

*Année universitaire 2024/2025*

## M2 - Research in Finance - PhD Qualifying Year

### LES OBJECTIFS DE LA FORMATION

- The PhD Qualifying Year is a track of the M2 104 Research in Finance, entirely taught in English. This one-year academic research training is the natural extension of the M1 Research in Finance track. It offers the best preparation for a PhD in Finance at University Paris Dauphine - PSL.
- The PhD Qualifying Year is indeed required from students who apply to our Finance PhD Program. Students can postulate at the doctoral level upon success in the qualifying year. They will then carry out a PhD thesis with the DRM Finance research team in a 3-year doctoral program, which structure and courses offer are available at [http://www.finance.dauphine.fr/en/phd/phd\\_program](http://www.finance.dauphine.fr/en/phd/phd_program).
- The research interests of our team cover all fields of finance including corporate finance, financial reporting, banking, asset pricing, asset management, market microstructure, financial econometrics, real estate, commodities etc. Our research center offers a wide range of resources for research (hardware, software, and databases) as well as a stimulating intellectual environment with a very active visiting program of leading scholars from all around the world.
- You can follow the program of the PhD Qualifying Year even if you do not intend to apply for a PhD thesis. This program indeed covers the main areas of finance and gives you the possibility to acquire a deep knowledge in finance that will be extremely valuable in the private sector.

### PROGRAMME DE LA FORMATION

- Semester 3
  - LEVELLING COURSES - Select 2 courses
    - Financial Econometrics I
    - Monte Carlo Simulations in finance - MathLab
    - Python for finance (Bloc 1/3 of the Certificate "Fundamentals of Data Science")
    - Introduction to corporate finance
  - MANDATORY FUNDAMENTAL COURSES - 4 courses for 24 ECTS
    - Finance in continuous time (mandatory course, unless validated previously)
    - Corporate finance (prerequisite: introduction to corporate finance)
    - Asset pricing theory
    - Term structures : theory, models and empirical tests
  - OPTIONAL FUNDAMENTAL COURSE - Select 1 course
    - Derivative Pricing and Stochastic calculus II (prerequisite: finance in continuous time)
    - Game theory
    - Fixed income derivatives
    - Management of Credit Risk : Theory and applications
  - OR OPTIONAL SEMINARS - Select 2 courses
    - Regulation and Financial Markets
    - Structured products in practice
    - Machine Learning in Finance

- Microeconomics for finance
- METHODOLOGY OF RESEARCH
  - Frontiers in Finance
  - Formation to R programming (option)
- Semester 4
  - MANDATORY SEMINARS - 6 courses
    - Advanced corporate finance
    - Advanced empirical corporate finance
    - Empirical Asset Pricing (it is strongly advised to have some knowledge in Python for this course)
    - Microstructure of financial markets
    - Advanced Market Microstructure
    - Time series (it is strongly advised to have some knowledge in R for this course)
  - SEMINARS - Select 2 courses
    - Machine Learning : empirical applications for finance (Bloc 3/3 of the Certificate "Fundamentals of Data Science")
    - Data management (Bloc 2/3 of the Certificate "Fundamentals of Data Science")
    - Behavioral Finance
    - Financial macroeconomics
    - Blockchains and Cryptocurrencies
    - Artificial Intelligence for finance
  - METHODOLOGY OF RESEARCH AND MASTER'S THESIS (Mandatory)
    - Seminar on research methodology (mandatory)
    - Research Master's thesis or Research project
  - PROFESSIONNAL TRAINING (Optional)
    - Formation Alumnye
    - AMF Certification (On line course)

## DESCRIPTION DE CHAQUE ENSEIGNEMENT

### AMF Certification (On line course)

ECTS : 0

#### Description du contenu de l'enseignement :

Content of the certification:

- Know the general principles of banking and financial law
- Identify the role and operation of the various financial actors
- State the main principles of French financial regulation
- Master the fundamentals of the monetary and financial code and the general regulations of the AMF
- Understand and explain the rules on client protection and the legal and ethical framework governing financial transactions,
- Know the different means of payment and describe their main characteristics: cards, checks, transfers, direct debits.
- Inform a client about the different types of financial instruments
- Distinguish the different types of financial instruments used by customer
- Know the organization and role of financial markets
- Ability to read business financial statements
- Get an overview of tax rules for businesses and individuals

#### Compétence à acquérir :

The AMF General Regulation requires investment services providers to verify that persons exercising certain functions under their authority or on their behalf have a minimum level of knowledge in 12 areas relating to the regulatory and ethical environment and financial techniques.

The AMF Certification is an online course proposed by an institution certified by the AMF. The M2 104 gives the possibility to follow it and to validate the exam, during the second semester.

#### Mode de contrôle des connaissances :

## Advanced Market Microstructure

ECTS : 3

### Description du contenu de l'enseignement :

1. Liquidity and Asset Prices
2. Limit Order Markets and OTC Markets: a Review of Theory
3. Market Transparency
4. Market Fragmentation
5. Algorithmic Trading and High-Frequency Trading
6. Microstructure and Corporate Finance
7. Information Technologies, Big Data, and Financial Markets

### Compétence à acquérir :

The course aims to acquaint students with advanced topics in market microstructure.

### Mode de contrôle des connaissances :

Referee reports or paper replications

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## Advanced corporate finance

ECTS : 3

### Description du contenu de l'enseignement :

Recent developments in the theory of corporate finance

To follow this course, the students must validate the course "Corporate finance". Course objective : the main objective of the course is to familiarize students with a number of important, recent results and subjects that have been added to the theory of corporate finance. A second important objective is to provide an overview of some of the modelling issues faced and of the methods that are currently employed in the area of corporate finance

### Compétence à acquérir :

The students will master the most recent reserach issues in corporate finance, with specific insights into modelling.

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## Advanced empirical corporate finance

ECTS : 3

### Description du contenu de l'enseignement :

Case studies, academic papers, and Stata.

### Compétence à acquérir :

This is a practical course in applied econometrics. We will be reviewing and replicating famous academic papers. You will learn how to use Stata to manipulate data, run regressions, use more complex estimation methods. We will discuss methods to determine causality.

The final goal is to produce a student who is comfortable performing an empirical research project from the data collection phase to the presentation of the final results.

### Mode de contrôle des connaissances :

Final project + presentation of an empirical question in corporate finance.

