Description courses and cases EMAS

Course 1 - Statistical Methods

The goal of this course is to provide concepts and techniques from probability theory and statistics that are widely used in the actuarial and financial industry.

The topics covered are Markov chains, survival analysis, time series analysis, nonparametric statistics, stochastic dependence, and extreme value theory.

- *Markov chains* provide a basic framework to model the dynamic (discrete-time) behavior of objects/individuals over time. Examples of applications are modeling the dynamics of credit ratings of a corporate bond portfolio and the modeling of a disability insurance portfolio.
- *Survival analysis* considers the modeling of durations. Examples of durations relevant for the financial and actuarial industry are: the time-to-death for life insurance policies, the time-to-prepayment of a loan or the time-to-early termination of a contract.
- The topic *time series analysis* discusses vector autoregressive (VAR) models, GARCH processes, and provides an introduction to the pitfalls and tools to deal with non-stationary time series. Time series models are used, for example, in economic scenario generators and asset management.
- *Nonparametric statistics* considers statistical inference, mainly estimation, in case it is not assumed that the underlying probability distribution follows a parametric model. Estimation of the distribution function and the density is studied in some detail, whereas nonparametric regression is briefly considered.
- *Stochastic dependence* of risks is crucial in insurance, e.g., dependence between losses, dependence between frequency and severity, or dependence of the different risks a financial institution faces. Stochastic dependence is considered in general, but the emphasis is on copulas.
- *Extreme value theory* is indispensable when dealing with catastrophes, like those caused by natural hazards. We consider the univariate theory and the corresponding actuarial applications in some detail. In the multivariate case we focus on tail dependence.

Learning outcomes

Having completed this course the participant should have:

- Understand and apply the techniques
- Understand and review (empirical) applications of the techniques/models

Compulsory reading

- Gourieroux, C. and J. Jasiak, The econometrics of individual risk: credit, insurance, and marketing, Princeton University Press, 200. (Chapter 6, 7 and 8)
- McNeil, A.J., R. Frey, and P. Embrechts, Quantitative risk management: concepts, techniques, and tools, Princeton University Press, 2005. (Chapters 3.3, 4, 5, and 7)
- Verbeek, M., A guide to modern econometrics, Wiley, 3rd edition 2008. (Chapters 8 and 9)
- Slides

Software

- EViews
- R and R Studio

  Please make sure the software is installed before starting the course. *R and R Studio* can be downloaded (for free) via http://www.r-project.org/ and https://www.rstudio.com

Prerequisites

Introductory courses in analysis, linear algebra, probability theory, mathematical statistics, and a course covering ARMA models (for time series).

Exam

Written exam

Teachers

Prof. dr. J. (John) Einmahl

Dr. R. (Ramon) van den Akker

Course 2 Life and Pensions

This course addresses issues that arise in the context of retirement provision and life insurance. Long-dated liabilities and intergenerational solidarity are key terms.

Having completed this course you should be able to value life insurance and pension liabilities and perform ALM analyses including longevity risk. You should also be able to participate in debates concerning pension systems and longevity, at policy level as well as at the level of underlying models.

Detailed contents are as follows.

1. Asset Management; optimal portfolio choice.

   We will first review the asset side of the pension fund balance sheet, covering such concepts as asset classification, mean-variance analysis, Sharpe ratios, the Capital Asset Pricing Model, and beta. We will then look beyond mean-variance analysis, taking into account higher moments of the return distribution, like skewness and kurtosis. You will make a case study on optimal portfolio choice.

2. Term structure modelling; Valuation of long-maturity liabilities; inflation risk; Long-run investments; nominal versus real term structures

We will introduce models for the term structure of interest rates that will be used to value liabilities, and we will analyze how ALM models, using inflation, (real) interest rates and stock returns as the relevant state variables, can be used to conveniently summarize the behavior of assets and liabilities on the pension fund balance sheet. You will make a case study in class. At this stage, longevity risk is ignored.

3. Modelling of mortality dynamics; Longevity risk: measurement and management; Effect of longevity risk on pension liabilities; Asset Liability Management; risk mitigating strategies.

