Financial Instruments

Bus 35100 Winter 2024

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Homework 3

Due at the beginning of class 4

1 Greece Currency Swaps

On June 1st 2001 Greece issued a 10 year dollar denominated note for a value of USD 50 billion and a semi-annual coupon rate $c = 6\%$ *Hint:* The bond pays semiannual coupons in the amount of USD $(6\%/2) \times 50$ billion = USD 1.5 billion along with the face value of USD 50 billion at maturity.

Issuing debt denominated in a foreign currency is common. There are few reasons why this happens: a country might need to make payments in a foreign currency or foreign investors' appetites for diversification allows the country to issue at more favorable conditions. In this example we will assume that Greece has obtained more favorable conditions issuing in US dollars and the money will be used for domestic operations. At issuance Greece therefore has to convert into Euros any US dollars obtained from the note. To make the payments (semi-annual coupons and principal) to the investors that purchased the note, Greece must to convert Euros into US dollars at coupon dates and at maturity. This exposes the country to exchange rate risk. In particular if the US dollar appreciates, Greece will have to use more Euros to get an amount equal to the US dollar value of coupons and principal.

The Greek Finance Minister contacts VeroTende Investment Bank to ask about how to hedge the position, and the bank suggests a currency swap. The swap will require an initial transfer of principal, in which Greece will pay USD (US dollar) 50 billion and receive EUR (Euro) 59 billion at initiation of the contract. Every six months after that Greece will receive USD 1.5 billion in exchange for a fixed payment in EUR. *At maturity Greece will pay 59 billion EUR and receive 50 billion USD.*

Table 1 reports the prices of European and American Government zero coupon bonds on June 1st 2001.

Maturity	**Greek ZCB**	**US ZCB**
0.0	1.0000	1.0000
0.5	0.9786	0.9822
1.0	0.9588	0.9647
1.5	0.9388	0.9431
2.0	0.9191	0.9192
2.5	0.8989	0.8973
3.0	0.8788	0.8749
3.5	0.8583	0.8520
4.0	0.8379	0.8287
4.5	0.8177	0.8051
5.0	0.7977	0.7812
5.5	0.7780	0.7603
6.0	0.7583	0.7397
6.5	0.7370	0.7194
7.0	0.7155	0.6993
7.5	0.6953	0.6795
8.0	0.6751	0.6600
8.5	0.6559	0.6407
9.0	0.6369	0.6218
9.5	0.6208	0.6032
10.0	0.6050	0.5848

Table 1. Greek and US ZCB prices on June 1st 2001

Hint: to use these number consider the value of the value (in dollars) of a dollar denominated bond with annualized coupon rate of c and face value N. This value is given by:

$$B_0^{\$} = \sum_{t=0.5}^{T} \frac{c}{2} \cdot N^{\$} \cdot Z^{\$}(0,t) + N^{\$} \cdot Z^{\$}(0,T)$$

(1) Using the data above, and knowing that the USD/EUR spot exchange rate on June 1st 2001 is equal to 0.8475 USD/EUR (=50/59 USD/EUR), compute the swap rate (i.e. the annualized coupon rate for the semi-annual payments in EUR) that sets the value of the currency swap to 0 at initiation of the contract.

The VeroTende Bank executives meet Greek officials, describe the currency swap and quote the rate calculated in point (1). To their surprise, the Greek Finance Minister

explains that they have decided to be advised by another bank. They shake hands and the finance Minister leaves.
Some rumors say that Goldman Sachs has set up a currency swap with structured as above, but with two minor differences:[1]

a) For the exchange of principal at time t = 0 the exchange rate utilized is not the market spot rate (i.e. 0.8475 USD / EUR), but rather the historical average of the spot exchange rate between March 12th 2001 and June 1st 2001, that is 0.8148 USD / EUR;

b) The rate quoted for the payments in euro is 7.00%

(2) Compute the value of the Goldman swap. Why do you think Greece has decided to accept Goldman proposal rather than the one suggested by VeroTende Bank? In answering the question give particular thought to the cash flows of the swap and their timing.

2 Hedging with Options: Southwest Jet Fuel Hedging Program

Consider again the hedging strategy of Southwest Airlines (see Homework 2). We are back on December 31st 2007. Instead of using commodity futures, the CFO is considering buying insurance on oil prices using options. Table 2 reports the prices, on December 31st 2007, of a set of European call and put options on crude oil. All options expire on March 31st 2008 and can only be exercised at maturity. Each options' underlying is one lot of 1,000 crude oil barrels, which equals 42,000 gallons of crude oil.

[1]This exercise is motivated by a real deal between Goldman Sachs and Greece. However, **all** of the details in this exercise are fictitious, as details of the deal are not known. For initial reference, please visit https://www.goldmansachs.com/media-relations/in-the-news/archive/greece.html

Call options		Put options	
Strike Price	**Option Price**	**Strike Price**	**Option Price**
60.00	35,674	60.00	3
65.00	30,744	65.00	17
70.00	25,859	70.00	76
75.00	21,098	75.00	259
80.00	16,593	80.00	698
85.00	12,513	85.00	1,562
88.61	9,923	88.61	2,541
90.00	9,016	90.00	3,009
95.00	6,195	95.00	5,132
100.00	4,060	100.00	7,941
105.00	2,541	105.00	11,366
110.00	1,522	110.00	15,292
115.00	875	115.00	19,589
120.00	485	120.00	24,142
125.00	259	125.00	28,861
130.00	135	130.00	33,680

Table 2. Crude oil options prices on December 31, 2007, USD per lot

Given the data in Table 2:

1. Assume that the CFO decides to buy the \$105 strike call options on oil (we can refer to this strategy as a **straight insurance**).

