Financial Modeling Module

MODULE INTRODUCTION

Throughout your actuarial studies you have worked with models. On the QFI track, most likely you have studied scenarios for projecting future market outcomes. In this module, you will build on this by exploring more modeling techniques particularly useful to investment-specialist actuaries. This module introduces and ultimately ties together two topics. First, you will model equity returns using the binomial model and use it in R to price options.

Next, you will look at typical retirement annuity products and identify options baked into them. You will build Black-Scholes option pricing tools, and then use futures to set up a hedge so that you are indifferent to whatever future market scenario ultimately emerges.

Throughout this module, you will use RStudio to build tools and run simulations. The module will walk you through the steps, but first you will be asked to try to create them yourself. You will most likely find this is the best way to learn the material and to solve the application problems at the end of the module.

The purpose of the Financial Modeling module is to provide you with extensive practice building and running the types of asset-side models you may be required to create as an actuary working with investments and market linked financial products. The McDonald derivatives textbook is used here for continuity and its detailed numerical examples.

We hope you find this module interesting and relevant to your exam study and practice as an actuary.

Module Learning Objectives

After completing this module, you should be able to:

- Identify options embedded in financial products and the risks and opportunities they pose.
- Build basic option pricing models.
- Combine these topics to either replicate or construct a hedge for those embedded options.

Module Sections

The Financial Modeling module consists of six sections:

- Section 1: Overview
- Section 2: Equity Returns and Options Pricing
- Section 3: Liability Options
- Section 4: Option Pricing
- Section 5: Delta Hedging
- Section 6: Applications

In addition, this module contains an End-of-Module Test and an End-of-Module Exercise.

SECTION 1: OVERVIEW

In this section, you will learn how R or RStudio are required to complete this module. The readings and organization of the module are also listed.

SECTION 2:EQUITY RETURNS AND OPTIONS PRICING

Introduction

In this section you will learn about using the binomial model to model equity returns and price options, and connecting the binomial model to the lognormal model. This in turn will motivate the Black Scholes formulae.

Learning Objectives

In this section, you will:

- Learn to use the binomial model for equity returns
- Explain how the model can be used to price any option via replication
- Model equity returns and price options using the binomial model in R
- Identify the connection between the binomial model and the lognormal model for equity returns
- Explain how the Black-Scholes Pricing formulae is implied from the lognormal model and the concept of replication
- Explain the differences between risk-neutral and real-world probabilities

SECTION 3: LIABILITY OPTIONS

Introduction

Here we look at two common types of retirement savings products which include financial market return guarantees, consider how these can be viewed as options, and how to use R code to build models of these guarantees.

Learning Objectives

In this section, you will:

- Describe some financial products that offer guarantees.
- Identify options “embedded” in those guarantees.
- Identify the risks and opportunities they pose and the product features that help control those risks.

SECTION 4: OPTION PRICING

Introduction

Here you will work hand-on with the Black-Scholes option pricing formula.

Learning Objectives

In this section, you will:

- Calculate option Greeks and describe how they relate to market changes.
- Visualize profitability results with the plot command.
- Execute simple hedging strategies with market data for stocks and derivatives.
- Describe the factors contributing to the gain and loss in a hedged portfolio.

SECTION 5: DELTA HEDGING

Introduction

In this section you will put together the risk exposure of the put option embedded in a GMAB with an offsetting put option to hedge it. You will create that put option hedge "synthetically" with futures.

Learning Objectives

In this section, you will:

- Learn how to model two products with two hedge strategies – a delta hedge and a full hedge.
- Compare the two hedge strategies.

SECTION 6: APPLICATIONS

Introduction

Given your new understanding of the fundamental theories and your experience with the hands-on activities from Sections 2 to 5 of this module, this section offers opportunities for you to further develop your understanding and enhance your experience through several case studies.

Learning Objectives

In this section, you will:

- Apply the understanding and the experience you gained from Sections 2 to 5 of this module to the case studies in this section.
- Utilize the R code you have built from Section 2 to 5 of this module to create a markdown report for each of the case studies.