   We will start by discussing state-of-the-art literature regarding mortality dynamics, starting from the seminal work by Lee and Carter, and then proceeding to more recent developments. Next, we will discuss the impact of longevity risk on pension and insurance providers, and we will extend ALM models to include longevity risk. We then analyze different methods to mitigate longevity and mortality risk. We will consider contracts that involve external financial parties, such as longevity swaps and survivor bonds, but also constructions that implement internal risk sharing mechanisms between different subgroups within a pension provider. We discuss the difficulties in establishing a market price for longevity risk, quantify the effectiveness of possible risk mitigation solutions for different

types of stakeholders, and we also take a look at implementation issues such as longevity basis spreads and counterparty risk.

4. Supervision models; nFTK and Solvency; supervision on keeping promises in case of stated ambitions; Transparency regarding future purchasing power of pension entitlements.

   We will first focus on pension regulation in the Netherlands, covering the following topics: funding ratio, solvency buffers, ultimate forward rate, recovery plans, indexation cuts, pension results. We will then also spend time on the historical evolution of Dutch pension regulation, and make international comparisons. You will combine the above-described models to make a case study on the calculation of a pension fund's required solvency.

Learning outcomes

Upon completion of the course, participants will be able to participate in debates concerning pension systems and longevity, at the policy level as well as at the level of the underlying models.

Literature

Lecture notes / presentation to be distributed by lecturer.	
Campbell & Viceira (2005), "*The Term Structure of the Risk-Return Trade-Off," Financial Analysts Journal*, Vol. 61, No. 1, p. 34—44	
Pitacco, E., Denuit, M., & Haberman, S. (2009). *Modelling longevity dynamics for pensions and annuity business*. Oxford University Press.	
De Waegenaere, A., Melenberg, B., & Stevens, R. (2010). Longevity risk. *De Economist*, *158*(2), 151-192.	
www.dnb.nl: Supervision on pension funds	

Software

Please make sure the software is installed before Meeting 1.

- Tilburg Finance Tool: please install this free download via http://www.tilburguniversity.edu/research/institutes-and-research-groups/center/staff/werker/TilburgFinanceTool/.
- Excel: please activate the Solver: Open Excel – click on the Office button on the left top – you will see a few options; at the bottom you will see "Excel Options" – you will then enter a menu with a few options on the left - please choose Add-ins – at the bottom you see Manage

Excel Add-ins – click on GO – there you will find the option Solver Add-in at the bottom – choose this option and then click OK.

Teachers

R. (Rob) van den Goorbergh Ph.D.

prof. dr. B. (Bertrand) Melenberg

dr. N.F.F. (Nikolaus) Schweizer

prof. dr. ir. M.H. (Michel) Vellekoop

Exam

Written exam.

Course 3 - Valuation and Hedging

This course aims to teach students the techniques of quantitative finance and apply them to insurance contracts. The underlying principle is that the market-consistent value of an (insurance) contract is based on the market value of a replicating portfolio plus an 'add-on' for the remaining (unhedgeable) risk.

Topics include:

1. Market-consistent valuation and total balance sheet approach in regulation
2. Pricing and hedging using derivatives, such as futures, swaps and swaptions
3. Stochastic calculus and option theory with applications to insurers (e.g. embedded unit linked options)
4. Stochastic interest rate models and interest rate options with applications to insurers (e.g. embedded profit sharing options)
5. Pricing of nonhedgeable risks (incomplete markets): using cost-of-capital method or actuarial pricing operators
6. Simulation techniques: (least-squares) Monte-Carlo

Learning outcomes

- Understanding the role of market-consistent valuation in managing the insurer's balance sheet and in regulation
- Modelling of stochastic financial processes using analytical and numerical techniques
- Valuation and hedging (replicating portfolio) of liabilities including (embedded) options and garantuees

Literature

- Options, Futures and other Derivates, John C. Hull
- Lecture notes to be distributed by lecturer

Software

R: you can download this program and the manuals (for installation and use of the program) for free via http://www.r-project.org/.

Exam

Written exam meeting 1, 2, 3 and 4.

Teacher

Dr. K.B. Gubbels

Course 4 Risk and Regulation

Building on previous courses, which treat specific risk domains, this course aims at providing a general perspective on the principles of risk management and regulation.

This course discusses topics from the recent journal literature in the area of actuarial science and quantitative finance, specifically risk management and regulation.

The specific contents of this course may change from year to year, depending on the latest developments. General topics to be discussed include the following:

- Risk measures: VaR and the alternatives;
- Risk transfer mechanisms: reinsurance and securitization;
- Regulatory structures, including Solvency II, Basel III.

Learning Outcomes

Participants who complete this course will have an integrative view of risk management and regulation. They will be able to address regulatory issues from a broad perspective.

