Financial Instruments
Fall 2022
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Midterm Exam

INSTRUCTIONS:

- There are 4 questions. Question 1: 15 points, Question 2: 25 points, Question 3: 20 points, Question 4: 30 points
- The allotted time on Canvas is 120 minutes. It should take you approximately 90 minutes to complete the exam. The number of points for each question are exactly equal to the number of minutes you should spend on the question. This should give you plenty of time to upload your solution.
- You are to submit a "pdf" file. **NO EXCEL** files. You may submit the exam in a format of your choosing including printing the version with space given and scanning your solutions.
- **NOTE: solutions without justification** (i.e. formulas showing what you calculated) will receive **no credit**. In other words: **show your work**.
- The questions cover various aspects of the class material. Read all the questions and start from those that you feel more comfortable with.
- Answer all questions as well as you can.
- Do not get hung up on calculations. Sometimes, just setting up an equation or providing a good intuitive argument will be sufficient for partial credit Remember to keep moving!
- Approximate all your calculations to **2 decimal points**.

Honor Code: I pledge my honor that I have not violated the Honor Code during this examination.

Name and ID number (Please print clearly):_____

Signature:_____

Problem 1. (15 points) True-False Questions (there are 3 of them). *Grade depends on completeness of answer.*

(a) (5 points) In a foreign exchange forward contract, the value of the forward contract is always positive.

(b) It is possible to calculate the swap rate S of a swap on *any* underlying factor X_t (e.g. exchange rates, golds, oil) with spot rate X_t and net cash flows $X_t - S$ from the current forward rates $F_{t,T}$ on the factor itself

(c) The current exchange rate between the United States and Canada is 1.02 US dollars per Canadian dollar. The one-year forward exchange rate is 1.03 US dollars per Canadian dollar. The market must be expecting that over the next year the US dollar will depreciate relative to the Canadian dollar.

Problem 2. (25 points) Binomial trees. Suppose that stock XYZ, whose current price is \$50, can either increase by $u = 1.1$ or decrease by $d = 1/(1.1)$ each year over the next 2 years. The continuously-compounded interest rate is 1% per year.

(a) (10 points) What is the no-arbitrage price of a European put option with strike price of \$48 and maturity of 2 years.

(b) (5 points) Consider now an 2-year *look-back* call option on the stock with a strike price of \$50. With this option, at maturity the buyer as the option to pay the strike price and receive the *maximum* value the stock achieves during the life of the option. What should be the price of this option?

(c) (10 points) You sold the option in point (b) to the client. You decide to hedge against the short position by going long the underlying, that is, *the option from part (a)*. What is your hedging position at time 0? Make sure to describe both the position in the underlying and in bonds.

Problem 3. (**20 points**) You run a firm that has operations in Great Britain. In each of the next two years you expect to generate earnings of 10 million British pounds (BPD). You would like to hedge the exchange rate risk you face.

The current exchange rate is 1.6 US dollars per British pound (USD/BPD). The current LIBOR rates (in continuously compounded units) are:

Maturity	USD	BPD
1 year	2%	3%
2 years	3%	3%

(a) (10 points) What are the implied one- and two-year forward exchange rates between US dollars and British pounds? How would you use these forward contracts to hedge your exchange rate risk?

(b) (10 points) Instead of using the forward contracts you would like to use a two-year exchange rate swap with a fixed rate of exchange during the life of the swap. If the terms of this contract are fare, at what rate would you swap pounds for dollars in

each of the next two years? How does this swap rate compare to the forward rates you calculated in part (b) above? Explain (in words only) the relationship between the forward rates and the swap rate.

Problem 4. (30 points) Consider the following properties of a "Capital Protected Note":

- Maturity: 4 years
- Issue Price: \$1,000
- Principal \$1,000
- Interest: 0
- Principal Protection 100%
- Payoff at maturity: Principal plus Supplementary Redemption Amount (SRA), if positive, where:

$$SRA = \text{Final Index Value - Initial Index Value}$$

- Index: S&P500 which has a current value of \$1000.

Make the following assumptions:

- The 4-year (c.c.) interest rate is 2%.
- The dividend yield of the S&P500 will be 0%. over the next 4 years (no dividends!).
- The volatility of the S&P500 will be 15% over the life of the note.

(a) (10 points) What should be the price of the Capital Protected Note? Is it properly priced? What is the Delta of the Note?

(b) (5 points) Suppose that you sold the Capital Protected Note? What initial positions in a 4-year European PUT option and the S&P500 could you use to hedge your exposure to the S&P500 and replicate the payoff to the Capital Protected Note?

(c) (10 points) Instead of using the put option and the S&P500 from part (b), you would like to hedge your sale of the Capital Protected Note using a 1-year at-the-money call option on the S&P500. According to the Black-Scholes model, what is the delta of this option? How many of the short dated call options would you have to hold to hedge your exposure to changes in the S&P500?

(d) (5 points) If immediately after you enter into the hedging positions of part (b), the S&P500 increases in price. Describe *in words* the directions in which you would have to change your positions and why. (Intuition only, no calculations here).

Cumulative Normal Distribution

$\Phi(x) = \int_{-\infty}^{x} \frac{e^{-y^2/2}}{\sqrt{2\pi}} dy$

x	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998