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## Artificial Intelligence for finance

ECTS : 3

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## Asset pricing theory

ECTS : 6

**Description du contenu de l'enseignement :**

In this course, we will discuss a wide range of topics ranging from optimal portfolio, the CAPM, factor models, consumption-based asset pricing, and arbitrage pricing, to more special ones including asymmetric information, and limits to arbitrage.

1. Optimal Portfolio Theory and the CAPM
2. Factor Models
3. Decision Making under Uncertainty
4. Consumption-based Asset Pricing
5. Arbitrage Pricing
6. Dynamic Asset Pricing
7. Asymmetric Information and Asset Prices
8. Limits to Arbitrage

**Compétence à acquérir :**

Master the theoretical concepts of asset pricing

**Mode de contrôle des connaissances :**

Evaluation: assignment 20%, final exam 80%

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## Behavioral Finance

ECTS : 3

**Description du contenu de l'enseignement :**

Introduce students to this relatively new sub-discipline of finance which incorporates insights from cognitive and social psychology into finance. In the past 20 years behavioral finance has emerged as an important stream of thinking in finance. Relaxing the traditional assumptions of finance models has proved a fruitful way of understanding financial decision-making.

Course outline:

The course will go through:

- The cognitive biases evidenced by cognitive psychologists;
- Financial anomalies and their interpretations through a behavioral finance lens;
- The implications of behavioral finance for investors and corporate financial policy.

**Compétence à acquérir :**

Relaxing the traditional assumptions of finance models has proved a fruitful way of understanding financial decision-making and anomalies found in empirical tests.

**Mode de contrôle des connaissances :**

Students will present a state-of-the art research paper among a selection of papers chosen by the instructors.

**Bibliographie, lectures recommandées :**

Daniel Kahneman, Paul Slovic, and Amos Tversky (eds.), Judgment under uncertainty: Heuristics and biases, Cambridge: Cambridge University Press, 1982.

Richard Thaler, ed., Advances in behavioral finance, New York: Russell Sage Foundation, 1993.

Richard Thaler, ed., Advances in behavioral finance, Volume II, New York: Russell Sage Foundation, 2005.

Shleifer, Inefficient markets : an introduction to behavioral finance, Oxford, Oxford University Press 2000.

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## Blockchains and Cryptocurrencies

ECTS : 3

**Description du contenu de l'enseignement :**

Although blockchain technology is a fairly recent concept, the rate of innovation in this space has been tremendous over the past years. This class will give students an overview of the fundamental concepts needed to properly understand most aspects around blockchains, with a focus on the Bitcoin and Ethereum blockchains. We will also cover the most recent advanced topics including : Consensus Algorithms (Proof-of-Work vs Proof-of-Stake), the scaling problem, Smart contracts as well as a detailed approach of Decentralized Finance (DeFi), Token economics (Fungible and Non-Fungible Tokens) and CDBC. The academic literature is also very dynamic and this class will heavily rely on this literature to explain in depth the main concepts.

Although an academic approach will help students get a solid knowledge about blockchains, this class will also incorporate

some practical training, including low-level bitcoin transaction scripting and smart contract development/deployment/interaction with Solidity.

Even if this class is not directed to computer scientists, students will be expected to make the effort to learn about the most important computer science primitives needed to understand the economics of blockchain. Such primitives will be taught in class.

#### **Compétence à acquérir :**

Students are expected to get an in-depth understanding of the functioning of any blockchain and DeFi projects, as well as an awareness of most of the current important issues and recent developments. Students will also be exposed to the most important papers in the literature as well as some knowledge on practical aspects like the basics of smart contract development. Students are not expected to become smart contract developers but rather to know the basics of it, how it works and ultimately to be able to interact with actual smart contract developers.

#### **Mode de contrôle des connaissances :**

Oral presentation (critical assessment of a chosen blockchain or DeFi project), Homework (coding, paper review) and/or final exam.

#### **Bibliographie, lectures recommandées :**

Books :

- Andreas Antonopoulos, Mastering Bitcoin, 2nd edition, O'Reilly, 2017
- Andreas Antonopoulos, Gavin Wood, Mastering Ethereum, 1st edition, 2018
- Primavera De Filippi, Aaron Wright, Blockchain and the Law : The Rule of Code, Harvard University Press, 2018
- Campbell Harvey, Ashwin Ramachandran, Joey Santoro, DeFi and the Future of Finance, 1st edition, Wiley, 2021

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## Corporate finance (prerequisite: introduction to corporate finance)

ECTS : 6

#### **Description du contenu de l'enseignement :**

##### **Part 1. Prof. Laurent Frésard ([Laurent.fresard@usi.ch](mailto:Laurent.fresard@usi.ch))**

#### **Course Objectives**

The objective of this part of the "Corporate Finance" course is to introduce you to key topics in corporate finance through the lens of empirical research. Corporate finance is largely a non-experimental field with lots of data. The nature, scope, and detail of available data continue to expand rapidly. These data are used to generate empirical insights to validate or invalidate existing theories and constitute a basis for further theories. In this class, we will discover central topics and mechanisms in corporate finance by focusing on how researchers have used data and empirical methods to develop novel knowledge that is relevant for the practice of finance.

The overall approach in this class is to read and understand (selected) prior empirical work and replicate or extend some of these studies. The topics have been selected to make you work with specific datasets and methods. The primary expertise necessary is the understanding of how to use or manipulate datasets. You will need to appreciate the methods, approaches, and intuition of econometrics including and beyond a first graduate level of econometrics. I will cover some of the underlying approaches in class but our objectives will be different from those of an econometric course. Rather than a formal derivation of the underlying assumptions and tests, we will assess why something works the way it does.

#### **Deliverables - Empirical exercises**

You will have three exercise sets and a mini project to hand in. They are designed to get you up and running with financial datasets and empirical methods. There is a lot of work going into extracting databases and matching datasets. You should treat this as a permanent lifelong investment and the costs will seem more bearable. You will have to extract data from the relevant source, run the assigned tests, and answer to question I will specify. You will write a short report for each assignment, explaining all your steps and interpreting your results.

#### **Course outline and Readings**

All chapters and articles marked with an \* should be carefully read in advance. As we will discuss these papers in class, not reading makes your attendance almost useless. I will ask questions related to these articles in class.