This course addresses the following EMAS objectives:

KU1. The EMAS graduate is familiar with a range of advanced statistical and mathematical methods which are needed for a proper assessment and management of risks of various nature as they arise in different branches of the insurance and pensions industry, but also in the wider fields of actuarial employment.
KU2. The EMAS graduate is well-versed in quantitative finance, and in particular is acquainted with the techniques of market-consistent valuation.
KU3. The EMAS graduate is aware of accounting principles and is familiar with the regulatory framework that apply to insurance and pensions but also the wider fields.
AK1. The EMAS graduate can make a link between practical actuarial problems and specialized knowledge of actuarial science, in order to apply this knowledge in practice;
AK2. The EMAS graduate can use mathematical and statistical models, methods, and techniques to solve risk management and risk measurement problems;
AK4. The EMAS graduate can comprehend, critically evaluate, and apply scientific literature in actuarial science;

Type of instruction

Four one-day meetings of lectures and tutorials. The tutorials require basic knowledge of MS Excel.

Literature

Up to date Literature can be found in the group page.

Teacher

Prof. dr. R.J.A. (Roger) Laeven

Examination

	Date/deadline	Exam Material	Allowed Material to take	Minimum grade	Distribution
Essay Individually (see below for further details)	To be determined	Meeting 1, 2, 3 & 4		5.5	100%

ESSAY

To conclude the course, students write an essay of 2500 words, in which they analyze a risk management or regulation issue on the basis of the principles provided during the course. Essays should be more than just a summary of a number of papers related to the subjects treated in the course. For instance, you may find opposing views of a given subject (for instance, axiom systems for risk measures) in different papers and discuss the validity of those views in the context of a specific application. Or, you may carry out calculations for a concrete problem (say, a capital allocation problem) on the basis of methods proposed in different papers, and draw conclusions on whether or not these methods are computationally feasible and produce reasonable answers. It would also be possible to write an extensive discussion of an example from a paper related to the course on the basis of your own implementation of the relevant computations, with some variation of the assumptions used in the paper and a discussion on the validity of the conclusions of the paper under these modified assumptions.

To find relevant literature, scholar.google.com is a good starting point. You should be selective; it is better to present an incisive analysis of two papers than to discuss five papers superficially. Your essay should of course be original; a standard plagiarism check will be applied.

Details of the evaluation process are provided below.

ESSAY EVALUATION GUIDELINES

STEP 1: CONTENT

Determine which description fits the essay best.

9.5: Outstanding essay. The work addresses a question of particular interest in the subject area of the course and presents an original answer. Forceful arguments are supplied to demonstrate why the new view is better than existing ones.

8.5: Excellent essay. A key question is addressed which has been a source of debate in the literature. An incisive analysis is provided on the basis of an original example constructed by the student for this purpose. For instance, such an example may consist of a (virtual) experiment that is relevant to the issue at hand. The consequences are investigated of various possible approaches suggested in the literature, and sharp conclusions are drawn.

7.5: Substantial essay. The student discusses a relevant issue and shows a firm grasp of it. Important aspects are highlighted, for instance by means of calculations in a worked-out example, or by insightful confrontation of different views expressed in the literature. Conclusions follow logically from the arguments and are neither too conservative nor too sweeping.

6.5: Satisfactory essay. The student has chosen a topic of interest in the subject area of the course, and shows good understanding. Approaches proposed in the literature are discussed in a way that does justice to the positions taken by various authors, and all important aspects are covered. Conclusions are specific and well-motivated.

5.5: Marginal essay. The student shows only a basic understanding of the topic discussed in the essay. The chosen topic is of limited interest and has not been discussed much in the literature. There are some flaws in the representation of material from the sources that have been used in the essay. Little discussion is added.

4.5: Inadequate essay. Material from the literature is rephrased in a straightforward manner. There is indication of insufficient understanding by the student. Some important aspects of the subject matter of the essay are overlooked or treated poorly. Conclusions are missing or are insufficiently motivated.

3.5: Deplorable essay. The student shows substantial lack of understanding. The discussion is fragmentary; some basic issues are misrepresented.

2.0: Essay does not meet basic requirements, such as minimum length.

Important note: no grade is assigned in cases in which it is found that the essay contains nonstandard material that has been reproduced from elsewhere without proper acknowledgment. Such cases lead to a plagiarism procedure. Self-plagiarism (i.e. reuse of material that was written as part of an assignment for another course, without proper acknowledgment) is also not allowed.

