:**
English

**Coordinator:**
D.P.I. de Crombrugghe

**Teaching methods:**
Presentation(s), Lecture(s), Assignment(s), Work in subgroups, Paper(s), Research, Skills

**Assessment methods:**
Final paper, Participation, Written exam, Presentation

School of Business and Economics

**Industrial Economics**

**Full course description**

Every week of this course consists of one theory lecture and one exercise session. During the exercise session we will discuss some exercises about the theory of that week. These exercise sessions will be highly interactive, as students will be asked to explain an exercise, or a part of it, to their fellow students on the whiteboard.

Some topics that we will discuss are: Static and dynamic models of quantity and price competition, horizontal and vertical product differentiation, price discrimination, asymmetric information, signaling by prices and advertising, cartels, and models of strategic entry.
Course objectives

The aim of this course is to guide the students through some of the most important models in Industrial Economics. In this area we investigate the behavior of firms, both in monopolistic and oligopolistic markets. In oligopolistic markets we study small numbers of firms that compete with each other by choosing quantities, prices, product characteristics, or marketing strategies. We often use game theory to investigate such competition models. This is natural since in these settings firms must reason about the decisions of other firms before deciding about their own strategy. Hence, such competition models can be seen as games between firms. In this course we will not only analyze the various models game theoretically, but will also discuss the findings in these models from an intuitive economic point of view. A good conceptual understanding and economic intuition is considered very important.

Prerequisites

A good understanding of micro economics, and a basic knowledge of game theory.

Recommended reading


EBC4007
Period 4
3 Feb 2020
3 Apr 2020
Print course description
ECTS credits:
6.5
Instruction language:
English
Coordinators:
- A. Perea y Monsuwé
- C.J. Woolnough

Teaching methods:
PBL, Lecture(s)
Assessment methods:
Written exam
School of Business and Economics

Time Series Methods and Dynamic Econometrics

Full course description

The emphasis of this course will be on studying in depth methods and techniques for the analysis of (nonstationary) economic and financial time series. We will cover and discuss issues related to:
- dynamic econometric modelling
- modelling nonstationary processes
Master Econometrics and Operations Research

- asymptotic theory for dependent and integrated processes
- unit roots (representation, tests, properties), cointegration and VECMs.
Empirical applications as well as simulation experiments will also be considered to provide students with practical experience in analyzing economic and business time series.

**Course objectives**

The objectives of this course are:
- to provide students with an understanding/intuition of the concepts of modern time series methods that are used in econometrics.
- introduce the student to fundamental methodological issues in dynamic econometric modelling (nonstationarity, nonstandard asymptotic theory).
- to provide students with some experience in analyzing univariate and multivariate time series from economics or business.

**Prerequisites**

Econometric methods (EBC2111), Stochastic Processes (EBC4004).

Exchange students need to have a solid background in econometric methods, probability theory, mathematical statistics, and some knowledge in stochastic processes (some familiarity with Brownian Motion theory is important). Exchange students need to have obtained a Bachelor degree and an advanced level in mathematics and probability and statistics.

An advanced level of English.

**Recommended reading**

The main textbook used in this course will be:
You might also want to consult the following book:
The first book is mathematically very concise, while the second book is more narrative of nature. Students often perceive the two books as complementary.

EBC4008
Period 2
28 Oct 2019
20 Dec 2019
Print course description
ECTS credits:
6.5
Instruction language:
English
Coordinator:
- I. Wilms

Teaching methods:
PBL, Presentation(s), Lecture(s), Work in subgroups
Equilibrium Theory and Financial Markets

Full course description

After introducing the necessary mathematical preliminaries and extending our knowledge on selected ingredients from consumer theory, the course focuses on general equilibrium models with complete markets, in particular classical exchange and production economies. Central concepts to be studied are the competitive equilibrium and the core. Next, the model is extended to include time and uncertainty, and the strong assumption of complete markets is relaxed. This makes it possible to incorporate financial markets in a satisfactory way. We study the relationships between equilibrium and arbitrage opportunities, and the valuation of financial securities. The well-known CAPM is a special case of the model studied. A rigorous derivation of the CAPM is provided.

