

**COLORADO STATE UNIVERSITY  
DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS**

*Problem Set 2  
Fall 2021*

**Agricultural and Resource Economics 412  
Agricultural Commodities Marketing**

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Basis, Basis Risk, Yield Risk, and Hedging

This problem set is to be an independent effort by a team of two students. Write both names and student ID numbers in the top right-hand corner. Partial credit will be awarded only if you show your work and if the work communicates. This problem set is worth 60 points. Round storage cost calculations to the nearest tenth of a cent per bushel and all other calculations to the nearest cent per bushel.

Assume you are a wheat producer in eastern Colorado. You have 3200 acres (or 5 sections) in production and your potential yield (based on a trend-yield projection) is 37.5 bushels per acre. Production costs are \$145 per acre.

It is currently December 1, 2021. You are considering hedging some of the wheat crop which you will market at harvest in early-July or which you will store until early-October. If you store the grain, you will only do so until October because you will need the cash flow to meet a production operating note payment. We will use the basis information that is similar to what was constructed from Problem Set 1.

You have made a small basis table and include the basis information for the relevant months. Averages and standard deviations are reported below.

Calendar Month	Potential Futures Contracts				
	MAR	MAY	JUL	SEP	DEC
Harvest Transaction Month <u>July</u>	-----	-----	-0.53 (0.47)	-0.62 (0.52)	-----
Storage Transaction Month <u>October</u>	-0.96 (0.48)	-1.00 (0.48)	-----	-----	-0.84 (0.47)

A. It is December 1, 2021 and the current KC wheat futures prices are

12/1	DEC	\$6.60/bu.
	MAR22	\$6.68/bu.
	MAY	\$6.55/bu.
	JUL	\$6.50/bu.
	SEP	\$6.64/bu.
	DEC	\$6.80/bu.

(The futures prices above are presented just like they are on exchange websites and in the WSJ. If you cannot read them and the dates correctly throughout the Problem Set then you will receive zero credit. In other words, you have to know what contracts are priced for and when.) Evaluate the profit opportunity for hedging until harvest. You will need to pick the “best” contract for the production hedge from the nearby and next-to-nearby contracts. Ignore any difference between actual bushels and hedged bushels unless you are specifically asked. Label the two different futures contracts.

<u>Production Hedge:</u>	<u>Contract</u>	<u>Production Hedge:</u>	<u>Contract</u>
Forward Price	\$ _____/bu.	Forward Price	\$ _____/bu.
Production Costs	\$ _____/bu.	Production Costs	\$ _____/bu.
	_____		
Profit	\$ _____/bu.	Profit	\$ _____/bu.
Risk	\$ _____/bu.	Risk	\$ _____/bu.

Which contract will you use for the production hedge? \_\_\_\_\_.

Show some of the necessary calculations here:

Production costs per bushel =

Forward price for production hedge using \_\_\_\_\_ contract =

Forward price for production hedge using \_\_\_\_\_ contract =

B. Let's evaluate some probabilities of different outcomes to support the decision making. Use the NORM.DIST function and write the arguments used in the function in the space below the question. The following statistics are based on the data history from Problem Set 1.

The average price of wheat in Colorado was \$5.30/bu. with a standard deviation of \$1.49/bu.

What is the probability that the market price will be below the breakeven? \_\_\_\_\_%

What is the probability that the market price will be below the forward price? \_\_\_\_\_%

The average harvest price was \$5.33/bu. with a standard deviation of \$1.39/bu.

What is the probability that the harvest price will be below the breakeven? \_\_\_\_\_%

What is the probability that the harvest price will be below the forward price? \_\_\_\_\_%

The above two expectations are not very thoughtful. We have better information.

Last year's harvest price was \$6.03/bu. The average harvest price change was +\$0.08 with a standard deviation of \$1.35/bu. (Careful, read and think.)

What is the probability that the harvest price will be below the breakeven? \_\_\_\_\_%

What is the probability that the harvest price will be below the forward price? \_\_\_\_\_%

You have a forecast from an econometric model of harvest prices of \$6.25/bu. and the standard deviation of the forecast error from that model is \$0.85/bu. (Wheat stocks have tightened in the last year.)

What is the probability that the harvest price will be below the breakeven? \_\_\_\_\_%

What is the probability that the harvest price will be below the forward price? \_\_\_\_\_%

What do you think? Does price risk management given current price levels offered to you make sense probabilistically? (Please answer but it will not be graded.)

