Queens College, CUNY, Department of Computer Science
Computational Finance
CSCI 365 / 765
Fall 2018
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5 Homework 5

- Please email your solution, as a file attachment, to `Sateesh.Mane@qc.cuny.edu`.
- Please submit one zip archive with all your files in it.
  1. The zip archive should have either of the names (CS365 or CS765):

     `StudentId_first_last_CS365_hw5.zip`
     `StudentId_first_last_CS765_hw5.zip`

  2. The archive should contain one "text file" named "hw5.[txt/docx/pdf]" and one cpp file per question named "Q1.cpp" and "Q2.cpp" etc.
  3. Note that not all homework assignments may require a text file.
  4. Note that not all questions may require a cpp file.

5.1 Homework Lecture 6: Options #1

- In most textbooks, the most common point of view is that the investor (= you) holds the option. Therefore you (= holder) decide whether to exercise the option or not.
- However, it is different when you are the **writer (= seller)** of an option. The arbitrage strategies for the call options require you to take a **short position** in the call option.
- ***You must be taught what happens and what to do, if you sell an option and it is exercised against you.***
- These homework exercises will give you practice on the subject.
- The perspective of the option writer is unfamiliar and not obvious.
    1. Recall that an option writer has **obligations** but **no rights** (see Lecture 6).
    2. This is an important fact and you must be taught the consequences.
    3. An option is exercised when it is in the money, *i.e. the option holder makes a profit.*
    4. This means the option writer will **suffer a loss** when the option is exercised.
- For a **call option** (both American and European), if the option is exercised, the option writer must **deliver the stock and accept cash** $= K$ **(= strike),** *even though the stock price is* $S \geq K$ *and the option writer will suffer a loss.*
- For a **put option** (both American and European), if the option is exercised, the option writer must **pay cash** $= K$ **(= strike) and receive the stock,** *even though the stock price is* $S \leq K$ *and the option writer will suffer a loss.*
- There are also **cash settled** options.
- Not all options involve delivery of stock. Options on stock indices are settled in cash. The option "strike" is measured in index points. To calculate the cash payment, there is a dollar multiplier M for every index point that the option is in the money.
- For a **cash settled call option** (both American and European), if the option is exercised, the option writer pays the holder cash of $M(S - K)$.
- For a **cash settled put option** (both American and European), if the option is exercised, the option writer pays the holder cash of $M(K - S)$.

5.2 Exercise of long & short call option positions

5.2.1 Long American call option

1. You are **long an American call option**.
2. The call option has a strike of 102.
3. The market price of the stock is 107 today.
4. **You exercise the option. State what you pay/receive.**
5. **State what the option writer pays/receives.**

5.2.2 Long European call option

1. You are **long a European call option**.
2. The call option has a strike of 101.5.
3. The market price of the stock is 106 today (= expiration day).
4. **You exercise the option. State what you pay/receive.**
5. **State what the option writer pays/receives.**

5.2.3 Short American call option 1

1. You are **short an American call option**.
2. The call option has a strike of 48.
3. The market price of the stock is 52 today.
4. **The option holder exercises the option. State what the option holder pays/receives.**
5. **State what the option writer (= you) pays/receives.**

5.2.4 Short American call option 2

1. An American call option has a strike of 55.
2. You sell the option to investor A at a price of 1.1.
3. Therefore you are **short an American call option**.
4. The stock price is 48 (on the day of the sale to A).
5. The stock goes up to 52 and investor A sells the option to investor B for a price of 1.2.
6. The stock goes up to 56 and investor B sells the option to investor C for a price of 1.5.
7. **Explain what B pays/receives if B exercises the option instead.**
8. The stock price goes up to 58 and **C exercises the option. State what C pays/receives.**
9. **The option is exercised against you.**
   State what the option writer (= you) pays/receives on the day of exercise.
10. **Calculate the profit of investor A.**
    Ignore interest rate compounding to answer this question.
11. **Calculate the profit of investor B.**
    Ignore interest rate compounding to answer this question.
12. **Suppose the stock price was 51 on the day A sold the option to B.**
    Explain how the new stock price affects the profit of investor A.
13. **Suppose the stock price was** 56.1 **on the day B sold the option to C.**
    Explain how the new stock price affects the profit of investor B.
14. **Suppose** B **holds the option and the stock price was** 56.6 **and the option price was** 1.5**. C wishes to buy the option from B (at a price of** 1.5**).**
    Describe the choices available to B and explain what B should do.

5.2.5 Short European call option 1

1. You are **short a European call option**.
2. The option has a strike of 84. The stock price is 89 today (= expiration date).
3. **The option holder exercises the option. State what the option holder pays/receives.**
4. **State what the option writer (= you) pays/receives.**

5.2.6 Short European call option 2

1. You are **short a European call option**.
2. The option has a strike of 77. The stock price is 75 today (= expiration date).
3. **The option holder does not exercise the option.**
   State what the option holder pays/receives.
4. **State what the option writer (= you) pays/receives.**

5.2.7 Short European call option 3

1. A European call option has a strike of 55.
2. You sell the option to investor A at a price of 1.1.
3. Therefore you are **short a European call option**.
4. The stock price is 48 (on the day of sale).
5. The stock goes up to 52 and investor A sells the option to investor B for a price of 1.2.
6. The stock goes up to 57 and investor B sells the option to investor C for a price of 1.5.
7. **Explain if B can execute an arbitrage strategy in this situation.**
   Describe the trades of the arbitrage strategy.
8. The stock price goes up to 58 on the expiration date and **C exercises the option. State what C pays/receives.**
9. **The option is exercised against you.**
   State what the option writer (= you) pays/receives on the day of exercise.
10. **Calculate the profit of investor A. Ignore interest rate compounding.**
11. **Calculate the profit of investor B. Ignore interest rate compounding.**
12. **Suppose the stock price was 51 on the day A sold the option to B.**
    Explain how the new stock price affects the profit of investor A.
13. **Suppose the stock price was 56.1 on the day B sold the option to C.**
    Explain how the new stock price affects the profit of investor B.