Course objectives

- Learn about the notion of competition in a setting with many households, firms, and commodities.
- Understand the notions of competitive equilibrium, the first and second fundamental welfare theorem, and the core.
- Understand the role of financial markets in reshuffling income across time and states of the world.
- Learn about the consequences of market incompleteness.
- Understand the Capital Asset Pricing Model.

Prerequisites

Intermediate microeconomics course, e.g. Microeconomics, or Information, Markets and Organisation. Exchange students need to have obtained a Bachelor degree with a major in Economics or Econometrics and have an advanced level in mathematics.

An advanced level of English.

Recommended reading

Master Econometrics and Operations Research

English
Coordinator:

- A. Predtetchinski

Teaching methods:
PBL, Assignment(s)
Assessment methods:
Written exam
School of Business and Economics

**Empirical Analysis of Financial Markets**

**Full course description**

In this course we consider in depth the fluctuations of stock prices. The purpose of the course is to provide you with an overview of recent empirical research in asset pricing and portfolio management. How are theoretical models of asset pricing being tested in practice? What are the strengths and weaknesses of various methodologies? What kind of statistical techniques are used?

Statistical methods in empirical asset pricing have evolved into a separate field called financial econometrics. These techniques are specifically designed to answer typical questions in finance. Examples are models of risk that look at how risk is measured, how it evolves over time, and how risks in different stocks are related. It also considers probabilities of crashes, bankruptcies and defaults, and statistical tests for the performance of trading strategies.

A more recent development are prediction models that build on insights from machine learning and advances in big data methodologies. These techniques seem to uncover new patterns in stock prices. From an investment perspective it is important to assess whether such new facts will remain or will be arbitraged away as soon as large investors start trading to exploit these patterns.

In the course we will review and discuss interpretations of new techniques and empirical findings.

A second aim of the course is to let you gain some experience in doing empirical research. An important aspect of the course is learning about the characteristics of stock returns by doing a small research project. The research projects are concerned with predictability of stock returns and the profitability of various trading strategies based on (seeming) anomalies. At the end of the course you should be able to make your own assessment about events on financial markets. Are reported superior returns pure chance, statistical illusion, a reward for risk or really an anomaly?

**Course objectives**

The purpose of the course is to provide students with an overview of empirical methods and stylised facts that will enable them to make their own assessment of events on financial markets.

**Prerequisites**

Knowledge of basics of asset pricing and portfolio management, and linear regression models. Exchange students need to have obtained a Bachelor degree in economics or business administration, and sufficient quantitative background. Exchange students need to major in finance in their master.
Algorithms and Optimisation

Full course description

This course is devoted to mathematical models and solution methods for hard optimization problems. First, we study the theory of computational complexity, including the concept of P versus NP. In particular, we prove that some problems are computationally intractable. Given the complexity insights, solving such problems is a challenge. Therefore, we study the design and analysis of exponential time exact algorithms as well as polynomial time approximation algorithms and approximation scheme. The course is open ended in the sense that some topics can be chosen according to student interests. Classical problems that will be covered are, among others, scheduling, colouring, set covering, and packing. Equired algorithm design skills will be used to solve challenging problems from Project Euler (projecteuler.net) throughout the entire course.

Course objectives

Ability to analyse the complexity of optimization problems, and ability to design fast algorithms providing good-quality solutions for hard optimization problems.

Prerequisites

Students need to have obtained a Bachelor degree in Econometrics, Operations Research, Mathematics, or Computer Science. Knowledge in optimization (Linear Programming) and basic
Master Econometrics and Operations Research

graph theory is highly recommended. Familiarity with basic algorithms and the analysis of algorithms (runtime complexity) is certainly helpful. C++ (or Java/Python/Basic) Programming skills are also prerequisites as there will be many practical programming cases. An advanced level of English.

**Recommended reading**

"Algorithms" by Dasgupta, Papadimitriou and Vazirani (Mc Graw-Hill).
Selected chapters from several books on combinatorial optimization.