#### **Reading list for part 1.**

- Selected chapters from the Handbook of Corporate Finance: Empirical Corporate Finance. Edited by B. Espen Eckbo: North Holland, 2007. (HCF)

- Cameron, A. Colin, and Pravin Trivedi, 2009, *Microeconometrics: Methods and Applications*, ISBN-13 #: 978-0-521-84805-3. Published by Cambridge University Press. **(CT#1)**
- Cameron, A. Colin, and Pravin Trivedi, 2009, *Microeconometrics Using STATA*, ISBN-13 #: 978-1-59718-048-1. Published by STATA Press. **(CT#2)**
- Angrist, D. Joshua, and Jorn-Steffen Pischke, 2009, *Mostly Harmless Econometrics: An Empiricist's companion*. ISBN-978-0-691\*12035-5. Princeton University Press. **(AP)**
- Scott Cunningham, 2021, *Causal Inference: The Mixed Tape*, ISBN-978-0300251685. Yale University Press. Free online version at: <https://mixtape.scunning.com/>. **(CI)**

## COURSE

### Identification and Causality

- **AP**, chapter 2
- **CI**, chapter 4
- Roberts and Whited (2012), section 2
- Bowen, Frésard, and Taillard (2017)\*
- Morck and Yeung (2011)
- Leamer (2010)
- Ruhm (2018)
- Ravallion (2020)

### Compétence à acquérir :

The objective of this course is twofold: a. to introduce the student to state of the art econometrics applied in empirical corporate finance (e.g. to address endogeneity issues, to determine an identification strategy), b. to introduce the student to some important topics in the scientific literature on empirical corporate finance. Each class will focus on a single topic and discuss different research designs and econometric approaches.

### Mode de contrôle des connaissances :

Part 1. The evaluation for the class consists of the exercise sets (45%) and a written final exam (55%).

Part 2. Project

### Bibliographie, lectures recommandées :

#### Some Background resources

Michael Roberts and Toni Whited (2013) "Endogeneity in Empirical Corporate Finance", in George Constantinides, Milton Harris,

René Stulz (eds) *Handbook of the Economics of Finance*, vol 2, Amsterdam, North Holland.

Joshua Angrist and Steffen Pischke (2008) *Mostly Harmless Econometrics*, MIT Press.

### Mandatory readings associated with part 2.

#### 1. Corporate social responsibility

- Ferrell, A., Liang, H. and L. Renneboog, 2016, **Socially Responsible Firms**, *Journal of Financial Economics*, 122(3), 585-606.

[https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2464561](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2464561)

- Liang, H. and L. Renneboog, 2017, **On the Foundations of Corporate Social Responsibility**, *Journal of Finance* 72 (2), 853-910. Victor and Jaouad

[http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2360633](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2360633) : Jaouad + Victor

- Flammer, C., 2015, **Does Corporate Social Responsibility Lead to Superior Financial Performance? A Regression Discontinuity Approach**, *Management Science* 61, 2549–568

[http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2146282](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2146282)

- (Just Skim in order to familiarize yourself with the law and finance literature; some other papers are below) Djankov, S., La Porta, R., Lopez-de-Silanes, F., Shleifer, A. 2008. **The law and economics of self-dealing**. *Journal of Financial Economics* 88, 430-465. [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=864645](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=864645)

#### 2. Social Responsible Investing

- Barko, T., M. Cremers, and L. Renneboog, 2022, **Shareholder Engagement on Environmental, Social, and Governance Performance**, *Journal of Business Ethics*, forthcoming.

[https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2977219](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2977219)

#### 3. Dividend policy / Bond markets

- (Not for class discussion but skim to familiarize yourself with the literature)

Survey paper: Farre-Mensa, J., R. Michaely, and M. Schmalz, 2014, **Dividend Policy**, In *Annual Review of Financial Economics*, Volume 6, edited by Andrew W. Lo and Robert C. Merton. Palo Alto, CA: Annual Reviews.

[https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2400618](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2400618)

- Feito-Ruiz, I., L. Renneboog, and C. Vansteenkiste, 2020, **Elective Stock and Scrip Dividends**, *Journal of Corporate Finance* 64, 101660.

[https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3245060](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3245060)

- Crane, A. D., Michenaud, S., & Weston, J., 2016. **The effect of institutional ownership on payout policy: Evidence from index thresholds**. *Review of Financial Studies*, 29(6), 1377-1408. Francesco and Wilson

[http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2102822](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2102822)

- Manconi, A., Neretina, E., & Renneboog, L., 2021. **Underwriter Competition and Bargaining Power in the Corporate Bond Market**, Working Paper. Ghalia and Dhia

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## Data management (Bloc 2/3 of the Certificate "Fundamentals of Data Science")

ECTS : 3

### Description du contenu de l'enseignement :

Data science is an interdisciplinary field that is rapidly evolving. Many companies have widely adopted machine learning and artificial intelligence methods to power many applications that have captured the imagination of society at large. Data systems and data engineering are an inevitable part of all these large-scale data-driven applications and decisions, as ML/AI methods are powered by massive collections of potentially heterogeneous and messy datasets and, as such, should be managed as part of an organization's overall data lifecycle.

This course corresponds to the third block of the Certificate "Fundamentals of Data Science". This Certificate is designed to train and familiarize professionals with the key technologies in this interdisciplinary field, with the aim of enabling them to take full advantage of the opportunities offered by data science and to become active players in this field within of their organizations. This is an accelerated training focused on the key modules of the profession of data scientist, in particular the management of massive data and machine learning.

