Session 5

Practice Questions

Exercise 1: Cost of Carry

The forward price of an asset is the current price of the asset adjusted to take into account the opportunity costs that arise from delayed delivery payment. This is called the cost of carry and include financing, storage, and insurance.

An energy trader who believes that WTI crude oil prices are about to rise decides to buy 10,000 barrels of light, sweet crude oil at the Cushing, Oklahoma, physical market at $ 60 a barrel. The trader finances the position by borrowing money at an interest rate of 5% per year (compounded annually). The trader estimates that the cost to store the crude oil for one year is $ 4.50 a barrel (including insurance).

1. What is the 12-month forward price for WTI crude oil at the Cushing delivery location?
2. If the 12-month forward contract is currently priced at $ 70 a barrel, describe the trading strategy to use to lock in a risk-free profit. What is the name of this strategy? What is the risk-free profit made?
3. Describe some conditions that have to be met to facilitate arbitrage?

Exercise 2: Commodity Swap (Not at the exam)

An industrial company, BP & Co, needs to buy 100,000 barrels of oil 1 year from today, 2 years from today and 3 years from today. The forward prices for delivery in 1 year, 2 years and 3 years are respectively $50, $51 and $52 a barrel. The 1, 2 and 3-year zero-coupon bond yields are 2%, 2.5% and 3%.

1. BP & Co can guarantee the cost of buying oil for the next 3 years by entering into long forward contracts for 100,000 barrels in each of the next 3 years. Determine the PV of this cost per barrel.
2. BP & Co could pay an oil supplier the PV of this cost as determined in 1, and the supplier would commit to delivering one barrel in each of the next three years. This is called a prepaid swap i.e. a single payment today for multiple deliveries of oil in the future. However, if BP & Co does not want to be exposed to the credit risk of the oil supplier, it can decide to defer payments until the oil is delivered while still fixing the total price; this is called a swap. Any payment stream with a PV equal to the one computed in 1 is acceptable. Typically, a swap will call for equal payments in each year. Determine the 3-year swap price.
3. Consider the financial settlement of the swap.

In which context, will the oil buyer BP & Co make a payment to the swap counterparty (the oil supplier)?
In which context, will the oil buyer BP & Co receive a payment from the swap counterparty (the oil supplier)?

4. Instead of entering into a swap with an oil supplier, BP & Co enters into a swap with a dealer who serves as a counterparty. The dealer decides to hedge the transaction by entering into a forward contract. Which position does the dealer have to take in the forward contract?
5. Describe the positions and the cash flows for the dealer for years 1, 2 and 3. Suppose a position of one barrel of oil to simplify the calculations.

Exercise 3: Are the following assertions true/false?

1. The US dollar and gold are closely linked and move in opposite directions.
2. Bonds and commodities tend to trend in opposite directions.
3. Equities and commodities tend to trend in opposite directions.
4. In a normal market, the basis (i.e. the difference between a spot price and a futures price) is always “under” (i.e. negative) and in an inverted market, the basis is always “over” (i.e. positive).
5. If the current forward price is greater than the contract initial fixed forward price, the contract has a positive value for the seller and a negative value for the buyer; if the current forward price is lower, however, the contract has a positive value for the buyer and a negative value for the seller.
6. Backwardation is a direct result of the always-present threat of near-term supply and production disruptions.
7. The steeper the backwardation, the more likely market participants are to store the asset.

Exercise 4: How is the oil price impacted by the following market events?

1. OPEC decides to decrease the export quotas of its members.
2. A Canadian oil company announces the development of new sources of oil.
3. Hurricane season in the Caribbean and Gulf of Mexico is intense.
4. A new study from the IEA (International Energy Agency) projects rising oil stockpiles.
5. The Asian economy is experiencing a period of great expansion.

Solution

Exercise 1: Cost of Carry

1. The 12-month forward price is equal to: $ 60 (spot price) + $ 3 (cost of financing per barrel for one year) + $ 4.50 (storage and insurance cost) = $ 67.5 a barrel.

2. Since the 12-month forward contract has currently a market price superior to the theoretical price, it is overpriced. One has to sell the "expensive" contract at $ 70, buy the "cheap" WTI oil at $ 60 (spot WTI), and stores the crude oil for one year (cash and carry arbitrage). A year later, when the future contract expires, one delivers the crude oil at $ 70 a barrel, $ 10 higher than its purchase price. After incurring the carrying cost ($ 4.5) and the interest on the money borrowed to buy the crude oil ($ 3), one has earned a risk-free profit of $ 2.5 a barrel.

