Compound Green shoe Option

Intro to Financial Engineering

Member List

วรพล คุณากรกอบกิจ 6231356021

พีรณัฐ ธีระวัฒนชัย 6231343821

ดรากรณ์ ผดุงพัฒโนดม 6231323221

บัณฑิตา มาลัยศิริรัตน์ 6241120126

Let's work together

Agenda

1. Overview
2. Related Theorem
3. Method
4. Analysis

Overview

Related Theorem

International Public Offering (IPO)

Greenshoe Option

Compound Option

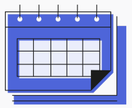
Asset Pricing Model

-Geometric Brownian Motion
-Trinomial Tree

IPO Process

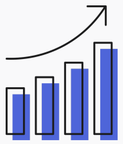
การตรวจสอบสภาพของบริษัท

การแปรสภาพเป็นบริษัทมหาชน



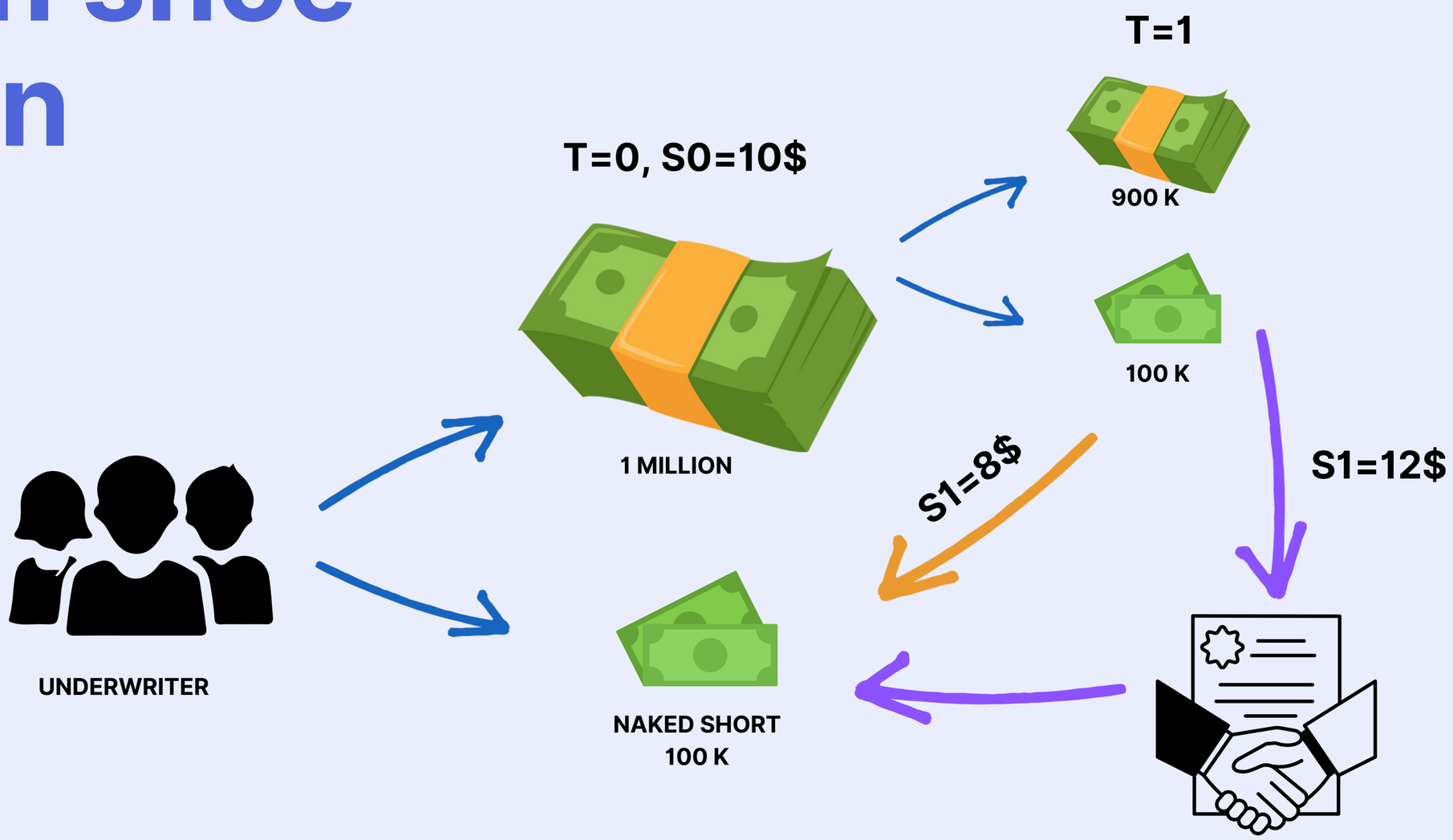
การยื่นขออนุญาตกระจายหุ้นและยื่นขอจดทะเบียน