### Course outline:

#### Module 1 : Why shall we engage a Data transformation program (1h)\*

- Introduction
  - The Role of Data in a company
  - Review of the evolution of Data topics
- Data value chain
- Presentation of the pillars of a Data transformation ( challenges / objectives)
  - The Data Strategy
  - Data Management & Governance
  - Analytics
  - IT
  - Project to Product team

#### \*Module 2: Data Management (4h)\*

- General presentation of the main concept of the framework (DAMA)
- Structure & organization (roles & responsibilities)
- Lineage & Metadata: data knowledge
- The importance of data quality
- Privacy / GDPR
- Data types and their characteristics
  - Structured
  - Unstructured data
- Examples of architectures
- Main tools to manipulate Data

#### \*Module 3: Case Analysis - From Theory to Practice: data retrieved from both a database and an excel file. (10h)\*

- From integration to visualization
  - Integration of data from Excel file via Python
    - Representation, cleaning, recoding

- Aggregates
- Merge and join

#### - \*Practical work 1\*

- Data integration from the database
  - Relational model
  - Introduction to SQL
  - SQL in Python

#### - \*Practical work 2\*

- Beyond SQL, other possible cases (NoSQL)
- Problems encountered when reconciling data (duplication, quality, veracity) > Can you put your trust into your data

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## Derivative Pricing and Stochastic calculus II (prerequisite: finance in continuous time)

ECTS : 6

### Description du contenu de l'enseignement :

The aim of this lecture is to present the theory of derivative asset pricing as well as the main models and techniques used in practice. The lecture starts with discrete time models which can be viewed as a proxy for continuous settings. We then develop on the theory of continuous time models. We start with a general Itô-type framework and then specialize to different situations: Markovian models, constant volatility models, local and stochastic volatility models. For each of them, we discuss their calibration, and the valuation and the hedging of different types of options (plain Vanilla and barrier options, American options, options on realized variance,...).

Course outline:

#### I. Discrete time modelling

I.1. Financial assets I.2. The absence of arbitrage I.3. Pricing and hedging of European options I.4. Pricing and hedging of American options

#### II. Continuous time modelling

II.1. Financial assets as Itô processes II.2. The Black-Scholes model II.3. Markovian models in complete markets II.4. Local volatility models II.5. Stochastic volatility models

- General setting
- Tree markets
- Risk-neutral measures
- Fundamental theorem of asset pricing
- The super-hedging problem
- The complete market case : example of the CRR model
- Approximate hedging in incomplete markets
- Examples: binomial and trinomial tree markets
- The Itô process framework
- Discussion of the Absence of arbitrage opportunity
- Complete and incomplete markets
- The general pricing and hedging principle for European and American claims
- Characterization of complete Black Scholes markets
- Explicit formulas : European call option (Black-Scholes formula), barrier option (reflection principle)
- PDE valuation (plain vanilla, barrier, Asian, American options)
- Greeks and hedging
- Tracking error and convexity
- Dupire's formula and calibration to the volatility surface
- Super hedging prices
- Completion of the market with options : general principle, Approximate static hedging: example of the variance swap hedging problem
- Specific models : CEV, Heston, SABR,...



**Compétence à acquérir :**

The lecture starts with discrete time models which can be viewed as a proxy for continuous settings, and for which we present in detail the theory of arbitrage pricing. We then develop on the theory of continuous time models. We start with a general Itô-type framework and then specialize to different situations: Markovian models, local and stochastic volatility models. For each of them, we discuss the valuation and the hedging of different types of options : plain Vanilla and barrier options, American options, options on realized variance, etc. Finally, we present several specific volatility models (Heston, CEV, SABR,...) and discuss their specificities.

**Mode de contrôle des connaissances :**

Final exam

**Bibliographie, lectures recommandées :**

Bouchard B. et Chassagneux J.F., Fundamentals and advanced Techniques in derivatives hedging, Springer, 2016.  
Lamberton D. et B. Lapeyre, Introduction au calcul stochastique appliqué à la finance, Ellipses, Paris, 1999.

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## Empirical Asset Pricing (it is strongly advised to have some knowledge in Python for this course)

ECTS : 3

**Description du contenu de l'enseignement :**

The course will cover the necessary tools in order to conduct independent research in asset pricing, focusing on the relation between theoretical and empirical explanations of prices, and risk. We will cover asset pricing anomalies, consumption based asset pricing, intermediary asset pricing, and production based asset pricing.

**Compétence à acquérir :**

Understanding of theory and empirics of asset pricing research, with a focus on how to bring models to the data.

**Mode de contrôle des connaissances :**

Project 20%

Final Exam 70%

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## Finance in continuous time (mandatory course, unless validated previously)

ECTS : 6

**Description du contenu de l'enseignement :**

Asset pricing, contingent claim, stochastic process, brownian motion, Itô's formula, optimal stopping time.

This course is an introduction to "Derivative pricing and stochastic calculus II".

It introduces the standard concepts and tools allowing to understand arbitrage theory in continuous-time. The requirements from probability theory are made as basic as possible to make the lectures accessible to students without a strong background in applied mathematics.

**Compétence à acquérir :**

In the end of this course, the students must be comfortable with:

- i) Basic concepts of contingent claims,
- ii) the binomial model;
- iii) stochastic integrals and Itô's calculus;
- iv) the Black and Scholes model,
- v) Merton's optimal portfolio problem.

**Bibliographie, lectures recommandées :**

[Steven Shreve](#), Stochastic Calculus for Finance I: The Binomial Asset Pricing Model, 2005.

[Steven Shreve](#), Stochastic Calculus for Finance II: Continuous-Time Models , 2005.

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## Financial Econometrics I

ECTS : 3

### Description du contenu de l'enseignement :

This course is an introduction and/or refresher course in Econometrics that focuses on techniques for estimating regression models, on problems commonly encountered in estimating such models, and on interpreting the estimates. The goal is to provide participants with the basic skills and knowledge necessary to undertake empirical research and to prepare them to the advanced course in Econometrics of Financial Markets. If Gretl will be the econometric software used in the course, it is possible to use R.

Course outline

- How to build an econometric model and how to use it?
- The (simple and multiple) linear regression model
- Inference, hypothesis testing and prediction
- Specification and diagnostic testing (heteroskedasticity, autocorrelation, model specification)
- Selection criteria
- Alternative to OLS (2SLS, ML, GLS, Quantile regression)

### Compétence à acquérir :

Theoretical and practical knowledge of linear regression models estimation technics. Being able to set up an econometric analysis.