EBC4049
Period 2
28 Oct 2019
20 Dec 2019
[Print course description]
ECTS credits:
6.5
Instruction language:
English
Coordinator:
- A. Grigoriev

Teaching methods:
PBL, Lecture(s), Assignment(s), Work in subgroups
Assessment methods:
Participation, Final take home exam

**Modelling and Solver Technology**

**Full course description**

This course is devoted to mathematical modelling of hard optimisation problems. We focus on integer programming techniques to solve these optimisation problems. During this course techniques as branch and bound, cutting planes and column generation will be discussed as well as the theory needed to understand these techniques. Furthermore, partially by using LP and ILP solvers, some of these techniques will be implemented.

**Course objectives**

After this course, the student is able to model (hard) optimisation problems as mathematical programs and knows several techniques to solve these problems. Moreover, the student can use general purpose software tools to solve these problems.

**Prerequisites**

Linear programming (including the simplex method), duality, basics in integer programming, combinatorial optimisation, graph theory, C++, Java (or some other programming language).
Master Econometrics and Operations Research
Exchange students need to have obtained a Bachelor degree and an advanced level in mathematics. An advanced level of English

**Recommended reading**

- Selected papers.
- Lecture notes.

EBC4051
Period 4
3 Feb 2020
3 Apr 2020
[Print course description](#)
ECTS credits:
6.5
Instruction language:
English
Coordinator:
- A. Abiad Monge

Teaching methods:
Work in subgroups, Lecture(s), PBL, Presentation(s), Assignment(s), Paper(s)
Assessment methods:
Attendance, Participation, Assignment, Presentation
School of Business and Economics

### Life Insurance I

**Full course description**

1. Pricing by Replication: Role of the actuary; Basic idea fair value; Bonds; Forward rates; Duration; Inflation.
2. Equity Options: Unit linked insurance; Intro to option theory; Equity derivatives; With-profit policies.
5. Time-Consistent and Market-Consistent Pricing: Two-step pricing operator; Pricing in continuous time.
6. Interest Rate Risk: Interest rate swaps; Swaptions; Minimum return guarantees.
7. Applications: Market-consistent embedded value; Solvency II; IFRS 17.

Study-load and grading:
* Study-load = 6.5 ECTS (= 182 study-hours).
* The course takes 7 weeks, with 4 contact hours every week plus mandatory homework assignments every week.
* Students work in groups of max. 3 students on the homework assignments. Each post-discussion two groups present their solution to the tutorial group, which will then be discussed by the tutorial group.
Master Econometrics and Operations Research

* Please note that the homework assignments are based on real-life cases. This means that the assignments are relatively unstructured. This also means that there is usually not a unique "correct" solution for the assignment. It is therefore important that students can motivate and defend the choices they have made to obtain their solution. Discussing the pro's and con's of different solutions will be an important aspect of the post-discussion.

* Average grade for all homework-presentations in the post-discussion counts for 50% of final grade. Final written exam counts for 50% of final grade.

**Course objectives**

In this course we aim to teach students the basic principles of pricing life-insurance and pension contract and basic principles of measuring value creation on a market-consistent basis (Market-Consistent Embedded Value).

The underlying principle for this course is the notion that the market-consistent value of a life-insurance or pension contract is based on the market-value of the Replicating Portfolio plus an “addon” for the remaining (unhedgeable) portions of the risk that are not covered by the Replicating Portfolio.

**Prerequisites**

Bachelor Level Econometrics and Operations Research, including preparatory courses Actuarial Sciences.

**Recommended reading**

To be announced.

EBC4119
Period 2
28 Oct 2019
20 Dec 2019
[Print course description](#)
ECTS credits: 6.5
Instruction language: English
Coordinator:
- A.A.J. Pelsser

Teaching methods: PBL, Lecture(s), Assignment(s)
Assessment methods: Participation, Written exam
School of Business and Economics
Life Insurance II

Full course description

The course provides students with statistical models that are useful in life insurance (many of these models are also used in other fields that are concerned with future lifetimes of individuals or groups such as biostatistics, epidemiology or public health planning). We first discuss methods to model mortality rates for a larger group or an entire population. A particular focus is on the Lee-Carter model and its extensions. We also learn how to estimate these models. Afterwards we turn to models that are appropriate to model the future lifetime of individuals. A focus will be on models that can incorporate covariates such as parametric regression models, the Cox model and the accelerated failure time model. We also address the multiple decrement model. Subsequently, we discuss how these models can be used to set premiums for life insurance products. In the last part of the course we introduce a model that allows to calculate premiums for insurances that may provide benefits depending on the current status of the insured. As part of the course students will also apply the methods introduced to real data.