C. Assume you decided to hedge all of your anticipated production in December. It is now July 1, 2022 and the KC wheat futures prices at harvest are

7/1	JUL	\$5.95/bu.
	SEP	\$6.08/bu.
	DEC	\$6.25/bu.
	MAR23	\$6.40/bu.
	MAY	\$6.27/bu.
	JUL	\$6.20/bu.

Complete the following T-account below assuming the actual basis at harvest is 48 cents per bushel weaker than expected, and assuming you achieved your expected production.

Date	Cash	Futures	Basis
12/1 2021	Forward Price = \$_____/bu.	_____/____ contracts (Buy or Sell) (#)  of _____ wheat (contract month & year)  @ \$_____/bu.	\$_____/bu (expected)
7/1 2022	Cash Wheat @ \$_____/bu.	_____/____ contracts (Buy or Sell) (#)  of _____ wheat (contract month & year)  @ \$_____/bu.  Futures Gain/Loss \$_____/bu.	\$_____/bu (actual)

Calculate the net price.

D. Instead of selling the wheat in the cash market at harvest, you could lift the production hedge and place a storage hedge. Calculate the interest and total costs of monthly storage. Think carefully about opportunity cost. Assume an annual interest rate of 10.0%. You will need to pick the “best” contract for hedging the wheat until October. Round the calculations to the tenth of a cent per bushel.

Commercial charge	\$ 0.050 /bu./mo.
Interest costs	\$ _____/bu./mo. (Work: _____)
Total monthly costs	\$ _____/bu./mo.

Show your work for the storage hedge using the three different contracts:

Futures Contract

	_____	_____	_____
Futures price	\$ _____/bu.	\$ _____/bu.	\$ _____/bu.
Expected basis	+\$ _____/bu.	+\$ _____/bu.	+\$ _____/bu.
Storage forward price	\$ _____/bu.	\$ _____/bu.	\$ _____/bu.
Current cash price	-\$ _____/bu.	-\$ _____/bu.	-\$ _____/bu.
Expected price improvement	\$ _____/bu.	\$ _____/bu.	\$ _____/bu.
Costs of storage	-\$ _____/bu.	-\$ _____/bu.	-\$ _____/bu.
Potential Storage Profit	\$ _____/bu.	\$ _____/bu.	\$ _____/bu.
Risk	\$ _____/bu.	\$ _____/bu.	\$ _____/bu.

Which contract would you use for the storage hedge? \_\_\_\_\_ If you chose a futures contract that did not maximize potential profits from storage then explain your choice.

Should you store and hedge, or sell in the cash market?

E. Assume you decided to store and hedge the wheat in July. It is now October 1, 2022 and you need some cash flow. You are going to lift the hedge and sell the stored wheat. The KC wheat futures prices at harvest are

10/1	DEC	\$6.95/bu.
	MAR23	\$7.05/bu.
	MAY	\$7.15/bu.
	JUL	\$7.97/bu.
	SEP	\$7.07/bu.
	DEC	\$7.15/bu.

Complete the following T-account below to examine its effectiveness. Assume the current basis is 12 cents per bushel stronger than expected.

Date	Cash	Futures	Basis
7/1 2022	Forward Price = \$_____ /bu.	_____ contracts (Buy or Sell) (#)  of _____ wheat (contract month & year)  @ \$_____ /bu.	\$_____ /bu (expected)
10/1 2022	Cash Wheat @ \$_____ /bu.	_____ contracts (Buy or Sell) (#)  of _____ wheat (contract month & year)  @ \$_____ /bu.  Futures Gain/Loss \$_____ /bu.	\$_____ /bu (actual)

Calculate the net price.

Cash price	\$_____ /bu.
Production hedge gain or loss	\$_____ /bu.
Storage hedge gain or loss	\$_____ /bu.
Net Price	\$_____ /bu.

F. It is time to compare the profit per bushel of the hedges to profit per bushel of just participating in the cash market.

1) Production profits

<u>Cash</u>		<u>Hedge</u>	
Cash Price	\$_____ /bu.	Cash Price	\$_____ /bu.
		Futures (Prod) G/L	\$_____ /bu.
Production Costs	\$_____ /bu.	Production Costs	\$_____ /bu.
	_____		_____
Profit	\$_____ /bu. Profit		\$_____ /bu.

2) Production and storage profits

<u>Cash</u>		<u>Hedge</u>	
Cash Price	\$_____ /bu.	Cash Price	\$_____ /bu.
		Futures (Prod) G/L	\$_____ /bu.
		Futures (Storage) G/L	\$_____ /bu.
Production Costs	\$_____ /bu.	Production Costs	\$_____ /bu.
Storage Costs	\$_____ /bu.	Storage Costs	\$_____ /bu.
	_____		_____
Profit	\$_____ /bu. Profit		\$_____ /bu.