### Bibliographie, lectures recommandées :

- Adkins L. C., [Using gretl for Principles of Econometrics](#), Version 1.041, August 2018, Free copy;
- Brooks C., *Introductory Econometrics for Finance*, Second Edition, Cambridge University Press, 2014 ;
- Gelman A., J. Hill and A. Vehtari, 2021, *Regression and Other Stories*, 1st Edition, Cambridge University Press, 2021 ;
- Gujarati D., *Basic Econometrics*, McGraw Hill Higher Education; 5th Revised edition edition, 2009 ;
- Hill C., W. Griffiths and G. Lim, *Principles of Econometrics*, Wiley, 5th Edition, 2018 ;

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## Financial macroeconomics

ECTS : 3

### Description du contenu de l'enseignement :

This 24-hour course is a graduate-level introduction to financial macroeconomics. The main objective of this course is to provide students with a rigorous approach to the basic ingredients behind any macroeconomic model, i.e the consumption/demand and production/supply sides. In an intuitive approach, students are first taught the standard techniques of dynamic programming. The traditional consumer's decision problem is then covered, potentially but not exclusively through the lens of this newly exposed method. Before studying real business cycle models as a whole and therefore being able to investigate why aggregate economic activity fluctuates in a general equilibrium setting, students learn about the neoclassical theory of investment (i.e the Ramsay model). Finally, to better understand the links between output and inflation and if time allows, students are introduced to the role played by money and the importance of prices. In particular, the New Keynesian framework with its price and/or wage rigidities allows students to analyze the costs and benefits of price stability and the inherent role of central banks.

### Mode de contrôle des connaissances :

#### Pré-requis obligatoires

Basic notions in intermediate macroeconomics (IS/LM model, etc)

### Bibliographie, lectures recommandées

There is no textbook that covers all the material of the course. Useful textbooks (even though some of them are really technical and should not scare the students) nevertheless include :

- Blanchard, O.J and Fischer, S. (1989), *Lectures on Macroeconomics*, Cambridge, MA : MIT Press.
- Obstfeld, M. and Rogoff, K (1996), *Foundations of International Macroeconomics*, Cambridge, MA : MIT Press

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## Fixed income derivatives

ECTS : 6

### Description du contenu de l'enseignement :

Interest rate derivatives, investment and hedging

The objective of the course is to give an all round comprehensive knowledge and understanding of the theory and the day-to-day use of interest rates derivatives, for both investment and hedging purposes.

Various views about the level and shape of the yield curve are implemented with selected absolute and relative value trades across "Directional" and "Volatility" strategies.

Finally, this course introduces to the the sustainable investing landscape ("ESG") which has met some growing and significant appetite over the past decade, while providing insights and methodology for managing fixed income ESG investment strategies.

**Compétence à acquérir :**

Participants will learn how banks, portfolio managers and corporate treasuries use rates derivatives alike in the management of risks, for trading, hedging and arbitrage and their role in the day-to-day running of the finances of businesses.

**Mode de contrôle des connaissances :**

Take home exam: trade idea

Table exam

**Bibliographie, lectures recommandées :**

**Fixed-Income Securities:** Valuation, Risk Management, and Portfolio Strategies, Lionel Martellini, Philippe Priaulet

**Fixed Income Analysis**, CFA institute, Barbara S. Petitt (Author), Jerald E. Pinto, Wendy L. Pirie, Bob

**Interest Rate Risk Modeling**, Wiley, Sanjay K. Nawalkha, Gloria M. Soto, Natalia A. Beliaeva

**Fixed Income Mathematics**, Analytical & Statistical Techniques, Frank J. Fabozzi

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## Formation Alumnye

ECTS : 0

**Description du contenu de l'enseignement :**

This short-term course is a professional formation proposed by the society AlumnEye. It is scheduled in the very beginning of the year, in September. It offers a coaching to the students who intend to pursue in the finance industry after the M2 104, especially those considering an international career, and who are willing to prepare themselves to the recruiting processes and the professional interviews in the fields of banking, finance and consulting.

The fees that the students must pay to attend this formation are offered by the University. The number of places is limited to those really interested in this formation.

**Compétence à acquérir :**

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## Formation to R programming (option)

### Frontiers in Finance

ECTS : 0

**Description du contenu de l'enseignement :**

Content:

- Presentation of the research team and academic careers (Carole Gresse)
- Presentation of the Dauphine PhD program in finance (Jérôme Dugast)
- Series of seminars on topics situated at the frontiers of finance.

This course is mandatory for the students enrolled in the cursus Phd Qualifying Year. It is optional for all others.

**Compétence à acquérir :**

The course Frontiers in Finance is a serie of seminars, proposed by academics of the university PSL Paris Dauphine. Most of them are members of the research team DRM-Finance.

The aim of this course is to present the different steps of an academic career and to offer a view on recent researches in finance performed by the members of the team. This is an open view on what could be done after the M2 104, as well as on the state of

the art in finance.

This course is mandatory for the students enrolled in the cursus Phd Qualifying Year. It is optional for all others.

**Mode de contrôle des connaissances :**

None

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## Game theory

ECTS : 6

**Description du contenu de l'enseignement :**

**Chapter 1: Normal form games:** pure and mixed strategy Nash equilibrium; weakly/strictly dominated strategies , iterated elimination of dominated strategies.

**Chapter 2: Dynamic games:** Backward induction, subgame perfect Nash equilibrium, repeated games.

**Chapter 3: Incomplete information (in static games):** Bayesian Nash equilibrium; introduction to some applications (auctions, finance...)

**Compétence à acquérir :**

The objective of the course is to give some fundamental background in interactive decision making and its applications. After having attended the classes, the students will be able to understand the basic tools of game theory and the importance of this field in economics and finance.

**Mode de contrôle des connaissances :**

A mid-term exam and a final exam

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## Introduction to corporate finance

ECTS : 0

**Description du contenu de l'enseignement :**

**Context**

This course is dedicated to students who have not studied the financial structure of the firm and practiced corporate finance. In that context, it presents the central place of valuation in finance and the usefulness of financial theory to deal with it properly. It also proposes an introduction to the Black-Scholes-Merton pricing model and to LBOs  
Corresponding corporate finance principle are evidenced and illustrated by real examples.