Course objectives

To become acquainted with statistical models that can be used in life insurance.

Prerequisites


Recommended reading

Research articles, the slides of the course.

EBC4120
Print course description
ECTS credits:
6.5
Instruction language:
English
Teaching methods:
PBL, Lecture(s), Assignment(s), Presentation(s)
Assessment methods:
Participation, Written exam, Final paper
School of Business and Economics

Mathematical Finance

Full course description

The aim of the course is to provide students with an appreciation and understanding of the main ideas and concepts of mathematical finance. The core of mathematical finance concerns questions of
pricing and hedging of financial derivatives such as options whose value depend on that of an underlying risky asset. We will discuss the general principles of continuous-time financial markets where the investor can buy and sell \( d+1 \) assets. As a special case we will consider the Black-Scholes model for a financial market. We will further point out the link between the no-arbitrage condition and certain probability measures, the so called equivalent martingale measures. In complete markets as well as in incomplete markets these measures allow to price financial derivatives in an arbitrage-free way. Moreover, we will consider probabilistic models for bond markets and apply the theory of equivalent martingale measures to the pricing of fixed income securities. Finally, we will address the issue of estimating the parameters of the probabilistic models from historical data.

**Course objectives**

The principal aim of this course is to provide students with an appreciation and understanding of how the application of mathematics, particularly stochastic mathematics, to the field of finance may be used to illuminate this field and model its randomness, resulting in greater understanding and quantification of investment returns and security prices.

**Prerequisites**

Students should have knowledge of stochastic processes, in particular Brownian motion, geometric Brownian motion and the underlying stochastic differential equations. Moreover, students should be familiar with the Itô integral and the Itô formula. Knowledge of the Girsanov transformation is helpful, but not required.

**Recommended reading**

Operations Research Applications

Full course description

This course is devoted to mathematical models and solution methods in logistics and telecommunication. Based on recent articles from scientific journals, we review classical as well as new optimisation models from problem domains such as facility location, vehicle routing, personnel scheduling, network design, traffic network analysis, railway planning, optical telecom networks, frequency planning for GSM-networks, and site location in UMTS. These problems are analysed with respect to solvability, complexity, and approximability. In particular, exact and approximation algorithms as well as heuristic techniques for these problem are studied. Students will learn how techniques learned from the courses "Algorithms and Optimisation" and "Modelling and Solver Technology" are applied to real world problems, and how these techniques can be refined in order to address specific problem structures.

Course objectives

Students learn how to apply general techniques from mathematical programming and combinatorial optimisation to specific classes of problems as well as to real-life applications in these areas. This includes the mathematical analysis of approximation algorithms and heuristics for these applications. Students will learn how to read state-of-the-art research articles, to understand the technical details, and to give presentations on the subjects.

Prerequisites

Students have to be familiar with the subjects of the Master courses "Algorithms and Optimisation" and "Modelling and Solver Technology" from the Master programme Econometrics and Operations Research. This includes at least basic algebra, linear programming, problems and techniques from combinatorial optimisation and complexity theory. Programming abilities in C++ and CPLEX.

Recommended reading

Recent research articles and lecture notes will be provided.

EBC4187
Period 5
6 Apr 2020
5 Jun 2020
Print course description
ECTS credits:
6.5
Coordinator:
- A. Berger

Teaching methods:
PBL, Paper(s), Assignment(s), Presentation(s), Lecture(s), Work in subgroups, Research
Assessment methods:
Participation, Attendance, Presentation, Assignment
High-Dimensional Econometric Methods for Big Data

Full course description

In this course we cover several advanced techniques that have recently been developed in econometrics and statistics for the analysis of high-dimensional problems, which often arise in the context of Big Data. We will discuss theoretical properties of the methods, their practical implementation using the statistical programming language R and the application of these methods to real-life economic and financial datasets.