การกระจายหุ้นต่อประชาชน



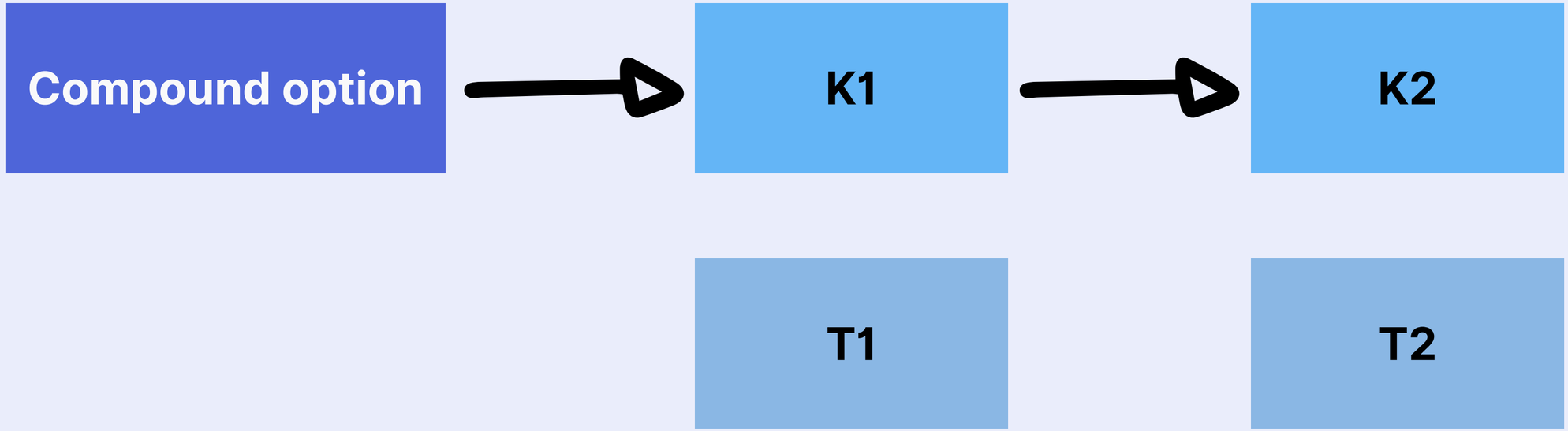
การเข้าจดทะเบียน

Green shoe option



Compound option

Underlying asset: Another option (Underlying option)