**Table of contents**

1. The place of valuation in finance
2. Peers approaches
  - a. Market cap and enterprise value
  - b. Listed peers approach
  - c. M&A peers approach
3. DCF
  - a. Principle
  - b. Terminal value
  - c. Discount rate
4. Focus on financial structure
  - a. Traditional approach
  - b. Modigliani & Miller approach without tax
  - c. Modigliani & Miller approach with corporate tax
  - d. Miller approach with personal tax
5. Usefulness of the Modigliani and Miller approach for valuation
  - a. Adjusted cost of capital
  - b. Unlevered/re-levered beta: the Hamada formula
  - c. Introduction to the trade-off theory
6. Option pricing models and corporate finance

- a. Black & Scholes formula
  - b. Usefulness to value equity and debt
  - c. Probability of bankruptcy
7. Conclusion
- a. Holdings and conglomerates: risk, return and valuation
  - b. Introduction to LBOs

**Mode de contrôle des connaissances :**

Test after the last course (2 hours)

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## Machine Learning : empirical applications for finance (Bloc 3/3 of the Certificate "Fundamentals of Data Science")

ECTS : 3

**Description du contenu de l'enseignement :**

**Basics of ML**

- Definitions, approaches and applications.
- Data mining (DM) : definitions and links with ML.
- Classification and regression problems.
- Building and evaluating an ML model.
- Presentation of the main approaches of ML/DM.
- Application I.

**Decision Trees :**

- Definitions and algorithms.
- Advanced methods based on DL : Bagging, Boosting and Random forests.
- Application II : Making a decision in finance.

**Neural networks:**

- Definitions.
- Learning in NN : gradient descent and Backpropagation.
- Advanced methods based on NN (Deep learning).
- Application III : Stock pricing.

**Reinforcement Learning :**

- Definitions : Agents and environments.
- Markovian Decision Process (MDP).
- Policies and optimal policies.
- Q-learning.
- Application IV : Trading.

**Compétence à acquérir :**

Building Machine Learning (ML) models for Finance problems. Using ML Python library (and in particular sickit-learn).

**Mode de contrôle des connaissances :**

Two/Three assignments (building a model + Python programming).

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## Machine Learning in Finance

ECTS : 3

**Description du contenu de l'enseignement :**

Methods of Statistical Learning, applied to some financial problems of credit rating, anomaly detection and yield curve approximations

**Compétence à acquérir :**

Vapnik Chervonenkis dimension, PAC learning, calibration versus prediction, SVM (Support Vector Machines) classifiers, Mercer's theorem, C-SVMs, mu-SVMs and single class SVMs. Basics of decision trees, random forests and penalized

regressions.

**Mode de contrôle des connaissances :**

Exam

**Bibliographie, lectures recommandées :**

Trevor Hastie, Robert Tibshirani, Jerome Friedman: The Elements of Statistical Learning, Springer  
Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani : An Introduction to Statistical Learning, Springer  
Christopher Bishop: Pattern Recognition and Machine Learning, Springer

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## Management of Credit Risk : Theory and applications

ECTS : 6

**Description du contenu de l'enseignement :**

This course is an introduction to Credit Risk in its different dimensions (Default/Recovery/Transition), starting from a description of the phenomenology of Credit Risk, the different instruments subject to credit risk to the different modelling approach both for single name or portfolio exposure. Numerous concrete examples illustrate the concepts introduced and the mathematical model are studied through exercises. The aim is to cover the broad domain of credit risk from retail products (credit card, mortgages) to sovereign credit risk, looking at the existing practical issues that students would have to solve in their future employment either as Risk Managers, Traders, Asset Managers, Credit Risk Officer, Analysts, ...

A book covering the different concepts presented in class is made available and corrected exercise are also available to the students.

**Compétence à acquérir :**

The key concepts pertaining to credit risk should be understood by students and a solid framework would allow an easier analysis of credit risk and its management in their future job.

**Mode de contrôle des connaissances :**

A final exam mixing (i) questions on topic seen during the class and (ii) quantitative exercises to measure credit risk.

**Bibliographie, lectures recommandées :**

Credit Risk - Pricing, Measurement, and Management - Darrelle Duffie - Princeton University Press  
Credit Risk Modeling - David Lando  
Credit Risk - Tomasz Bielecki, Marek Rutkowski

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## Microeconomics for finance

ECTS : 3

**Description du contenu de l'enseignement :**

**Syllabus:**

1. Equilibrium in an Exchange Economy
2. Decision Making under Uncertainty
3. Equilibrium in Markets for Securities
4. Investment Decision under Market Imperfections: the Principal-Agent Problem

**Compétence à acquérir :**

This 24 hours course aims at acquainting students with relevant microeconomics methods to tackle finance issues.

**Mode de contrôle des connaissances :**

Final exam and assignment

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## Microstructure of financial markets

ECTS : 3

**Description du contenu de l'enseignement :**

The field of market microstructure combines theoretical modeling, institutional knowledge, and empirical analysis to understand how prices result from the interactions of traders in financial markets. The course aims to acquaint students with (i) the canonical models in microstructure, and (ii) econometric models used to test the predictions of those models.

Course structure:

1. Trading Mechanisms
2. Measuring Liquidity
3. Price Dynamics and Liquidity
4. Trade Size and Market Depth
5. Empirical Analysis

**Compétence à acquérir :**

Master the concepts of financial markets microstructure

**Mode de contrôle des connaissances :**

Evaluation: assignment and final exam

**Bibliographie, lectures recommandées :**

Foucault, Thierry, Marco Pagano, and Ailsa Röell, Market Liquidity: Theory, Evidence, and Policy, Oxford University Press, 2013.

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## Monte Carlo Simulations in finance - MathLab

ECTS : 0

**Description du contenu de l'enseignement :**

**Lecture 1 and 2:** Introduction to MATLAB. Tutorial with numerical optimization of Rosenbrock's function and simulation of the Brownian Motion. Markowitz portfolio optimization.

**Lecture 3:** Binomial options pricing model. European, American, Butterfly and Barrier Knock - Out options. Simulation of a Binomial tree and assets trajectories.

**Lecture 4:** Black and Scholes Model. Monte-Carlo method for option valuation. European option. Correlated Brownian motions. Basket et Exchange options.

**Lecture 5:** Black and Scholes Model. Strongly Path-dependent options. Asian option. Lookback and Choosers. Stochastic volatility models. Euler-Maruyama approximation of Stochastic Differential Equations. Option and asset pricing in the Heston model.

**Lecture 6 and 7:** Merton Model. Poisson distribution. Simulation of assets trajectories with jumps. Option pricing in the Merton model.

**Compétence à acquérir :**

The students will learn important principles of implementation of financial models and master algorithms of evaluation of different types of derivative securities: European, American, standard, barrier and path dependent options on stocks. This course gives a comprehensive introduction to Monte Carlo and finite difference methods for pricing financial derivatives. At the end of the course, the student should have a thorough understanding of the theory behind Monte Carlo methods, be able to implement them for a range of applications, and have an appreciation of some of the current research areas.