Topics that are covered include:

- Linear regression with many regressors: the "curse of dimensionality" in standard least squares estimation and standard approaches to model selection (such as information criteria and cross-validation);
- Modern statistical techniques for estimating high-dimensional regression models such as penalized regression (the lasso, ridge and variants): implementation, interpretation and properties;
- The standard modern tool in high-dimensional econometrics: Estimation, inference and forecasting in common factor models;
- Inference in high-dimensional regression models: multiple hypothesis testing, post-model selection inference, construction of 'honest' confidence intervals and hypothesis tests;
- High-dimensional discrete choice/classification methods.

The course will consist of lectures, in which the methods and theory are introduced, and tutorials, in which groups of students present specific papers on the subject. Students also have to write a paper for which they implement and apply the methods to economic problems.

Course objectives

The objective of this course is to provide students with an understanding of modern and advanced econometric techniques for the analysis of high-dimensional data. Students will be able to read and understand theoretical papers on the subject, to implement the techniques themselves in statistical software, and to apply the techniques to data used in economics and business. In addition to gaining this knowledge they will develop the skills to assess such methods critically and consequently adapt them to suit their needs.

Prerequisites

This is an ADVANCED econometric course. Familiarity with the mathematical methods underlying econometric theory is therefore essential. In particular, students need to have solid background in probability theory, mathematical statistics, econometric methods and time series analysis, comparable to the knowledge obtained during the econometric courses of the bachelor programme Econometrics and Operations Research. Familiarity with asymptotic analysis is necessary. In addition, a solid knowledge about time series econometrics is recommended, in particular about VAR models. One way to achieve (more than) sufficient knowledge of time series econometrics is by following the course Time Series Analysis and Dynamic Econometrics (potentially in parallel).
Recommended reading

- Selected papers and book chapters (to be announced on Eleum/Student Portal)

EBC4218
Period 4
3 Feb 2020
3 Apr 2020
Print course description
ECTS credits:
6.5
Coordinator:

- S.J.M. Smeekes

Teaching methods:
Lecture(s), PBL, Presentation(s), Work in subgroups
Assessment methods:
Final paper, Participation, Written exam
School of Business and Economics

Machine Learning

EBC4257
Period 5
6 Apr 2020
5 Jun 2020
Print course description
ECTS credits:
6.5
Instruction language:
English

Free Electives

School of Business and Economics

Capita Selecta Quantitative Economics: Econometrics, Mathematical Economics and Operations Research

Full course description

This course does not have a fixed content, block period, or teacher. Instead, its code can be used for special topics that are not offered within the regular offering of the master program Econometrics
Master Econometrics and Operations Research and Operations Research of the SBE. The initiative can be taken jointly by a teacher (member of the Department of Quantitative Economics) and a group of students.

Students who participate in this course have to register for it in period 5, even if the course has been given in an earlier period of the same academic year.

**Course objectives**

See the Course Contents

**Prerequisites**

Only (Research) Master students and PhD students can take this course.

The general level is the level of the master program Econometrics and Operations Research.

EBC4011
Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
6.5
Instruction language:
English
Coordinator:

- [A.J. Vermeulen](#)

Teaching methods:
PBL, Lecture(s), Assignment(s)
Assessment methods:
Participation, Written exam

School of Business and Economics

**Supply Chain Operations**

**Full course description**

The course Supply Chain Operations deals with the design, management and improvement of the processes that create a firm's primary services and products. Topics include scheduling, facility layout, facility location, sales & operations planning, inventory control, and project management. The course combines theory and exercises with several cases and recent research articles from the manufacturing and service industry.

**Course objectives**

Understanding the basic concepts of operations management in a supply chain context. Students will learn specific methods and techniques to model and solve problems in managing a firm’s operations
Prerequisites

Basic knowledge of statistics, probability and simulation; knowledge of Linear Programming and familiarity with Excel and the Solver plugin (as e.g. from the courses "Quantitative Methods" and "Operations Management" from the Bachelor International Business).

A previous course on Operations Management will be useful.

An advanced level of English.

Recommended reading

Literature will consist of recent research articles as well as case studies that will be made available. A list of textbooks on Operations Management is given in the course manual for additional reading/basic concepts.