STEP 2: WRITING STYLE

The result of Step 1 may be adjusted by 0.5 pts in the following situations.

+ 0.5: Particularly well-written essay. There is a logical ordering of the constituent parts of the paper, such as problem description, discussion of relevant literature, model formulation, mathematical development, examples, conclusions, appendices, and bibliography. The section structure is well-balanced. Within sections, each paragraph represents a natural expository unit, and the flow of the reasoning is smooth with proper announcement of new elements that are brought into the discussion. Sentences are clear upon first reading. The organization of sentences is used to achieve the appropriate emphasis effects, for instance by placing elements that need to be highlighted either at the beginning or at the end. Grammar and spelling are correct, and typos are rare. The bibliography is organized in a systematic way.

– 0.5: Poor writing style, as evidenced by one or more of the following characteristics. Lack of relevant structure. Paragraphs that are too short or too long. Badly constructed sentences that need adaptation to be understood. Unexpected turns in the reasoning or changes of perspective; sentences not leading to each other in a natural way. Use of referential expressions without a clear antecedent. Substantial distraction of the reader as a result of spelling errors, grammatical errors, and mistakes in the use of words. Inconsistent and / or incomplete listing of bibliography entries.

Course 5

Module description IFRS for Insurers

27 January 2021

The first part of this module focuses on the importance of accounting for understanding the business world. We will first discuss whether and how accounting can be useful to set up economic interactions. Next, after a general introduction into financial reporting rules, we discuss: (i) the difference between cash accounting and accrual accounting, and, (ii) how accounting standards can influence decision-making in insurance firms.

The second part of this module deals with the latest developments in the accounting standards relevant to actuaries. First, an overview of the accounting principles applicable for insurers will be discussed. Next we will dive into how these principles are applied in practice and focus on the relevance of assumptions and model choices for the representation of the financial position and the financial performance of an insurer. We will conclude with discussing how accounting for insurance contracts is expected to affect decision making of management.

Learning outcomes

By the end of this module, we expect you to

- Understand the economic role of accounting
- Be able to explain the difference between cash accounting and accrual accounting
- Be able to discuss the impact of historical cost accounting versus fair value accounting for insurance firms
- Have a principle overview of which accounting standards are relevant for actuaries as a starting point for further self-study
- Have a basic understanding of IFRS4/IFRS17 & IFRS 9 (insurance contracts & financial instruments)
- Be able to perform basic valuations of insurance contracts as specified in IFRS4 and IFRS17
- Understand how accounting affects management decisions of insurers (in parallel to how Solvency II has affected management decisions)

Literature

- Bloomfield, R.J. 2008. Accounting as the Language of Business. *Accounting Horizons,* 22(4), 433-436.
- Ellul, A., Jotikasthira, C., Lundblad, C. T., & Wang, Y. (2015). Is historical cost accounting a panacea? Market stress, incentive distortions, and gains trading. *The Journal of Finance*, *70*(6), 2489-2538. https://poseidon01.ssrn.com/delivery.php?ID=423027122029096009117026099102093085055056033007026070025023079117106122081089094030097010120030123038049120097

088069014022105016054063082050070118094112114013111038062040121064003023006115026124000018067029121125123127080090100083069091073013074067&EXT=pdf

- IASPlus Overview of IFRS4 – Insurance contracts (or equivalent)
- IASPlus Overview of IFRS17 – Insurance contracts (or equivalent)
- IASPlus Overview of IFRS 9 – Financial instruments (or equivalent)

Exam

Written exam and Assignment

Teachers

Prof.dr. B.C.G. Dierynck

F. Kratz AAG MSc

Module description 'Insurance Law'

Date: 20 January 2021

Insurance is a remarkable sector; globally payments for insurance premiums amount to over 4 trillion dollars each year, which is 7% of the world gross domestic product. Insurance is an essential element in nearly all commercial transactions and many situations encountered by private individuals. This course in Insurance Law introduces you to the essential features and principles of Dutch insurance law and insurance contracts.