**Mode de contrôle des connaissances :**

Control of Knowledge: Defense of a Project.

**Bibliographie, lectures recommandées :**

Reading List:

- 1) S E Shreve, Stochastic Calculus for Finance II: Continuous-Time Models, Springer 2004.
- 2) P Glasserman, Monte Carlo Methods in Financial Engineering, Springer-Verlag, 2004.
- 3) P Wilmott, S D Howison and J Dewynne, Mathematics of Financial Derivatives, CUP, 1995.

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## Python for finance (Bloc 1/3 of the Certificate "Fundamentals of Data Science")

ECTS : 0

**Description du contenu de l'enseignement :**

Our aim in this course is to implement some key concepts in quantitative finance using popular Python packages such as :

- NumPy : the fundamental package for scientific computing.
- Matplotlib : the main 2D plotting library.

- SciPy : another scientific computing library containing toolboxes dedicated to optimization, statistics and many other fields.
- Pandas : A library offering powerful data structures and tools for data analysis.

The data we will use is extracted from free online sources (Google, Yahoo, ...). The main parts of the course are the following :

1. Python basics : Data types, data structures, programs structure and packages.
2. Numpy, Matplotlib : discovering these packages with application to Monte Carlo simulation (look at the potential evolution of asset prices over time/Random walk).
3. Scipy : Introduction and application to a regression analysis of stock prices.
4. Pandas and Matplotlib. Introduction and Application (I) : importing, visualizing and analysing Time series financial data.
5. Pandas and Matplotlib. Advanced aspects and application (II) : Volatility calculation, Algorithmic trading, Creating, testing and improving a trading strategy.

**Compétence à acquérir :**

Mastering the structure of the Python language, a good knowledge of the most important libraries for financial applications (Numpy, Matplotlib, Scipy, Pandas).

**Mode de contrôle des connaissances :**

Several programming assignments (one for each class).

## Regulation and Financial Markets

**ECTS : 3**

**Description du contenu de l'enseignement :**

Banks, and the financial sector more broadly, operate in a highly regulated environment. Financial regulations have evolved over time, in response to key events, such as the 2008 Global Financial Crisis, emerging risks (e.g., data, cyber security, FinTech, etc) and more recently the COVID19 pandemic, or the failure of SVB and Credit Suisse.

Regulations have broadened to encompass all parts of the financial system: banks and non-banks—insurers, market infrastructures, credit rating agencies, hedge funds, etc. Global policymakers (including BCBS, FSB, IOSCO) have developed international standards to support the G20 mandate—ensuring the stability and resiliency of the global financial system. At the local and regional level (in the EU for instance), prudential and market regulators are tasked with transposing these global standards in their own framework, which may cause some variations in the way regulations are implemented across jurisdictions.

This lecture aims to provide students with an understanding of the global regulatory architecture, ensure they understand where regulations come from, and how to stay up-to-date with a complex and constantly evolving topic. The course will also provide students with an overview of the current rules and regulations applying to banks and financial market operators in general. Via the drafting of a two-page note on a specific topic from the course, students will practice their written English communication and capacity to summarise complex matters. Finally, via the participation of experts from various background, the course will provide students with an insight into working for global organisations.

**Course outline:**

- 1) An introduction to financial regulations
- 2) Prudential regulations (Basel standards, CRD/CRR, DFA)
- 3) Crisis management (FSB standards, BRRD/CMDI, DFA)
- 4) Overview of Market regulations (International standards, MIFID/EMIR)
- 5) Sustainable Finance (Key risks, FSB/BCBS standards, EU taxonomy/GBS/ SFDR)
- 6) Digital Finance (Key risks, FSB/BCBS standards, DORA/MiCAR)
- 7) Outro (Wrap-up, critical considerations on financial regulations)

**Compétence à acquérir :**

Master the regulatory prudential and market reforms, at the global level and across regions

**Mode de contrôle des connaissances :**

Each students will be asked to prepare a two page note aimed at summarising a key issue of the programme.

## Research Master's thesis or Research project

**ECTS : 6**



**Description du contenu de l'enseignement :**

Students are required to write a Master's thesis on an innovative topic, which enables them to gain true expertise on their subject.

**Compétence à acquérir :**

The research Master's thesis is designed for the students who wish to pursue a career in research after the M2 104. This could be done in a private firm or by applying to a PhD program in Finance (at Dauphine, or in another academic institution).

The research master's thesis is also an opportunity to meet a thesis director who might become the supervisor of the PhD thesis at Dauphine PSL

Writing a research Master's thesis is mandatory for all students enrolled in the PhD Qualifying Year. All other students can choose between either a research Master's thesis or the combination of an applied Master's thesis and an internship.

When a student chooses the research master's thesis, there is no need, for him ou her, to do an internship. There are, however, some possibilities to do a short *research* internship in our research lab (at DRM-Finance).

**Mode de contrôle des connaissances :**

When the student wants to enrol in the PhD program in finance of PSL - University Paris Dauphine, he/she need to write a research project, which is due in May.

The thesis supervisor should receive the research master's thesis in the beginning of September. The defense of the thesis must occur before the 15th of September.

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## Seminar on research methodology (mandatory)

ECTS : 0

**Description du contenu de l'enseignement :**

In this seminar, the students will learn:

- to define a research subject;
- to select, read and use the articles related to their subject
- to organize the content of their Master's thesis, and to write their review of the litterature.

**Compétence à acquérir :**

This course is an introduction to the methodology of research through the writing of the Master's thesis. Throughout the year, the students of the M2 104 will have to work on their master's thesis, which is a very important part of their formation.

The aim of the Master's thesis is to produce an original piece of research work on a clearly defined topic within the investigative field of contemporary finance, under the guidance of one of the Masters' Professors.

- For students considering a career in the industry, the Master's thesis is a unique opportunity to demonstrate their scientific expertise in the field of finance and experience shows that employers highly value this research approach.

- For students considering a doctoral thesis, the Master's thesis enables them to get an initial feel for what research involves and is often the foundation for further investigation for a student's doctorate.

