

## Practice problems for Lecture 1

1. (short answer) Answer each question in no more than one sentence of normal length.

a. Define *arbitrage*.

b. Counterparty risk is usually less for futures contracts than for forwards. Why?

c. Name a type of derivative security whose value depends on private attributes as well as market variables.

d. Name one consideration in the decision of whether or not to hedge a risk.

2. (convergence trade) Following hurricane damage to the orange groves in Florida, there is a significant difference between the spot price 135¢/pound of frozen concentrated orange juice and the six-month futures price of 160¢/pound. Grade A frozen concentrated orange juice contracts FCOJ-A are listed on ICE (following the purchase of the New York Board of Trade) consist of 15,000 pounds each. (See <https://www.theice.com/products/30/specs> for more detail on these contracts.) One contract worth of frozen concentrated orange juice can be stored at a qualified warehouse for \$600/month with a transfer fee of \$900 to transfer one contract's worth to or from the warehouse. Delivery of an initial purchase or delivery on a futures contract is made in physical orange juice at one of the official warehouses.

a. Supposing you can borrow money at 5% straight interest, is there an arb from taking advantage of the expected increase in futures price? To keep things simple, assume that the storage fee is paid up front and there is no variation in the futures price until maturity.

b. Suppose you can make a deal with a warehouse with excess capacity to rebate half of the storage fee so the effective cost of storage is \$300/month. Is there an arb in this case?

c. Given that we set up the arbitrage with the storage cost of \$300/month, and that after three months the spot price is 155¢/pound and the futures

price is still 160¢/pound. Should you unwind the position or leave it until maturity? (To keep things simple, assume that you can get a refund at month three on the remaining three months' storage, and you can also collect the variation in the futures contract so far at month three.)

(extra for experts) How does the analysis change if we collect/pay the variation as the futures price goes up or down over the six months? In particular, you have to have the ability to pay whatever variation payments are due on the futures contracts. Suppose you provide for this using a line of credit — how big would it have to be?

(extra for experts: a little more work) What happens if we have to keep margin in cash (a non-interest-bearing account) according to the exchange's rules?

3. A market index is worth 1100 today and has a volatility of 15%/year. Assuming no dividends, evaluate a European digital option maturing three months from now paying \$100 if the index exceeds 1105 and zero otherwise. Assume the risk-free rate is 2%. Evaluate the option using a three-period binomial.

(extra for experts) Write a computer program or use a spreadsheet to evaluate the digital option using 90 periods (approximately daily time interval).