In this course, the following topics will be addressed:

Preliminary matters

- Introduction to principles of insurance law and their sources
- Main types of insurance
- Major players in insurance market
- Main documents in insurance

The Insurance Contract

- Formation of the contract
- Concealment
- Warranties
- Conditions
- Exclusions
- Other terms

Premiums

- Non-payment

Insurance claims

- Notification of claims
- Claims under claims made policies and under losses occurring policies
- Causation: determining the cause of the loss; losses caused by the insured
- Claims: the claims process, the requirement of good faith
- Subrogation: the insurer's, the insured's and the other parties' rights

Literature:

- Baas, D. and Dekker, N. *The International Comparative Legal Guide to Insurance* (2018). Chapter 32 The Netherlands; https://www.dirkzwager.nl/media/21453/ir18_chapter-32-netherlands.pdf

- Clarke, D. *Cyber warfare and the act of war exclusion* (2019); https://iclg.com/practice-areas/insurance-and-reinsurance-laws-and-regulations/3-cyber-warfare-and-the-act-of-war-exclusion

- Huckstep, C. *How IoT shows prevention is better than cure for insurers* (2020)*;* https://www.the-digital-insurer.com/blog/insurtech-insurance-of-things-how-iot-shows-prevention-is-better-than-cure-for-insurers/

- Behm, S. *Digital ecosystems for insurers opportunities through the internet of things (*2019) https://www.mckinsey.com/industries/financial-services/our-insights/digital-ecosystems-for-insurers-opportunities-through-the-internet-of-things

Learning objectives:

1. Provide a working understanding of what insurance is and the insurance market
2. Offer an understanding of different variations of coverage (i.e. occurrence based, claims made) and other terms and conditions concerning insurance contracts
3. Discuss key issues including non-payment of premiums and other areas where disputes frequently arise

Exam

A case-based take home exam.

Teacher

Mrs. mr. W.H.M. Venmans

Description Elective "Data Science and statistical learning in the actuarial profession"

Dates

6 January 2021

13 January 2021

In 1956 IBM launched the first hard disk drive (152 cm long, 172 cm high, and 74 cm wide), which was able to contain 3.75 MB of data. Nowadays one can buy, on the consumer market, 3.5 inch 6 TB hard disk drives, which is an increase by a factor more than 10^6. Computing power, measured in flops, has followed a similar trend; an Apple iPhone 4, for example, is as powerful as the 1985 super-computer Cray-2.

The availability of cheap data storage, and in some cases also regulatory and legal requirements, have led to the collection of large amounts of data by financial and actuarial institutions. The increased computing power makes it possible to analyze these data streams. Up to today the common impression is that companies have only started to recognize and to exploit the (business) opportunities such data offers. Examples in the actuarial industry include pricing based on driving behavior from car sensors, anomaly detection in insurance claims to prevent fraud, and the use of micro-level claim data to determine loss reserves.

Although there is no agreed upon definition of data science, a common description of the role of a data scientist is to "make sense of (huge amounts of) data" and to "create value from data". This requires knowledge on handling databases (traditional relational databases as well as "big data platforms" as Hadoop), a solid background in mathematics, statistical & machine learning. Moreover, working with large datasets often yields practical problems: datasets often do not fit into the memory of a computer. Therefore, a modern data scientist also has knowledge on distributed/cloud computing (for example, Spark).

This short course provides an introduction to data science with an emphasis on machine & statistical learning. We cover the situations in which the learning target is known (supervised learning), both continuous (regression) and discrete (classification), as well as the case of an unspecified target (unsupervised learning). The focus is on techniques and examples that are useful for the actuarial profession.

During the first meeting of this module the following topics on supervised learning are covered:

- Introduction to data science and statistical (machine) learning;
- Techniques to automatically deal with a large amount of risk drivers (forward stepwise, the Lasso, Ridge regression) starting from the familiar (generalized) linear regression model;
- Overfitting, the bias-variance tradeoff, (cross-)validation;
- Classification and regression trees
- Ensemble learning, such as bagging, boosting and random forests.

The second meeting covers the following topics:

- Naive Bayes classifiers;

- Imbalanced data and cost-sensitive learning for supervised learning problems;
- Neural networks and deep learning;
- Dimension reduction (PCA, auto encoders);
- Anomaly detection;
- Responsible Data Science.

Both meetings consist of theoretical parts and practical parts. In the practical parts, the data preparation, model training and validation procedures are applied to realistic cases.

Learning outcomes

1. Prepare, analyze and visualize a large data set;
2. Understanding and being able to apply the abovementioned techniques;
3. Awareness of potential pitfalls, such as overfitting and imbalanced data, and the importance of proper validation;
4. Awareness of ethical concerns when applying data science techniques.

