EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

**Faculty of Economics and Social Sciences**

Department of Finance

# TAKE-HOME ASSIGNMENT - Summer Term 2022

## B401: Continuous-time Derivatives Pricing

## Organization

This take-home assignment aims at making you familiar with the basics in continuous-time derivatives pricing and practical applications of the contents encountered during the lecture. The assignment is due by **Monday, July 25, 2022 (1:00 PM)**. Please submit your assignment by uploading your files (poster, code, data) to Ilias. The presentation of your assignment will take place shortly after the submission (details tba).

The calculations can be done with an advanced software package (MatLab, Mathematica, SAS), or you can use Excel as well. No matter which program you use, please **insert comments** describing your computational steps and showing all results and needed answers. Most importantly, make sure that all your **calculations are traceable**, results are highlighted, and sources are labeled. This implies that your code is smoothly running, and your results are displayed after a **rational amount of time**. Additionally, you have to hand in a 1-page A3-format presentation poster **(minimum font size: 11)**, which contains your name and student ID in the top left corner of your poster. Furthermore, the poster must be a **self-explanatory** solution to the below stated problems. This means that it contains all the necessary plots, tables, interpretations, and justifications.

We offer support within teaching sessions/practical classes. The date of the first session will be announced during the lecture. In this session, we will have a detailed look at the tasks of the assignment. Of course, you are always welcome to ask questions after the lecture.

The final grade is mainly based on the complexity of the product chosen and your poster. However, the technical implementation counts as well. A proper application of the chosen valuation method, a reasonable parameter choice, and your economic reasoning are the crucial drivers of your final grade.

Some important notes on **individual** solutions: You may form groups to discuss the general contents discussed in the lecture, but you have to name your student fellows with whom you talked to (also in the top left corner of your poster). However, the implementation steps and economic reasoning has to be done **individually**, as this is **not** a group assignment.

In case you consider the PhD track, we offer the option to get a special assignment on demand. Therefore, please send a mail to martin.kipp@uni-tuebingen.de until the first teaching session to discuss the way your assignment can be raised to a PhD-level.

# Problems

## Part 1: Retail certificates

I. **Product selection:**
Select a traded retail certificate with derivative features. Please do not select open-end products! Provide its key information and, most importantly, its ISIN. *Note:* When selecting your product, you should already think about the valuation method (Black-Scholes model, binomial tree, etc.) you want to apply.

II. **Product characteristics:**
Explain the characteristics of your choice in problem I. Illustrate the payoff profile and the market situation(s) under which the product does (and does not) outperform its underlying graphically.

III. **Parameter selection:**
Provide an overview of all input parameters that you require for the valuation of your product and how you obtain those. All inputs must be justified separately. In this list, you should not report the specific numbers but the required parameter in general.

*Example:*

| Parameter | Type | Source/Calculation Method |
|---|---|---|
| DAX performance index | daily closing price | Thomson Reuters Datastream |

IV. **Valuation:**
Value your product using your preferred valuation method over a valuation window of at least 100 trading days and compare your (daily) results to (observable) market prices. Calculate appropriate error metrics (e.g. mean error, RMSE, error quantile, etc.). Report your results in a table and comment on your observations.

V. **Sensitivity analysis:**
Conduct a thorough sensitivity analysis of your product towards the most relevant parameters. To do so, plot the greeks (Delta, Gamma, Vega, etc.) of your product and discuss your observations. You are free to choose either fictitious or actual observed parameters. Anyway, all inputs must be sensible.

## Part 2: Portfolio insurance strategy

*For this task, assume a fictive investor with an investment horizon of $T^* = 1$ year, planning to invest 10,000 euros. Assume that the investor has the possibility to invest in a stock or index (e.g., the underlying from Part 1), and put options for portfolio insurance purposes.*

VI. **Performance analysis (without risk management):**
Choose an appropriate simulation approach to derive the payoff/return distribution at the end of the investment horizon $T^*$ of an investment in the stock/index. Calculate meaningful performance and risk measures and explain.

VII. **Performance analysis (with risk management):**
Implement a portfolio insurance strategy by including put options to hedge the portfolio against downside risks. Consider fictitious puts, which prices are based on the historical volatility of the underlying, and analyze the impact of

i) the fraction of initial wealth invested in put options, and

ii) the strike $K$ of the put options

on the performance and risk measures of the resulting portfolio. Illustrate and discuss your observations and compare them to the results of Problem VI.

VIII. **Stress scenario analysis**
For a specific portfolio allocation from Problem VII, consider that the volatility for pricing purposes of the options equals the historical volatility of the underlying $\pm 5$ percentage points and/or a sudden drop of the stock/index price by 20% after half a year. Compare the results and explain.