Compound option

Payoff of compound option at T1

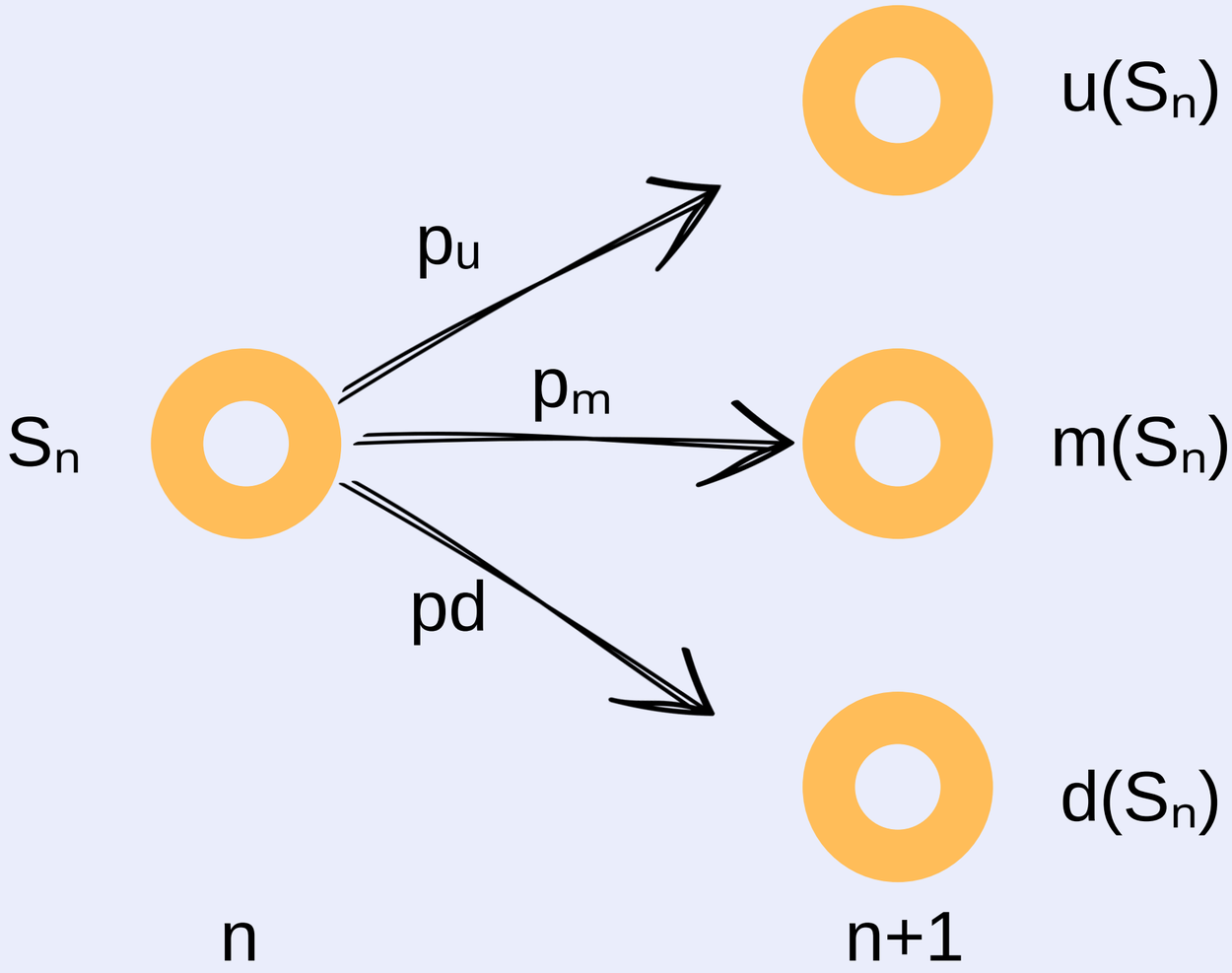
$$Call\ on\ call:\ max(C(S,T_1) - K_1,\ 0)$$

$$Call\ on\ put:\ max(P(S,T_1) - K_1,\ 0)$$

$$Put\ on\ call:\ max(K_1 - C(S,T_1),\ 0)$$

$$Put\ on\ put:\ max(K_1 - P(S,T_1),\ 0)$$

Trinomial tree



Trinomial tree

Estimate GBM with trinomial tree: combine 2 steps of the binomial tree into 1 step of the trinomial tree

$$u = e^{\sigma\sqrt{2\Delta t}}, \quad d = e^{-\sigma\sqrt{2\Delta t}}$$

Risk-neutral probability:

$$p_u = \left(\frac{e^{\frac{r\Delta t}{2}} - e^{-\sigma\sqrt{\frac{\Delta t}{2}}}}{e^{\sigma\sqrt{\frac{\Delta t}{2}}} - e^{-\sigma\sqrt{\frac{\Delta t}{2}}}} \right)^2$$