Literature

- *The Elements of Statistical Learning*, by Hastie, Tibshirani and Friedman. You can download this textbook for free via https://web.stanford.edu/~hastie/Papers/ESLII.pdf
- Elkan, C. (2001). The Foundations of Cost-sensitive Learning. Published in: Proceedings of the 17th International Joint Conference on Artificial Intelligence - Volume 2}, page 973—978, Morgan Kaufmann Publishers Inc. https://scholar.google.nl/scholar?q=%E2%80%A2%09Elkan,+C.+(2001).+The+Foundations+of+Cost-sensitive+Learning&hl=en&as_sdt=0&as_vis=1&oi=scholart&sa=X&ved=0ahUKEwiPlMW5mPXXAhUO26QKHdPYCwcQgQMILDAA
- Lecture slides

Software

Python and *R*

During the course you will be provided with R notebooks (R markdown documents) and Jupyter notebooks for Python and you will have to extend/adjust these notebooks to solve the exercises.

It is therefore required to have installed the open source programs R, R studio, Python, and Jupyter as well as associated packages for data science before the first lecture. A short instruction will be made available before the start of the course. A laptop with the installed programs is needed during the lectures.

Prerequisites

- Solid background in probability theory, statistics and linear algebra (as a refresher: see Verbeek, *A Guide to Modern Econometrics* (4th ed.), Chapters 2, 7.1, Appendix A and B);
- Basic programming skills in a language such as Matlab, R, Python, or similar (e.g. writing functions, using loops, some debugging);
- A laptop with R, R studio, Python and Jupyter installed.

Exam

Exam consists of an empirical assignment on a large dataset (using R, Python or Matlab).

Teachers

dr. R. (Ramon) van den Akker

dr. K.B. Gubbels AAG

Description Risk Perception EMAS 10

January 6 and 13, 2021

Jorgo Goossens, Tilburg University and APG,
Eduard Ponds, Tilburg University and APG

Contents

In the Netherlands we observe a trend toward more choice options in the 2nd pillar pension plans. Choice opportunities are already available around retirement, like the choice of the retirement age and options regarding the annuity profile. More choice options are being prepared or being discussed in the debate, among them partial lump sum at retirement, premium holiday in the accumulation phase and the use of pension wealth for home financing. A main issue in this field is whether plan participants have the capabilities to manage these options to their own best interest. Behavioral economics and behavioral finance have identified several behavioral biases (i.e., time inconsistency, probability weighting and loss aversion) leading to sub-optimal utility choices by individuals.

Given the trend to more pension choices, the course explores the question whether the pension professional should support individuals in their decision-making process regarding pension choices and, if so, how? What can be offered in the choice architecture to protect individuals and to guide them to adequate choices? How should we offer choice options, especially for a heterogeneous group of participants?

Structure of the course

The course has two main parts.

A) Which support is effective?
- International overview
- Effectivity
- Ethics and support

B) Risk and time preferences
- Elicitation and estimation of preferences (risk aversion and patience), including behavioral biases (loss aversion, present bias and probability weighting)
- Heterogeneity among plan participants
- Welfare effects and choice architecture
- Trading under behavioral biases (e.g. optimal asset allocations and the disposition effect)

C Assignment 1: Measure preferences and/or behavioral biases by a (provided) dataset. How small or big is the heterogeneity among participants? Do you think that individuals need support in the economic-decision making regarding pension choices and, if so, how?

D Assignment 2: Discussion in class of an academic paper to be chosen from a list of pre-selected papers.
List of pre-selected papers (examples; tbc):

- Brown J. R., J. R. Kling, S. Mullainathan and M.V. Vrobel, 2008, Why don't people insure late life consumption: a framing explanation of the under-annuitization puzzle, http://www.nber.org/papers/w13748, NBER.
- Beshears, J., et al., What makes annuitization more appealing?, Journal of Public Economics (2013), http://dx.doi.org/
- Goossens J. and B. Werker, 2020, Asset allocation & time preferences
- Frederick, S., G. Loewenstein, and T. O'Donoghue (2002). \Time Discounting and Time Preference: A Critical Review". In: Journal of Economic Literature, 40, pp. 351-401.
- Eckel, C.C. en P.J. Grossman (2002) Sex differences and statistical stereotyping in attitudes toward financial risk. Evolution and Human Behavior, 23(4), 281–295.
- Holt, C.A. en S.K. Laury (2002) Risk aversion and incentive effects. The American Economic Review, 92(5), 1644–1655