### Valuation Project 1: Binomial Tree

**Due Wed, 16 October 2024**

**(This is a group assignment. Groups may have up to 3 members.)**

**The assignment is to:**

**(a) Develop and implement a binomial model to value a financial instrument from the list below (or of your choice). You should clearly discuss any accuracy concerns you have about your choice of models, discussing your choice of the number of steps, nonlinearity errors etc.**

**(b) Select reasonable inputs and estimate the value of the financial instrument, justifying your choices and indicating any concerns that you have about these parameters.**

**(c) Prepare a short (3-5 pages) written report documenting your implementation of the valuation model and your results. The valuation model and documentation must be completed by March 1. This should contain:**

* **An executive summary of your findings including your estimated value (or range of values)**
* **A description of the data you collected and used.**
* **A brief description of your algorithm (in mathematical notation NOT code!).**
* **A discussion of any sensitivity analysis performed and possible errors in your valuation. Pay attention to volatility choices and nonlinearity error here.**

**Projects will be graded out of 25 points:**

**5 points for parameter estimation and discussion of data collection and tree construction**

**15 points for the valuation procedure**

**5 points for a discussion of your results, discussion of accuracy of valuation and any necessary sensitivity analysis for uncertain parameters.**

**Grading will be based on:**

* **the complexity of the product and/or valuation model.**
* **how well you carry out the implementation of the valuation model – I would recommend attaching your code as part of your submission.**
* **your clear description of the model and your analysis.**

*NOTE: If you wish to choose your own product (see EDGAR notes at the end) you should select a financial instrument that is interesting (complicated) enough that developing your binomial tree is somewhat challenging, but simple enough that developing a valuation model is feasible. With a binomial tree there should, ideally be a call (early exercise) or autocall (barrier) feature.*

*However, there are many financial instruments that are too difficult for you to value at the moment. For example, some convertible bonds have complicated path-dependent features, and some hybrid securities are exposed to multiple underlying assets, leading to a high-dimensional problem. I strongly recommend that you identify your financial instrument and come and talk to me about it beforehand, so that I can help you decide whether you have chosen an instrument that is too difficult.*

**Choice #1: Contingent Coupon Auto-Callable Notes**

**Marathon Oil**

<https://www.sec.gov/Archives/edgar/data/1665650/000121390023066937/ea159893_424b2.htm>

Key features:

1. One underlying asset.
2. Intermediate autocall feature (check exactly how many business days after redemption you receive the payment)
3. Coupon calculations based on stock prices levels on discrete dates – be very careful with this as it is similar to a discrete barrier and so may lead to nonlinearity errors.

Data: You will need risk-free rates, and dividend yields and implied volatilities for the underlying stocks. These can be obtained from Bloomberg (see below) and other sources.

**Choice #2: Issuer Callable Contingent Coupon Barrier Notes**

<https://www.sec.gov/Archives/edgar/data/1114446/000183988224025517/ubs_424b2-15153.htm>

Key features:

1. One underlying asset
2. Simple call feature (check exactly how many business days after redemption you receive the payment)
3. Coupon calculations at different dates – be very careful with this as it is similar to a discrete barrier and so may lead to nonlinearity errors.

Data: You will need risk-free rates, and dividend yields and implied volatilities for the stock. These can be obtained from Bloomberg and other sources.

**Choice #3: Challenging product with memory feature**

<https://www.sec.gov/Archives/edgar/data/1114446/000183988224030366/ubs_424b2-18282.htm>

Key features:

1. One underlying asset
2. Simple autocall feature (check exactly how many business days after redemption you receive the payment)
3. Complicated (path dependent) coupon calculations at different dates as the size of the coupon payment is path dependent. Here, you will have to consider the different scenarios.

**Choice #4 Lookback option with a simple payoff**

https://www.sec.gov/Archives/edgar/data/1419828/000095017024010380/spxe1275\_final.htm

Key features:

1. One underlying asset – S&P 500 Index
2. Path dependent feature – a lookback feature
3. Otherwise simple – no coupons, no call features

Data: You will need risk-free rates, and dividend yields and implied volatilities for S&P500. These can be obtained from Bloomberg and other sources.

**Choice #5 Very Challenging Buffered Callable Range Accrual Notes linked to the Russell 2000®**:

<https://www.sec.gov/Archives/edgar/data/1419828/000095017024101956/gs-20240829.htm>

Key features:

1. One underlying asset – Russell 2000.
2. Very Challenging path dependent feature to determine coupon payments.
3. Also callable which makes it difficult to value even with Monte Carlo, so you’ll have to use the binomial for now.
4. Payment at maturity also depends on stock price level.

Data: You will need risk-free rates, and dividend yields and implied volatilities for S&P500. These can be obtained from Bloomberg and other sources.