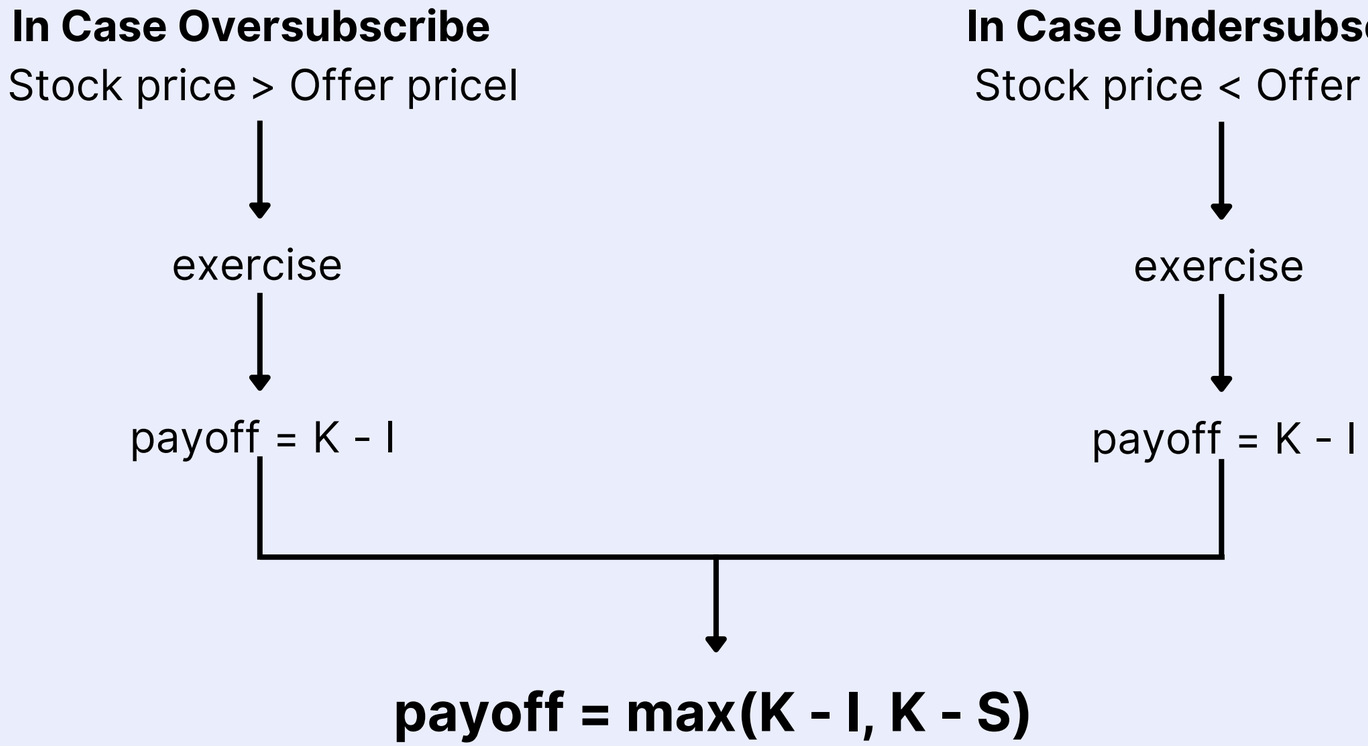
$$p_d = \left(\frac{e^{\sigma\sqrt{\frac{\Delta t}{2}}} - e^{\frac{r\Delta t}{2}}}{e^{\sigma\sqrt{\frac{\Delta t}{2}}} - e^{-\sigma\sqrt{\frac{\Delta t}{2}}}} \right)^2$$

$$p_m = 1 - p_u - p_d$$

Method

Green shoe option

- Denote K = Offer price, I = Net price, S = Stock price



Compound Green shoe option

- **Underlying asset** -> Green shoe option with American option-like payoff
- **Green shoe option** -> Call option
- ***Call-on-call option***

Option price calculation

1. Green shoe option

Parameter:

S0 = initial stock price
r = annualized continuously compounded interest rate
sigma = annualized volatility of stock return
K = strike price
I = net price (ราคาที่บริษัทขายให้กับ underwriter)
T = time to the expiration date of the option
N = number of time steps in the CRR model

Option price calculation

1. Green shoe option (cont)

- Approximate stock price (GBM) with trinomial tree
- Find the option payoff using max(K-S, K-I)
- Discount the option payoff from n=N until n=0 (check whether you can exercise this option before n=N)
- Get option price

