

Undergraduate Program in Economics – 2nd Semester (Fall) 2023

Course: Financial Derivatives

PROFESSOR: Marcelo Verdini Maia

TA: TBD

CREDITS: 60h

PREREQUISITES: The prerequisites for Financial Derivatives are Investments. In addition, the course requires familiarity with the basic tools of calculus, probability, statistics and with a software package that can be used for numerical computation (such as Excel, Matlab, R and Python).

OFFICE HOURS: TBA

1. Syllabus

Introduction. Forwards. Futures. Swaps. Options. The Binomial Model. Modeling the Evolution of Market Prices. The Black-Scholes-Merton Model. Hedging and the “Greeks”. Advanced Topics: Equity Derivatives (Volatility Models, Jump-Diffusion Models, Applications), Interest Rate Derivatives and Credit Risk.

2. Course Description and Objectives

This course focuses on derivatives (such as forwards, futures, swaps, options and similar securities). These instruments offer a direct way of trading the risk associated with the change in interest rates, exchange rates, stock and commodity prices, and other market variables. They are widely used by both individuals and corporations to hedge existing market risks, to speculate on the future movements of market variables, or, more generally, to tailor the return distribution of a portfolio.

This course is a rigorous study of how derivatives are priced and how they are used for risk management. Also, it will offer an advanced analysis of complex derivative pricing models. It aims at building an integrated framework allowing students to: 1) decide what factors should be incorporated in a reasonable pricing model for the given derivative; 2) formulate a consistent model incorporating the

chosen factors; 3) calibrate the model using market data; 4) price the derivative and identify a hedging strategy.

Although every effort will be made to introduce the models as intuitively as possible, the class will be by its nature very quantitative.

3. Class Format

The classes will primarily consist in lectures with real case studies. It is heavily focused on quantitative implementation of the models. In some cases, we will implement using machine learning techniques.

6. Course Outline (tentative)

1) Mathematics Background

- The Random Nature of Prices
- Binomial Model
- PDEs and Transition Density Functions
- Applied Stochastic Calculus
- Martingales

2) Equity and Currencies

- Black-Scholes Model
- Martingale Theory - Applications to Option Pricing
- Martingales and PDEs: Which, When and Why
- Introduction to Numerical Methods
- Exotic Options
- Understanding Volatility
- Further Numerical Methods
- Derivatives Market Practice
- Advanced Greeks
- Advanced Volatility Modeling in Complete Markets

3) Fixed Income and Credit

- Fixed Income Products and Analysis
- Stochastic Interest Rate Modeling
- Calibration and Data Analysis
- Probabilistic Methods for Interest Rates
- Heath Jarrow and Morton Model
- The Libor Market Model
- Further Monte Carlo
- Co-Integration for Trading
- Credit Derivatives and Structural Models
- Credit Default Swaps
- Intensity Models
- CDO & Correlation Sensitivity
- X-Valuation Adjustment

7. Requirements and Grading

There will be two projects, each contributing 35% to your grade. The remaining 30% of the grade will be based on performance on class presentation of a selected topic.

8. Course Material (required)

Ali Hirta e Salih Nefcti. An Introduction of the Mathematics of Financial Derivatives. Academic Press, 3rd edition, 2013.

John C. Hull. Options, Futures, and Other Derivatives, 11th edition, Pearson, 2021.

Paul Willmott. Paul Willmott Introduces Quantitative Finance, second edition, 2007, John Wiley.

9. Course Material (suggested)

1. **Aurelien Gueron**. Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems. Third Edition, 2023, O'Reilly
2. **Bodie, Kane e Marcus**. Investimentos. 10ª edição. McGraw-Hill (in Portuguese)
3. **C. Bishop**, Pattern Recognition and Machine Learning, 2006, Springer
4. **Darrel Duffie**. Dynamic Asset Pricing Theory.
5. **Damiano Brigo and Fabio Mercurio**, Interest Rate Models - Theory and Practice, 2nd edition, Springer, 2006
6. **Das, Satyajit**. Traders, Guns & Money, 3rd ed. Financial Times/Prentice Hall 2006.
7. **J. Gregory**, The xVA Challenge: Counterparty Credit Risk, Funding, Collateral and Capital, third edition, 2015, Wiley
8. **Leonel Molero e Eduardo Mello**. Derivativos: Negociação e Precificação. SaintPaul, 1ª edição, 2019 (in Portuguese)
9. **Lawrence McMillan**. Options as a Strategic Investment. Prentice Hall Press, 5th edition, 2012.
10. **Paul Wilmott**, Machine Learning: An Applied Mathematics Introduction, 2019, Wiley
11. **Martelini, Priaulet, Priaulet**. Fixed Income Securities: Valuation, Risk Management and Portfolio Strategies.
12. **M. Kuhn and K. Johnson**, Applied Predictive Analytics, 2013, Springer
13. **M. Lopez de Prado**, Advances in Financial Machine Learning, 2018, Wiley
14. **Riccardo Rebonato**, Volatility and Correlation, 2nd edition, Wiley, 2004.
15. **Veronesi, Pietro**. Fixed Income Securities: Valuation, Risk, and Risk management, Wiley 2010
16. **Yves Hilpisch**, Python for Finance, 2019, O'Reilly
17. **Yves Hilpisch**, Artificial Intelligence in Finance, 2020, O'Reilly
18. **T. Hastie et al.**, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2009 (2nd edition), Springer

10. Resume

Marcelo Verdini Maia is Ph.D. in Finance at the Wharton School - University of Pennsylvania (2010), M.A in Finance at the Wharton School - University of Pennsylvania (2006), M.A in Economics at EPGE/FGV (2003), B.A in Economics at UERJ (2000) and B.A in Law at Universidade Estácio de Sá (2015). Counsellor-Judge at TCE/RJ (since 2016). Full-time professor of Economics at UERJ (since 2012) and Lecturer at EPGE/FGV (since 2015). Marcelo also holds CFA level 2 (level 3 exam scheduled in February, 2024) and is candidate for certificate in quantitative finance – CQF, expected in December, 2023. Research interests are in the field of Economics and Finance, working on the following subjects: Behavioral Finance, Quantitative Finance and Investments.

11. CV Lattes

<http://lattes.cnpq.br/9986329538902629>