3. - Ease of short selling: if one cannot sell short the underlying asset, reverse cash and carry arbitrage is not possible.
   - A large supply of the underlying asset makes it easier for cash and carry arbitrageurs to buy and store the underlying asset against the sale of a futures contract. It also makes it easier for reverse cash and carry arbitrageurs to borrow the asset.
   - The underlying asset is easy to store.
   - There are no seasonal fluctuations in production or consumption of the underlying asset. Temporary imbalances in supply and demand can make arbitrage very difficult.

Exercise 2: Commodity Swap

1. $\frac{\$50}{1.02}+\frac{\$51}{1.025^2}+\frac{\$52}{1.03^3}=\$145.1496$

2. The payment per year per barrel, *x*, which is the 3-year swap price must satisfy the following equation: $\frac{x}{1.02}+\frac{x}{1.025^2}+\frac{x}{1.03^3}=\$145.1496$

   X = $ 51 (Excel Solver)

3. The oil buyer, BP & Co, makes a payment to the swap counterparty when the oil spot price is inferior to the swap price. The oil buyer, BP & Co pays the difference between the swap price and the spot price, and then buys oil at the spot price.

   If the spot price is superior the swap price, the oil buyer, BP & Co receives a payment from the swap counterparty equivalent to the difference between the spot price and the swap price. BP & Co then buys oil at the spot price.

Note that at the end of the day, regardless of the spot price, the net cost to the buyer is and will always be the swap price.
For instance, if the spot price is $ 55, the oil supplier makes a payment of $ 4 to BP & Co. BP & Co then buys oil at the spot price. The net cost to BP & Co is equal to: +4 – 55 = $ - 51.
If the spot price is $ 45, BP & Co makes a payment of $ 6 to the oil supplier and then buys oil at the spot price. The net cost to BP & Co is equal to: - 6 – 45 = $ - 51.

4. The dealer has to take a long position in the forward contract in order to hedge the swap transaction. Since he has an obligation to receive the fixed price (he is selling oil at the fixed price), he has to buy forward oil contracts to hedge his transaction. He has to take the opposite position in the forward contract. Remember that the dealer makes a payment to BP & Co when the spot price is superior to the swap price and receives a payment from BP & Co when the spot price is inferior to swap price.

5. Position and cash flows for a dealer who has an obligation to receive the fixed price in an oil swap and who hedges his exposure by going long year 1, year 2 and year 3 oil Forwards.

Year	Payment from oil buyer	Long Forward	Net
1	$ 51 – Year 1 Spot Price	Year 1 Spot Price – $ 50	$ 1
2	$ 51 – Year 2 Spot Price	Year 2 Spot Price - $ 51	$ 0
3	$ 51 – Year 3 Spot Price	Year 3 Spot Price - $ 52	$ -1

Exercise 3

1. True. Gold is a US dollar-denominated asset. Hence, an appreciation of the USD leads to a decrease in gold price.
2. True. Bonds and commodities tend to trend in opposite directions due to inflationary pressures. Rising inflation, which is often caused by advancing raw material prices, creates an environment where interest rates increase, thereby raising bond yields, and lowering bond prices.
3. True. Equities and commodities also trend in opposite directions because of their reactions to inflationary pressures. According to the dividend discount model, rising bond yields lead to an increase in the discount rate used to calculate the present value of the future expected cash flows from holding equities. An increase in the discount rate has the impact of reducing the present value of the equity.
4. True. In a normal market, spot price is inferior to futures prices and hence the basis (difference between the spot price and the futures prices) is negative. We say “the basis is under”. In an inverted market, spot price is superior to futures prices and hence the basis is positive. We say “the basis is over”.

5. False. If the current forward price is greater than the contract's fixed initial forward price, the contract has a positive value for the buyer and a negative value for the seller; if the current forward price is lower, however, the contract has a positive value for the seller and a negative value for the buyer.
6. True. Spot commodity prices can rise sharply because of the threat of supply disruptions while longer-term forward prices can remain in a normal price range if market participants do not expect disruptions to last long.
7. False. When a market is inverted, market participants who want to secure future supplies can do so much more cheaply by buying forward contracts to lock in a purchase price rather by buying the asset in the physical market and storing it. Hence, the steeper the backwardation, the less likely market participants are to store the asset, which creates a reinforcing spiral.

Exercise 4:

1. OPEC decides to decrease the export quotas of its members. Global oil supply will eventually decrease causing an increase of oil price.
2. A Canadian oil company announces the development of new sources of oil. Global oil supply will eventually increase causing a decrease of oil price.
3. Hurricane season in the Caribbean and Gulf of Mexico is intense causing disruptions in oil supply. Oil price increases.
4. A new study from the IEA (International Energy Agency) projects rising oil stockpiles. This will cause oil price to decrease.
5. The Asian economy is experiencing a period of great expansion. This will increase the demand for oil causing price to increase.