UNIVERSIDAD ADOLFO IBÁÑEZ

# Dynamic Asset Allocation

## FINAL PROJECT

Financial engineering is a discipline that combines various fields (e.g., economics, probability, optimization, numerical methods, etc.) with the aim of solving relevant problems in finance.

This project is designed to provide a challenging task that will require students to combine the concepts and techniques learned in previous courses.

### Goals

- To read and comprehend an academic research paper, or a business case, that has a direct application in the development of a financial product
- To explore and research a specialized subject, within the asset allocation industry
- To provide a practical application in finance that requires the simultaneous display of mathematical modeling, empirical estimation, optimization, and presentation skills.

### Instructions

Groups

- Students will form groups (of no more than 3 students) and choose one of the 22 project topics listed below.
- Project's topics will be assigned on a first-come first-served basis. A member of each group must send an email through Webcursos, announcing the members of the group, as well as the selected topic.
- After de midterm exam, each group will have a 25min weekly meeting (*Zoom* or other similar can be used if convenient) with the instructor to discuss the steps needed to accomplish the goals of the project. Students are expected to come well prepared to each meeting.
- The instructor will offer available time slots for the weekly meetings, which will be assigned on a first-come first-served basis among the groups, and schedule the meetings accordingly.
- Students will elaborate a presentation with the outcome of the project, which will be delivered to the whole class.

Deliverable

- A Power Point (or similar) presentation of no more than 10 slides. The PPT will have three sections: *Motivation*, *Analysis*, and *Final Remarks*, and should have as its target audience your classmates and a potential industry guest.

- The *Motivation* must convey all the necessary background and context in order to help the audience to assess the relevance of the project's topic, and its contribution as a potential improvement in a asset management entity.
- The *Analysis* section must (1) describe the logic of the chosen mathematical model, (2) explain the reasons behind the considered financial market model, (3) explain how the problem was solved (with emphasis only on the key equations, that later on will be used to implement some numerical scheme or approximation), (4) describe the sources and nature of the data used to carry out the estimation of the model, (5) discuss how the parameters of the model were estimated/calibrated, and (6) present the results obtained in the best didactic way possible. The *Analysis* must contain a sensitivity analysis to tackle potential model risk. The sensitivity analysis must be carried out for at least three parameters, or key modeling assumptions.
- The *Final Remarks* section must briefly summarize the purpose and main findings and highlight the key points of interest for an asset management company.

## Evaluation criteria

The score of each project will be based on the class presentation (**50%**) and the instructor's evaluation of the process that resulted in final presentation (**50%**).
The class presentation will take place on our last day of class, **December 17th** from 3:30PM till 7:30PM. Each group will have 30min to present its project, and each member of the group must play an equal part during the presentation.
The aspects to be considered in the evaluation of the presentation are the following:

- Degree of accomplishment in the *Motivation* in relation to its ability to convey all the necessary background needed for the audience to correctly assess the value of the project, and the added value of the final proposal, and clarity of the *Final Remarks* section (**25%**)
- Quality of (1) the description of the mathematical model, (2) its key assumptions, and (3) the formulation of the mathematical problem and its solution[1] (**25%**)
- Quality of (1) the description of the data used, and (2) the estimation/calibration process, (3) including an assessment about how well the data used in the report compares itself with the ideal data set for the chosen investment problem (**25%**)
- Degree of (1) accomplishment in describing the results, and (2) the sensitivity analysis, in a didactic way (**25%**)

## List of projects

1. Optimal Life Cycle Consumption & Investment: Chile (Male)
2. Optimal Life Cycle Consumption & Investment: US (Female)
3. Optimal Investment with Benchmarking: Chile
4. Optimal Investment with Benchmarking: US
5. Asset Liability Management: Banking (Chile)
6. Asset Liability Management: Life Insurance (Chile or US)
7. Asset Liability Management: Central Bank International Reserves (Liquidity)
8. Asset Liability Management: Central Bank International Reserves (Investment)
9. Asset Liability Management: Chilean SWF (FEES)

[1] All unnecessary algebra should be placed in an online appendix.

10. Asset Liability Management: Chilean SWF (FRP)
11. Structured Portfolio Strategies: Retail Fund for Loss Averse Investors
12. Structured Portfolio Strategies: Optimal Design of a Benchmark Portfolio
13. Structured Portfolio Strategies: Optimal Standardized Portfolios
14. HBS Cases

## Projects description

### *Lifecycle Consumption & Investment*

Lifecycle investment refers to the investment problem of a flesh and blood person, who is not only concerned about how to invest his savings, but that also must decide about other things, such as his consumption, retirement, and housing plan for the future. All this, having in mind his current financial wealth, the labor income he/she will receive over his lifetime, and the unexpected disbursements that might face in the future (e.g., college tuition, uncovered medical expenses, etc.).
Your task is to model a lifecycle investment problem for a specific representative person and determine his/her optimal lifetime investment rules. This involves (but it is not limited to) 1) choosing a specific representative person (male, female, Chilean, or US citizen, highly, medium, or poorly educated, etc.), 2) characterizing his/her financial net worth (financial wealth, housing status, real estate, mortgage, children, etc.), including the foreseeable expenditures that he/she might encounter over his/her lifetime, 3) proposing a sensible objective function, 4) modeling the lifetime labor income, 5) estimating the financial and labor market parameters, and 6) presenting the main determinants of the optimal investment plan. The technical reference for this project is Munk and Sorensen (2010).