Was the production hedge a good decision? Was the storage hedge a good decision? Explain why. Should you use the outcome from one year to determine whether or not hedging is a good decision? Explain your answers clearly.

G. It is time to rework the original production hedge and see what might go wrong. Assume you hedged all of your anticipated production on December 1, 2021. Bad news, the spring rains were not adequate so your actual production is 70% of expected. The futures prices on July 1, 2022 are instead

7/1	JUL	\$7.25/bu.
	SEP	\$7.24/bu.
	DEC	\$7.17/bu.
	MAR23	\$7.13/bu.
	MAY	\$7.04/bu.
	JUL	\$6.95/bu.

Complete the following T-account. Assume you hedged all your expected production in December. Assume the actual basis equaled the expected level.

Date	Cash	Futures	Basis
12/1 2021	Forward Price = \$ _____/bu.	_____ contracts (Buy or Sell) (#)  of _____ wheat (contract month & year)  @ \$ _____/bu.	\$ _____/bu (expected)
7/1 2022	Cash Wheat @ \$ _____/bu.	_____ contracts (Buy or Sell) (#)  of _____ wheat (contract month & year)  @ \$ _____/bu.  Futures Gain/Loss \$ _____/bu.	\$ _____/bu (actual)

Calculate the net price below.

$$\text{Cash receipts} = \$ \text{_____}/\text{bu.} \times \text{_____ bushels} = \$ \text{_____}.$$

$$\text{Futures receipts} = \text{Gain/Loss } \$ \text{_____}/\text{bu.} \times \text{_____ bushels} = \$ \text{_____}.$$

$$\text{Total returns} = \text{cash receipts} + \text{futures receipts} = \$ \text{_____}.$$

$$\text{Net price/bu.} = \text{total returns} \div \text{_____ bushels} = \$ \text{_____}/\text{bu.}$$

$$\text{Total costs} = \$ \text{_____}/\text{acre} \times \text{_____ acres} = \$ \text{_____}.$$

$$\text{Cost/bu.} = \text{total costs} \div \text{_____ bushels} = \$ \text{_____}/\text{bu.}$$

$$\text{Profit or loss per bushel} = \$ \text{_____}/\text{bu.}$$

Why were the net price and the forward price not equal even though the basis was correctly estimated?

What does this suggest in terms of how much of a growing crop to hedge when yield is uncertain? Is this issue relevant for a storage hedge? Is this issue relevant for a livestock hedge? Explain why.

A more realistic result would be that actual basis is stronger than expected during a drought year. Write a couple of sentences below and tell me why. (This is a trick question.)

Suppose basis was 15 cents per bushel narrower than expected at harvest, recalculate the net price.

$$\text{Cash receipts} = \$ \underline{\hspace{2cm}} / \text{bu.} \times \underline{\hspace{2cm}} \text{ bushels} = \$ \underline{\hspace{2cm}}.$$

$$\text{Futures receipts} = \text{Gain/Loss } \$ \underline{\hspace{2cm}} / \text{bu.} \times \underline{\hspace{2cm}} \text{ bushels} = \$ \underline{\hspace{2cm}}.$$

$$\text{Total returns} = \text{cash receipts} + \text{futures receipts} = \$ \underline{\hspace{2cm}}.$$

$$\text{Net price/bu.} = \text{total returns} \div \underline{\hspace{2cm}} \text{ bushels} = \$ \underline{\hspace{2cm}} / \text{bu.}$$

$$\text{Total costs} = \$ \underline{\hspace{2cm}} / \text{acre} \times \underline{\hspace{2cm}} \text{ acres} = \$$$

$$\text{Cost/bu.} = \text{total costs} \div \underline{\hspace{2cm}} \text{ bushels} = \$ \underline{\hspace{2cm}} / \text{bu.}$$

$$\text{Profit or loss per bushel} = \$ \underline{\hspace{2cm}} / \text{bu.}$$

Did the basis error hurt or help your net price given the reduced yield? By much?

H. (Do but this part will not be graded.) There is another strategy that you could use to help you out of this over-hedged predicament. Futures prices for grain contracts are linked by the costs of storage to a large degree. Look at the prices at harvest during the drought year. The drought year prices are at the high end of the range of prices in the spreadsheet for Problem Set 1. Further, during the drought year, the price of contract for the next harvest reflects some of this price premium. You will execute a “rollover hedge” in this section. To implement this strategy, at the same time that you lift the production hedge for this year, you sell the number of contracts that you were over hedged this year in next year’s harvest contract and you sell additional contracts to bring your production hedge for next year **up to** your total expected production. (Read that again carefully.) You are “rolling” a portion of this year’s production hedge (the over-hedged portion) into the next crop but be careful and **don’t over hedge** the second year. You are also hoping that there will not be two drought years in a row. Complete the top of the T-account below for the trades on the 2023 contract.