EBC4016
Period 4
3 Feb 2020
3 Apr 2020
Print course description
ECTS credits:
6.5
Instruction language:
English
Coordinator:

- C.J.G. Defryn

Teaching methods:
PBL, Presentation(s), Lecture(s), Assignment(s), Work in subgroups, Paper(s)
Assessment methods:
Participation, Written exam, Attendance, Assignment, Presentation
School of Business and Economics

Supply Chain Strategy

Full course description

Supply Chain Strategy helps the student in the study of organising and optimizing supply chains. Supply chains are constellations of firms that together form the link between raw materials and the end consumer. Both upstream and downstream functions and supporting activities will be reviewed, and what it means to strategically “manage” the different connected organisations for overall performance of the chain. An introduction with background and overview of the different components of the chain to be managed will be followed by a state-of-the art review of contemporary strategic issues in Supply Chain Management, such as supply chain integration, relationship management, resilience and sustainability.
Course objectives

Serves as introduction to the discipline, and provides an overview of the pivotal elements of the supply chain management program. Provides students with strategic insights into managing supply chains and a solid basis for understanding the subsequent elements of the program.

Prerequisites

Courses and workload are very demanding for all IB Master courses. Exchange students need to have obtained a Bachelor degree in business. Exchange students need to major in supply chain management/ logistics in their Master.

An advanced level of English.

Recommended reading

Academic and practitioner articles.

EBC4018
Period 1
2 Sep 2019
25 Oct 2019
Period 4
3 Feb 2020
3 Apr 2020
Print course description
ECTS credits:
6.5
Instruction language:
English
Coordinator:

- D. Pinto Pereira Rebelo Cotta

Teaching methods:
PBL, Presentation(s), Lecture(s), Assignment(s), Work in subgroups
Assessment methods:
Participation, Final paper, Presentation
School of Business and Economics

ECB and Monetary Policy

Full course description

The 2008 financial crisis and the subsequent Great Recession have put monetary policy once again in the spotlight. On the one hand central banks are blamed for creating the crisis, on the other hand they are relied on to provide a way out of economic stagnation. Even almost 10 years later, we are still facing extreme monetary conditions. Interest rates are at the zero lower bound and central banks struggle with the question of how long to continue unconventional monetary policies and when and how to reverse these.
This course aims at deepening students’ knowledge of the relation between monetary and real phenomena in an economy, to facilitate a thorough analysis of the role of (ECB) monetary policy. In particular, we focus on

- the role of money in the economy and the effectiveness of monetary policy in the short run and the long run,
- the relation between money and credit and the role of commercial banks and the central bank in their creation
- the transmission channels from monetary policy to the real economy under various conditions, and the role of the banking sector in the transmission - the causes and consequences of financial crises
- the distinction between the goals and implementation of monetary policy (macroeconomic stability) and macro-prudential policy (financial stability)
- the optimal design of monetary policy (independence, transparency and accountability; rules vs discretion; reputation and credibility),
- the actual position and policies of the European Central Bank (including a visit)

**Course objectives**

- To understand and apply the workhorse (3-equation) model for macroeconomic analysis in a closed economy
- To understand the role of expectations in modern macroeconomics and monetary policy
- To understand the role of the banking sector in the interac

**Prerequisites**

Second-year macro-economics (BSC; level book Blanchard Et Al "Macroeconomics: A European Perspective").

Exchange students need to have obtained a Bachelor degree with a major in Economics or Econometrics.

**Recommended reading**

- Selected articles.

EBC4023
Period 1
2 Sep 2019
25 Oct 2019
Print course description
Master Econometrics and Operations Research

ECTS credits:
6.5

Instruction language:
English

Coordinator:
- **C.J.M. Kool**

Teaching methods:
Paper(s), Work in subgroups, Lecture(s), PBL, Presentation(s)