5.3 Exercise of long & short put option positions

5.3.1 Long American put option

1. You are **long an American put option**.
2. The put option has a strike of 97.
3. The market price of the stock is 94 today.
4. **You exercise the option. State what you pay/receive.**
5. **State what the option writer pays/receives.**

5.3.2 Long European put option

1. You are **long a European put option**.
2. The put option has a strike of 51.
3. The market price of the stock is 47 today (= expiration day).
4. **You exercise the option. State what you pay/receive.**
5. **State what the option writer pays/receives.**

5.3.3 Short American put option 1

1. You are **short an American put option**.
2. The put option has a strike of 65.
3. The market price of the stock is 58 today.
4. **The option holder exercises the option. State what the option holder pays/receives.**
5. **State what the option writer (= you) pays/receives.**

5.3.4 Short American put option 2

1. An American put option has a strike of 45.
2. You sell the option to investor A at a price of 1.1.
3. Therefore you are **short an American put option**.
4. The stock price is 48 (on the day of sale).
5. The stock price changes to 47 and investor A sells the option to investor B for a price of 1.2.
6. The stock price changes to 44 and investor B sells the option to investor C for a price of 1.5.
7. **Explain what B pays/receives if B exercises the option instead.**
8. The stock price goes down to 43 and **C exercises the option. State what C pays/receives.**
9. **The option is exercised against you.**
   State what the option writer (= you) pays/receives on the day of exercise.
10. **Calculate the profit of investor A. Ignore interest rate compounding.**
11. **Calculate the profit of investor B. Ignore interest rate compounding.**
12. **Suppose the stock price was 46 on the day A sold the option to B.**
    Explain how the new stock price affects the profit of investor A.
13. **Suppose the stock price was** 44.4 **on the day B sold the option to C.**
    Explain how the new stock price affects the profit of investor B.
14. **Suppose** B **holds the option and the stock price was** 43.4 **and the option price was** 1.5**. C wishes to buy the option from B (at a price of** 1.5**).**
    Describe the choices available to B and explain what B should do.

5.3.5 Short European put option 1

1. You are **short a European put option**.
2. The put option has a strike of 82. The stock price is 79 today (= expiration date).
3. **The option holder exercises the option. State what the option holder pays/receives.**
4. **State what the option writer (= you) pays/receives.**

5.3.6 Short European put option 2

1. You are **short a European put option**.
2. The put option has a strike of 65. The stock price is 68 today (= expiration date).
3. **The option holder does not exercise the option.**
   State what the option holder pays/receives.
4. **State what the option writer (= you) pays/receives.**

5.3.7 Short European put option 3

1. A European put option has a strike of 45.
2. You sell the option to investor A at a price of 1.1.
3. Therefore you are **short a European put option**.
4. The stock price is 48 (on the day of sale).
5. The stock price changes to 47 and investor A sells the option to investor B for a price of 1.2.
6. The stock price changes to 43 and investor B sells the option to investor C for a price of 1.5.
7. **Explain if B can execute an arbitrage strategy in this situation.**
   Describe the trades of the arbitrage strategy.
8. The stock price goes down to 42 on the expiration date and **C exercises the option. State what C pays/receives.**
9. **The option is exercised against you.**
   State what the option writer (= you) pays/receives on the day of exercise.
10. **Calculate the profit of investor A. Ignore interest rate compounding.**
11. **Calculate the profit of investor B. Ignore interest rate compounding.**
12. **Suppose the stock price was 49 on the day A sold the option to B.**
    Explain how the new stock price affects the profit of investor A.
13. **Suppose the stock price was 43.2 on the day B sold the option to C.**
    Explain how the new stock price affects the profit of investor B.

5.4 Exercise of cash settled option positions

- Not all options involve delivery of stock.
- Options on stock indices are settled in cash.
- All of the options below are on stock indices and the strike is 1000 index points.
- All of the options below pay $100 per index point that the option is in the money.

5.4.1 Long cash-settled call option

1. You are **long a call option (American or European) on a stock index**.
2. The value of the stock index is 1040 today (= expiration day).
3. **You exercise the option. State what you pay/receive.**
4. **State what the option writer pays/receives.**

5.4.2 Short cash-settled call option

1. You are **short a call option (American or European) on a stock index**.
2. The value of the stock index is 1070 today (= expiration day).
3. **The option holder exercises the option. State what the option holder pays/receives.**
4. **State what the option writer (= you) pays/receives.**

5.4.3 Long cash-settled put option

1. You are **long a put option (American or European) on a stock index**.
2. The value of the stock index is 945 today (= expiration day).
3. **You exercise the option. State what you pay/receive.**
4. **State what the option writer pays/receives.**

5.4.4 Short cash-settled put option

1. You are **short a put option (American or European) on a stock index**.
2. The value of the stock index is 920 today (= expiration day).
3. **The option holder exercises the option. State what the option holder pays/receives.**
4. **State what the option writer (= you) pays/receives.**