   (a) How many options should be bought? In computing the number of options, make the (somewhat unreasonable) assumption that 1 barrel of oil is sufficient to produce 1 barrel of jet fuel, that a \$1 price change of crude oil per barrel barrel, <u>always</u> causes a \$1 price change of jet fuel per barrel, that is the same as a $\frac{1}{42}$ = \$0.02381 price change of jet fuel per gallon and that all fuel is consumed on March 31st 2008.

   (b) How does your answer in (1.a) change if we assume that a \$1 price change of crude oil per barrel, <u>always</u> causes a \$1.1964 price change of jet fuel per barrel? Maintain the (still unrealistic) assumption that 1 barrel of oil is sufficient to produce 1 barrel of jet fuel.

(c) Suppose that you have bought the number of call options determined in (1.a). If the assumptions mentioned in point (1.b) are true, how would your (1.a) strategy perform? Would you be over-hedged or under-hedged?

(d) How does your answer in point (1.b) change if we assume that to produce 1 barrel of jet fuel one needs to employ 1.1964 barrels of oil? Why are the answers in point (1.b) and (1.d) different or the same? (Tip: don't spend more than 2 minutes on this. Just think about the implication for the relationship between jet fuel price and oil price if you assume that you need 1.1964 units of oil to produce 1 unit of fuel.)

(e) Under no hedging, Southwest position is *de facto* a short position on jet fuel between December 31st 2007 and March 31st 2008. Indeed if fuel price goes up Southwest is loosing money as it has to spend more to buy the same amount of fuel; conversely if jet fuel price falls, Southwest experiences a gain as it can buy the same quantity of fuel at a lower price. With this in mind, draw the payoff diagram, at maturity, of the implicit short position that Southwest has on jet fuel.

(f) Now draw the payoff diagram, at maturity, of the **straight insurance** strategy determined in (1.a) and, in another chart, the diagram of the overall position of Southwest, that is the implicit short position in jet fuel plus the **straight insurance**; please label the axes of the diagram, specify the units of measure and show some values on each axis. Compare the costs and benefits of the **straight insurance** with the costs and benefits of hedging with futures.

2. Assume that the CFO is a Booth alumni, and reasons that one drawback of the straight insurance is that it costs money upfront. Instead he decides to set up a **collar**, that is, sell some out-of-the-money put options to finance the purchase of out-of-the-money calls. The goal of this collar is that it must **cost nothing** (or near to nothing) to the firm at initiation. In other words, the total amount from the puts must compensate for the calls.

(a) Keeping the same strike for the insurance (call) as in point (1.a) above, find the strike of the put option that the CFO must sell to achieve the **zero-cost collar strategy**. To determine the total number of options (calls and puts), you make the same assumptions as in point (1.a) above.

(b) Draw the payoff diagram, at maturity, of the **collar** strategy determined in (2.a) and, in another chart, the diagram of the overall position of Southwest: the implicit short position in jet fuel plus the **collar**; please label the axes of the diagram, specify the units of measure and show some values on each axis. Compare the costs and benefits of the **collar** with the costs and benefits of both the straight insurance and the hedging with futures.

3. Assume now that the CFO is a Booth student who is taking the Financial Instruments course and is very excited about the variety of different options strategies. Instead of selling just one put option to finance the purchase of the call option (used for insurance) as in point 2, the CFO wants to experiment different quantities of put options, still maintaining the constraint that the cost of the strategy must be zero.

   (a) If the CFO chooses the \$80 strike put options, how many options does he have to sell to set up the collar?

   (b) How would your answer in point (3.a) change if the CFO chooses the \$90 strike put options?

   Draw the payoff diagrams, at maturity, of these two new strategies as well as of the overall Southwest position in each case. Please label the axes of the diagrams, specify the units of measure and show some values on each axis. Compare the costs and benefits of the two strategies with the costs and benefits of both the straight insurance and the first collar determined in point (2.a).

   (c) If you would have set up a bear spread, how would its payoff have compared with the payoff of the portfolio discussed in point (2.b) (i.e. the collar determined in point (2.a) plus the implicit short position on fuel)? Which strategy

is more expensive? Why? (No need to carry out calculations; just provide an intuition. Tip: drawing payoff diagrams helps intuition with intuition.)

(d) While the CFO is on a plane to Italy, he thinks that he would like to know what is the continuously compounded interest rate implied by the options markets market. As "all electronic devices have been turned off", he does not have access to any additional data. He just remembers that the spot price of oil on December 31, 2007 was \$ 95 per barrel and that the maturity of the quoted options was $T = 0.25$ years. How can he compute the implied continuously compounded interest rate using option prices? (Tip: is there any relationship that holds between put and call prices?)