Assessment methods:
Final paper, Participation, Written exam

School of Business and Economics

**Open Macroeconomics in a Global Society**

**Full course description**

Over the past decades, the global economy has steadily become more integrated, leading to larger flows of trade in goods and services and of financial capital, longer and more complicated value chains in the production of manufactured goods, and a build-up of large stock of both financial and non-financial foreign assets and liabilities. Obviously, this makes national economies more interdependent and requires taking into account spill-overs from the rest of the world into the domestic economy. It raises the issue how an economy adjusts to demand and supply shocks and the role of the current account, the (real) exchange rate and monetary and fiscal stabilization policies in the adjustment. Similarly, it asks what the influence is of the chosen exchange rate regime: floating, fixed or monetary union and the limitations this puts on policy. In the course, we develop an open economy framework to address these questions. Initially, we build on the closed economy 3-equation model developed in the course ‘ECB and Monetary Policy’. We extend the analysis to an open economy setting. Important additional issues are the stock-flow dynamics in the Balance of Payments as well as stock-flow dynamics in government debt. These explicitly require an intertemporal approach. In the final part of the course, we explicitly focus on stabilization and risk sharing in the Euro area. As a monetary union, it faces different constraints on monetary and fiscal stabilization policy than stand-alone countries. Moreover, the chosen institutional design further restricts the possibilities for stabilization.

**Course objectives**

At the end of the course, students should be able to:

* Discuss causes and consequences of international economic and financial integration;
* Understand and explain the role of the Balance of Payments and its components in accounting for the interconnection of the domestic economy with the rest of the world;
* Understand and discuss the role of the real exchange rate (versus the real interest rate) in macroeconomic adjustment;
* Understand, explain and apply the 3-equation model for the open economy under fixed and floating exchange rates;
* Understand and explain the pros and cons of different foreign exchange rate regimes: floating, fixed, and monetary union;
* Understand how the current account can be analyzed from the perspective of intertemporal risk sharing - using a stock-flow framework – and apply this concept to real world cases;
* Understand and use the importance of stock-flow dynamics in government debt;
* Understand the – institutional – stabilization policy framework in the euro area and use it in combination with the 3-equation model for policy analysis;

**Prerequisites**

Second-year International Monetary Economics course (level book Krugman and Obstfeld), “International Economics: Theory and Policy”. Exchange students need to have obtained a Bachelor degree with a major in Economics or in Econometrics/Quantitative Economics.

An advanced level of English.

**Recommended reading**

Selected chapters and articles.

EBC4029
Period 2
28 Oct 2019
20 Dec 2019

[Print course description](#)

ECTS credits:
6.5

Instruction language:
English

Coordinator:
- C.J.M. Kool

Teaching methods:
PBL, Presentation(s)

Assessment methods:
Participation, Written exam, Presentation

School of Business and Economics

**Risk Management**

**Full course description**

The course is built around three important topics: first, it is important to identify financial risks and to measure them. Important topics, such as value-at-risk, volatility, correlation and copulas, as well as credit risk loss measurement will be addressed. The increased notion of concentration risk, warrant a proper discussion of alternative ways to model/measure co-movements (through copulas), as well as provide alternative ways to represent the variability in a financial variable (this includes alternative volatility models, such as GARCH models).

Second, this course focuses on understanding alternative approaches to manage risk. This includes the usage of derivative securities such as options and futures. It is a fact that derivatives' markets are skyrocketing, and it is becoming increasingly common for non-financial corporations to make heavy use of financial derivatives. Indeed, internationally, over 60% of non-financial corporations are
reported using derivatives. As of December 2007, the total notional value of over-the-counter derivatives was $596 trillion, a 200% increase over its value in December 2005. Financial risk management is reported to be the main reason for the use of financial derivatives by non-financial institutions.

Third, this course will focus on regulatory developments for banks under Basel II. Basel II has set new capital requirements standards for credit risk, operational risk and market risk. We will review the Basel II three pillar model and will discuss the three risk types mentioned above in detail as well.

**Course objectives**

- Understand the different dimensions of risk in banks, learns how to measure market-, credit-, liquidity- and operational risk.
- Understand the concepts of regulatory- and economic capital in a Basel II context and how to integrate these in a firm wide framework for performance measurement.

After completion of the course, participants should be able to measure alternative risk types, be able to carry out capital requirements, and determine risk mitigating strategies such as hedging and portfolio selection.

**Prerequisites**

Exchange students need to have obtained a Bachelor degree in economics or business administration. Exchange students need to major in finance in their master.

An advanced level of English.

**Recommended reading**


Additional literature may be available through Eleum.

Data and programs for assignments will be available through Eleum.
Master Econometrics and Operations Research
Assessment methods:
Written exam