Good news. The following crop year had a perfect growing season. Things were a little questionable in the early fall because of low soil moisture (margin calls, margin calls, margin calls) but during the spring a record large crop was never in doubt. Your actual production is 115% of expected production. Harvest prices on July 1, 2023 are

7/1	JUL	\$6.35/bu.
	SEP	\$6.39/bu.
	DEC	\$6.48/bu.
	MAR24	\$6.52/bu.
	MAY	\$6.46/bu.
	JUL	\$6.40/bu.

and basis is -75 cents per bushel. Complete the T-account.

Date	Cash	Futures	Basis
7/1 2022	Forward Price = \$ _____/bu.	_____ _____ contracts (Buy or Sell) (#)  of _____ wheat (contract month & year)  @ \$ _____/bu.	\$ _____/bu (expected)
7/1 2023	Cash Wheat @ \$ _____/bu.	_____ _____ contracts (Buy or Sell) (#)  of _____ wheat (contract month & year)  @ \$ _____/bu.  Futures Gain/Loss \$ _____/bu.	\$ _____/bu (actual)

Calculate the total returns to the cash and futures position for the second year and calculate the net price and profit.

$$\text{Cash receipts} = \$ \underline{\hspace{2cm}} / \text{bu.} \times \underline{\hspace{2cm}} \text{ bushels} = \$ \underline{\hspace{2cm}}.$$

$$\text{Futures receipts} = \text{Gain/Loss } \$ \underline{\hspace{2cm}} / \text{bu.} \times \underline{\hspace{2cm}} \text{ bushels} = \$ \underline{\hspace{2cm}}.$$

$$\text{Total returns} = \text{cash receipts} + \text{futures receipts} = \$ \underline{\hspace{2cm}}.$$

$$\text{Net price/bu.} = \text{total returns} \div \underline{\hspace{2cm}} \text{ bushels} = \$ \underline{\hspace{2cm}} / \text{bu.}$$

$$\text{Total costs} = \$ \underline{\hspace{2cm}} / \text{acre} \times \underline{\hspace{2cm}} \text{ acres} = \$ \underline{\hspace{2cm}}.$$

$$\text{Cost/bu.} = \text{total costs} \div \underline{\hspace{2cm}} \text{ bushels} = \$ \underline{\hspace{2cm}} / \text{bu.}$$

$$\text{Profit or loss per bushel} = \$ \underline{\hspace{2cm}} / \text{bu.}$$

Calculate the total returns to the cash and futures positions, the net price and profit for the two years.

$$\text{Cash receipts for 2022} = \$ \underline{\hspace{2cm}}.$$

$$\text{Cash receipts for 2023} = \$ \underline{\hspace{2cm}}.$$

$$\text{Total cash receipts} = \$ \underline{\hspace{2cm}}.$$

$$\text{Futures receipts for 2022} = \$ \underline{\hspace{2cm}}.$$

$$\text{Futures receipts for 2023} = \$ \underline{\hspace{2cm}}.$$

$$\text{Total futures receipts} = \$ \underline{\hspace{2cm}}.$$

$$\text{Total cash and futures returns} = \$ \underline{\hspace{2cm}}.$$

$$\text{Production costs for 2022} = \$ \underline{\hspace{2cm}}.$$

$$\text{Production costs for 2023} = \$ \underline{\hspace{2cm}}.$$

$$\text{Total production costs} = \$ \underline{\hspace{2cm}}.$$

$$\text{Total profits} = \$ \underline{\hspace{2cm}}.$$

$$\text{Net price/bu.} = \text{total returns} \div \underline{\hspace{2cm}} \text{ total bushels} = \$ \underline{\hspace{2cm}} / \text{bu.}$$

$$\text{Cost/bu.} = \text{total costs} \div \underline{\hspace{2cm}} \text{ total bushels} = \$ \underline{\hspace{2cm}} / \text{bu.}$$

$$\text{Profit or loss per bushel} = \$ \underline{\hspace{2cm}} / \text{bu.}$$

You are going to have to have banker that understands hedging to make this strategy work. Also, notice that you are rolling over the futures gains and losses and not the grain.