Option price calculation

2. Compound Green shoe option

Parameter:

S0 = initial stock price
r = annualized continuously compounded interest rate
sigma = annualized volatility of stock return
K1= strike price ของ overlying option
K2= strike price ของ underlying option
I = net price
T1 = time to maturity (years) ของ overlying option
T2 = time to maturity (years) ของ underlying option

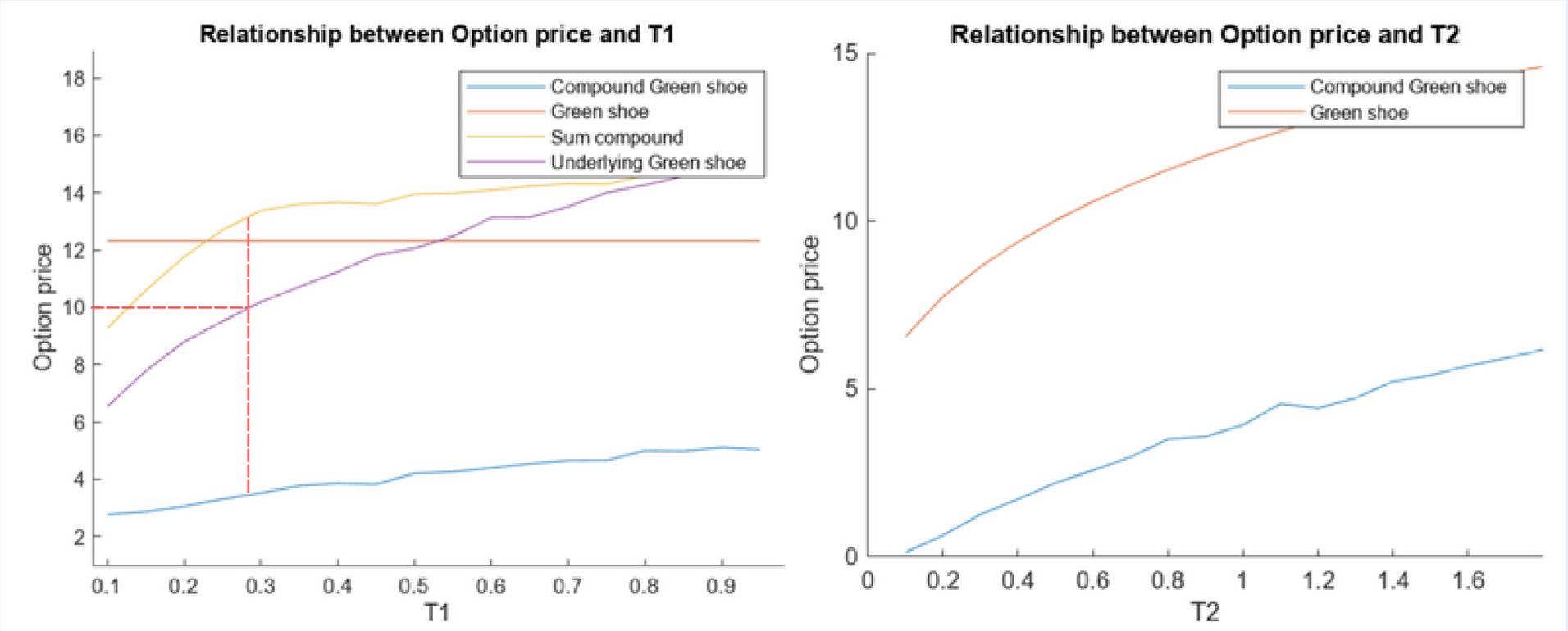
Option price calculation

2. Compound Green shoe option (cont)

- Simulate stock price with GBM at time T1 using Monte Carlo simulation with Antithetic sampling
- Find the underlying option price at time T1 using trinomial tree approximation
- Find payoff of the compound option = max(Option_price-K1, 0)
- Discount the option payoff until time 0 and get option price