**Mode de contrôle des connaissances :**

The seminar is mandatory for all students of the M2 104. Their grades depend on the assiduity of the student and his /her ability to produce in due time, five documents. Each document represents one step in the writing of the Master's thesis.

Document n°1 reveals the preferences of the students about the research subjects in which they are especially interested

Document n°2 gives a definition of the subject, in accordance with the supervisor of the Master's thesis

Document n°3 is a synthesis about the main references that will be needed to write the Master's thesis

Document n°4 is a first draft of the review of the litterature

Document n°5 is the Master's thesis

**Bibliographie, lectures recommandées :**

Adresse du site de l'enseignant : <https://sites.google.com/site/delphinelautierpageweb/>

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## Structured products in practice

ECTS : 3

**Description du contenu de l'enseignement :**

Structured products, evaluation and control.

This course is an initiation to new structured products. It shows how to value such products, and how to control the associated risks

**Compétence à acquérir :**

Participants will learn how financial institutions can build and structured products, how they value them, and what they are done for.

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## Term structures : theory, models and empirical tests

ECTS : 6

**Description du contenu de l'enseignement :**

The term structure is defined as the relationship between the spot price and the futures prices of a derivative instrument, for any delivery date. It provides useful information for hedging, arbitrage, investment and evaluation: it indeed synthesizes the information available in the market and the operators' expectations concerning the future price of the underlying asset.

In many derivative markets, especially in interest rates and in commodity markets, the concept of term structure is very important, because the contract's maturity increases as the markets come to fruition. In the Eurodollar market, for example the maturities reach 10 years.

Chapter 1 presents a general introduction to derivatives today.

Chapter 2 examines the traditional theories of commodity prices and the explanation of the relationships between spot and futures prices. It proposes an empirical review of the results obtained through these frameworks and explains why these theories are still investigated today. It finally shows how to apply these theories to other assets: exchange rates and interest rates.

The traditional theories are however a bit limited when the whole term structure is considered. As a result, there is a need for a long-term extension of the analysis, which is the very subject of the Chapter 3. We first present a dynamic analysis of the term structure. Then the focus turns towards term structure models. The examples rely on the case commodity prices but can be extended to interest rates. Simulations highlight the influence of the assumptions concerning the stochastic process retained for the state variables and the number of state variables. We then explain the econometric method usually employed for the estimation of the parameters. In the presence of non-observable variables, there is a need for filtering techniques. We present the method of the Kalman filters. Finally, we study two main applications, i.e. dynamic hedging and investment valuation.

Chapter 4 is devoted to the study of structural models, ie micro-founded equilibrium models that also examine the interactions between the physical and the derivative markets. In this situation the spot price becomes endogenous. The interactions between prices are studied thanks to rational expectations equilibriums.

**Compétence à acquérir :**

At the end of this course, the students must have a broad knowledge about the term structures of derivative prices: the theories, the valuation methods, the econometric techniques, the empirical tests as well as the applications.

They will also be trained to use their knowledge on this topic in order to develop a critical view on recent research articles.

This course is mandatory for all students enrolled in the cursus PhD Qualifying Year. It is optional for all other students of the M2 104.

**Mode de contrôle des connaissances :**

Ongoing assessment, 20%

One final exam, 80%.

**Bibliographie, lectures recommandées :**

- Danthine J.P., Donaldson J.B., Intermediate Financial Theory, 2d Ed., Elsevier, 2005.
- Hull J., Options, futures and other derivatives, 9th Ed.
- Kolb R.W. , Overdahl J.A. , Futures, options, and swaps, 5th Ed., Blackwell, 2007.
- Williams J., The economic function of futures markets, Cambridge University Press, 1986
- Wilmott P., Paul Wilmott on Quantitative Finance, 3-volume set, 2nd Ed., Wiley, 2006.

Adresse du site de l'enseignant : <https://sites.google.com/site/delphinelautierpageweb/>

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Time series (it is strongly advised to have some knowledge in R for this course)

ECTS : 3

### Description du contenu de l'enseignement :

This course will present the modelling and forecasting of time series. We will expose the main concepts and methods applied to univariate time series : stationnarity and unit roots, ARIMA models, univariate volatility models, forecasting. We will also present the methods for multivariate framework : VAR, Cointegration and VECM, Multivariate GARCH.

The learning goal of this course is that students become able to engage in and conduct original research. It is also to prepare them to be professionals in careers that require training in econometrics.

### Outline

1. Univariate time series modelling and forecasting  
Stationnarity and unit roots, unit root tests, ARIMA models : estimation, testing
2. Univariate volatility models  
ARCH, GARCH models and their extensions
3. Multivariate times series models  
VAR models, Causality, Impulse-Response analysis, Cointegration, VECM
4. Multivariate GARCH models BEKK, CCC and DCC models

### Software

The software that will be used in this course is R. No prior knowledge of this software package is assumed. This package will be introduced in lectures and in the problem sets as the course proceeds. Students are asked to install R and RStudio Desktop :

1. R can be found on <https://pbil.univ-lyon1.fr/CRAN/>
2. RStudio Desktop can be found on <https://www.rstudio.com/products/rstudio/download/>

### Compétence à acquérir :

After this course, the students should be able to produce their own empirical study with time series. They also should have acquired sufficient knowledge to read and understand more complex time series econometric methods.

### Mode de contrôle des connaissances :

The grade is based on an individual project.

### Bibliographie, lectures recommandées :

Brooks, C., Introductory Econometrics for Finance, Cambridge University Press, 3rd edition 2014.

Ghysels, E. and M. Marcellino, Aided Economic Forecasting using Emerging Methods, Oxford University Press, 2018.

Mills, T., et R.N. Markellos, R.N., The Econometric Modelling of Financial Markets, Cambridge University Press ; 3ème Édition, 2008

### Additional references

Campbell, J., A. Lo and C. MacKinlay, The Econometrics of Financial Markets, Princeton University Press, 1997

Bauwens L., Hafner C. et S. Laurent, Handbook of Volatility Models and their Applications, John Wiley & Sons, 2012.

Taylor, S. J., Asset Price Dynamics) Volatility and Prediction, Princeton University Press, 2007. Jondeau, E., Poon S.-

H. et M. Rockinger, Financial modeling under non-gaussian distributions,

Springer.

Linton, O., Financial Econometrics) Models and Methods, Cambridge University Press, 2019