### *Investment with Benchmarking*

Benchmarking refers to an investment problem in which the portfolio manager must take into account the deviation with respect to a so-called *benchmark portfolio*, when selecting the assets to be held in the portfolio. In the case of a mutual, hedge, or defined *contribution* pension fund, the task of the portfolio manager is to produce risk adjusted returns, observing the *relative risk* restriction that forces the chosen portfolio not to deviate from the benchmark portfolio beyond a predetermined amount.
Your task is to model an investment problem with benchmarking for a specific market and determine its optimal asset allocation rule. This involves (but it is not limited to) 1) choosing a specific market (Chile, Brazil or US), 2) selecting both a benchmark portfolio and a set of investable assets, 3) proposing a sensible objective function, 3) estimating the financial market, and 3) presenting the in-sample and out-of-sample performance of your proposed asset allocation rule. The technical reference for this project is Basak, Pavlova and Shapiro (2008).

### *Asset Liability Management*

ALM refers to an investment problem that must take into account the mismatch between the assets and liabilities of the asset owner, when selecting the assets to be held in the portfolio. In the case of a commercial bank, a life insurance company, or a defined *benefit* pension fund, the task of the portfolio manager is to produce risk adjusted returns, taking into account the risk of insolvency for the asset owner (i.e., the investment management company).
Your task is to model an ALM problem for a (Chilean or US) Commercial Bank, a Life Insurance, or a similar entity, and determine its optimal asset allocation rule. This involves (but it is not limited to) 1) choosing a real company, 2) proposing a sensible objective function, 3) analyzing and modeling their assets and liabilities, and 4) making the necessary simplifying assumptions that allow you to model and solve a meaningful ALM problem for the company. The technical reference for this project is Detemple and Rindisbacher (2008).

### *Retail Fund for Loss Averse Investors*

Loss aversion refers to an asset owner's inclination towards avoiding losses, relative to a so-called "reference point" (e.g., the initial investment, a popular financial index, etc.).
Your task is to model an investment problem aimed at designing a retail fund for the Chilean market, which takes into account this specific behavioral feature. This involves (but is not limited to) 1) proposing a sensible objective function, 2) selecting a set of investable assets, 3) determining the optimal asset allocation rule, and 4) presenting the in-sample and out-of-sample performance of

your proposed asset allocation, compared to the standard case (i.e., without the loss aversion feature). The technical reference for this project is Berkelaar, Kouwenberg and Post (2004).

### *Optimal Design of a Benchmark Portfolio*

A benchmark portfolio is used to measure the ex-post performance of a portfolio manager, and also serves as an anchor of the selected asset allocation. Ideally, it should be set to ensure that the selected asset allocation is well aligned with the risk preferences of the asset owner. Unlike optimal asset allocation rule (which is usually time-varying), a benchmark portfolio is usually given by a constant combination of financial assets and/or contracts.

Your task is to model an investment problem with benchmarking, and determine the constant benchmark portfolio that best approximates the optimal asset allocation rule chosen by the portfolio manager, to the one of that is optimal from the point of view of the asset owner. The technical reference for this project is Haugh and Lo (2001).

### *Optimal Standardized Portfolios*

In the ideal world each investor should have access to a customized optimal portfolio, whose level of risk and investment horizon exactly matches that of his/her preferences. In practice, however, only a small number of portfolios are offered by financial institutions. This naturally cause a utility loss to most investors.

Your task is to determine the best positioning of standardized optimal portfolios for a population of investors, which will depend on the distribution of the investors risk aversions and investment horizons, and the potential revenue that each investor amounts to the financial institution. The technical reference for this project is de Palma and Prigent (2009).

## *HBS Cases*

This is a list of business cases co-authored by Luis M. Viceira for his course on Asset Allocation at Harvard Business School. The list includes the following business cases:

1. *Clare College: Seeking Investment Opportunities in a Financial Crisis* (PDF)
2. *Harmonized Savings Plan at the BP Amoco* (PDF)
3. *Harvard Management Company* (PDF)
4. *Investment Policy at the Hewlett Foundation* (PDF)
5. *Investment Policy at New England Healthcare* (PDF)
6. *North Forty: Managing a Microsoft Family Office* (PDF)
7. *Pension Policy at The Boots Company, PLC* (PDF)
8. *Prudential Financial and Asset Liability Management* (PDF)
9. *The Vanguard Group, Inc. in 2006 and Target Date Funds* (PDF)