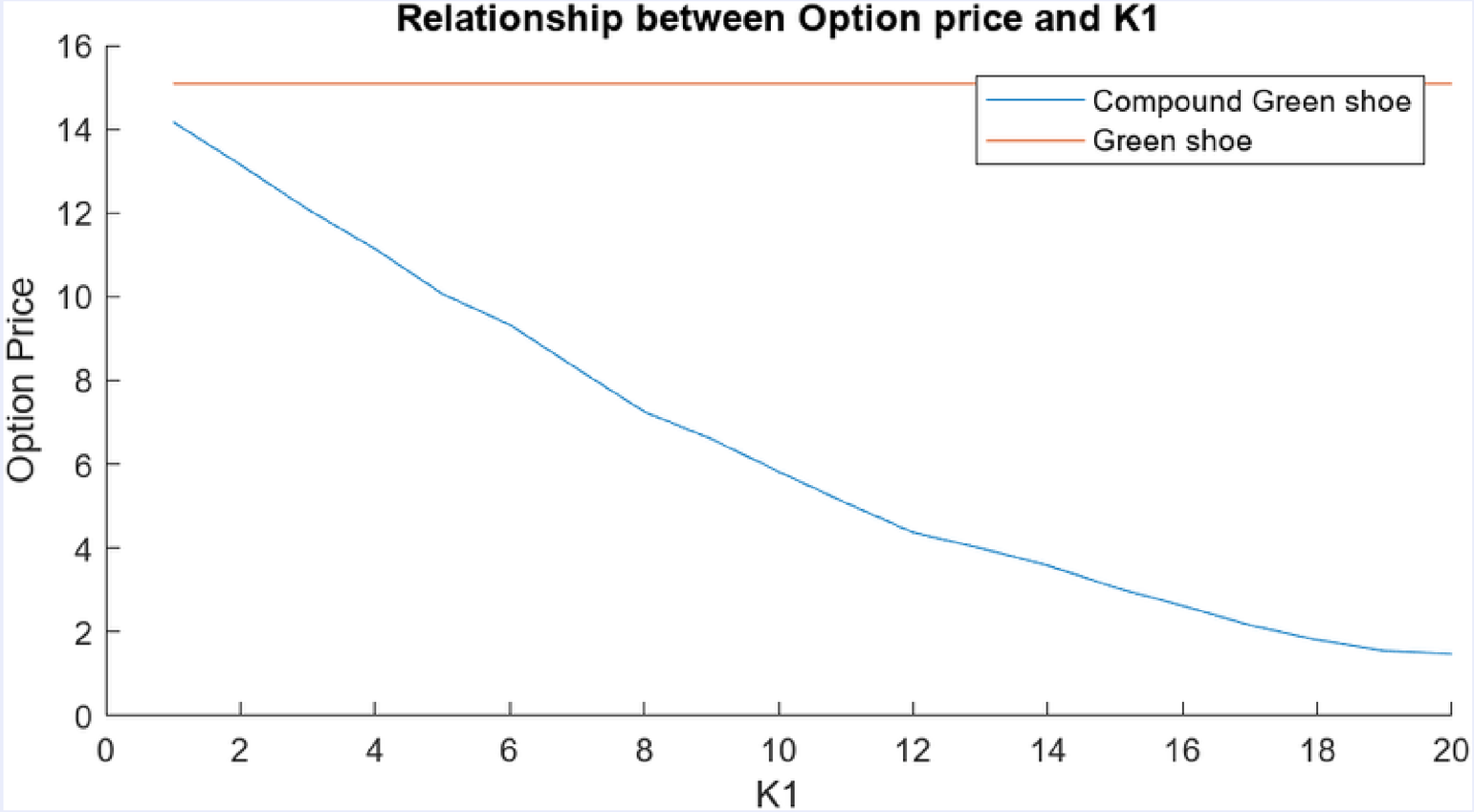
Analysis

Analysis: T1, T2



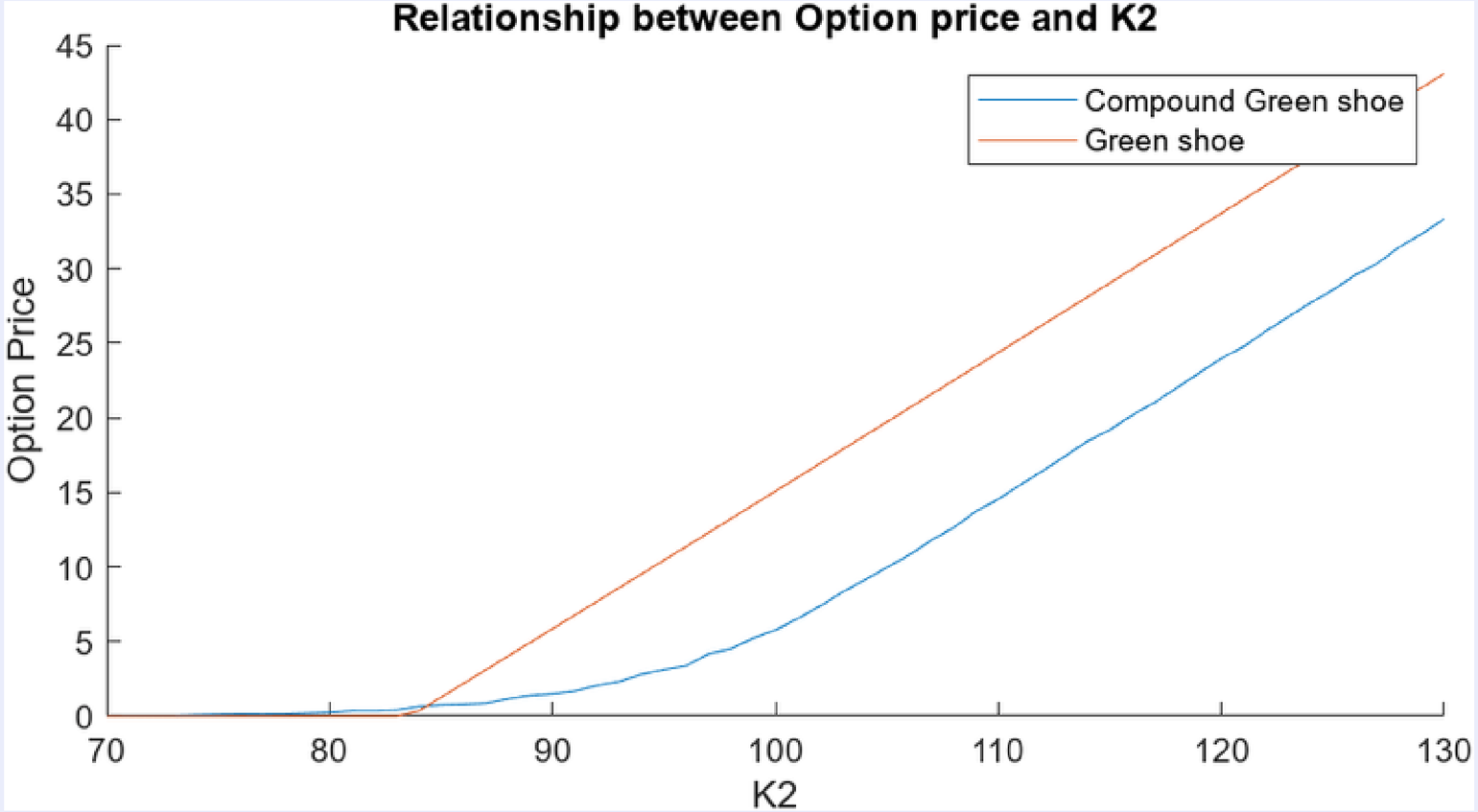
$S_0 = 100,\ r = 0.05,\ \sigma = 0.3,\ K_1 = 10,\ K_2 = 100,\ T_1 = 0.5,\ T_2 = 2,\ M = 1000$

Analysis: K1



$S_0 = 100,\ r = 0.05,\ \sigma = 0.3,\ K_1 = 10,\ K_2 = 100,\ T_1 = 0.5,\ T_2 = 2,\ M = 1000$

Analysis: K2



$S_0 = 100,\ r = 0.05,\ \sigma = 0.3,\ K_1 = 10,\ K_2 = 100,\ T_1 = 0.5,\ T_2 = 2,\ M = 1000$

Demo