**Modeling Uncertainty and Risk**

**Course Project**

**Instructions:**

In this project, you will work through an optimization problem that has increasing complexity.

*You will make two submissions in the course of completing this project. After completing Part One of the project, you will submit a partially completed version of this project document for instructor review. A submit button can be found on the Part One assignment page.*

*Once you have completed Part Two of the project, resubmit this project document and any supporting documents to your instructor for grading. A Submit button can be found on the Part Two assignment page. Information about the grading rubric is available on both course project assignment pages.* *Do not hesitate to contact your instructor if you have any questions about the project.*

#### **Part One—Perform a Marginal Analysis**

In this part of the course project, you will calculate empirical probabilities and perform a marginal analysis based on a provided scenario and data.

In order to satisfy this part of the project, you will

1. *C*haracterize a fictitious scenario in terms of what you need to decide and the appropriate key performance indicators to evaluate (in this document).
2. Use Excel to generate probabilities and expected marginal values based on a data sample and *submit that Excel workbook to your instructor*.
3. Interpret the information from your calculations and make a recommendation (in this document).

Scenario:

Frontier airlines sells seats on its flights for two prices: $195 and $235. It starts accepting reservations at $195, and then once it has sold a sufficient number of seats, it increases prices to $235 and attempts to sell all the remaining seats. Past experience shows that if they kept prices at $195, the plane would be full.

The airline knows some last-minute customers will be willing to pay $235 for a seat, but the number of customers willing to pay $235 varies from day to day. The airline has some historical data on the number of seats it has sold at $235. You have been asked to help Frontier figure out how many seats it should hold in reserve at the $235 price in order to maximize profit.

Answer the following:

1. For this scenario:

* What do you need to decide?
* What key performance indicators do you need to consider?

1. Using the supplied Excel workbook, generate an analysis that shows the following:

* Minimum and maximum values for number of seats sold at $235
* A frequency table for seats sold at $235
* Cumulative probabilities (probability demand ≥ N) at each level of seat demand
* Expected marginal revenue at each level of seat demand

Include the Excel workbook in your submission to your instructor.

1. Based on your marginal analysis, how many seats should Frontier sell at $235? Explain the reasoning behind your recommendation.

**Part Two—Make a Simulation-Based Decision**

In this part of the course project, you will create and use a simulation to analyze a cash flow situation with two random variables. You will then extend your use of the simulation to examine outcomes based on manipulating two decision variables. This project part has two required sections and a third optional section.

Scenario:

You are doing some retirement planning to make sure you have sufficient funds for retirement. You plan to retire in 15 years. You have already saved $250,000 toward retirement. Presently, you are making $100,000 per year and contributing 10% of your salary to retirement. You estimate that you will receive annual salary adjustments of 2.5% over the next 15 years and will be able to generate an 8% annual return on your investments. You feel relieved because according to your estimates, you will have over $1,100,000 at the time you retire.

But you are wondering about the impact of uncertainty on your retirement plans. While on average your raises have been 2.5%, they have been as low as 0% some years and as high as 5% other years. While average returns on your investments have been 8%, they have a lot of uncertainty with a standard deviation of 4%.

Using the spreadsheet model as a template, build a simulation model to help investigate the impact of uncertainty on your retirement. Assume your annual salary adjustments are uniformly distributed between 0% and 5%, and that returns are normally distributed with a mean of 8% and standard deviation of 4%.

To satisfy this part of the project, you will:

* Create an Excel workbook with a simulation of your retirement income
* Answer questions related to the baseline assumptions in the scenario
* Modify your Excel workbook to incorporate decision variables and then submit that modified workbook to your instructor
* Answer additional questions based on manipulating the decision variables you have included in your workbook

**Section A**

Working with the assumptions in the baseline scenario, create a simulation that projects the balance in your retirement account after 15 years. An Excel template is provided on the course project page to help you get started. Be sure to include sufficient iterations in your simulation to generate a reliable sample.

Assuming you retire in 15 years, use your simulation to answer the following questions:

1. What is the average simulated value of your retirement account after 15 years?
2. What is the probability that you have more than $1,000,000 at retirement?
3. What is the probability that you have less than $750,000 at retirement?

**Section B**

After consulting with your financial advisor, you decide that you are not comfortable with your existing retirement savings plan, and you resolve to improve your prospects. You consider two options:

* Increasing your retirement savings contribution.
* Seeking out higher-risk investments with a higher average rate of return.

(For the purposes of this scenario, assume that the standard deviation for the rate of return is equal to the mean.)

You decide that you want a 95% or better probability that you will have at least $1,000,000 at retirement. Use a two-way table to identify options for securing that 95% likelihood. Your two-way table should look at the impacts of increasing your annual contribution and using higher return (and riskier) investment alternatives. Select two possible options (that satisfy the 95% criteria) from your two-way data table and describe them below.

**Option 1**

*Inputs (decisions)*

Annual contribution (%):

Expected return (%):

*Outcomes*

Probability of at least $1,000,000 in retirement fund:

**Option 2**

*Inputs (decisions)*

Annual contribution (%):

Expected return (%):

*Outcomes*

Probability of at least $1,000,000 in retirement fund:

**Section C (optional)**

You further consider your desire for a near-certain $1,000,000 retirement nest egg. Given your cash flow needs, investments with a higher return seem to be by far the more attractive option, but you are also concerned about the downside risk.

Create a second two-way table to assess the risk that you will have less than $750,000 at retirement, again assuming that the standard deviation of return for the investments equals the mean return. Now that you are directly measuring the downside risk, you are less concerned about the probability of having $1,000,000. List one option for which you have an 80% or better probability of having at least $1,000,000 and at most a 1% chance of having less than $750,000. **List the parameters here:**

*Inputs (decisions)*

Annual contribution (%):

Expected return (%):

*Outcomes*

Probability of at least $1,000,000 in retirement fund:

Probability of less than $750,000 in retirement fund: