COLORADO STATE UNIVERSITY
DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS

Problem Set 1   **Agricultural and Resource Economics 412**   *S.R. Koontz*
Fall 2023   **Agricultural Commodities Marketing**

<u>Estimating Basis, Basis Risk, and Price Risk</u>

This problem set is to be an independent effort by a team of two students. Submit one report and identify both names and student ID numbers. Partial credit will be awarded only if work is shown and answers communicate. This problem set is worth 40 points. Round calculations to the nearest cent per bushel. Create a MSWord document and label your answers following the letters below. Complete work in your spreadsheet and cut & paste needed tables and figures. Print to PDF.

Assume you are a wheat producer in eastern Colorado. It is September 2023. You are developing the hedging part of your marketing plan. To do this you need basis information. You want to be able to hedge some of the wheat crop which you will market at harvest in July and you want to be able to hedge any grain placed in storage until October. If you store grain, you will only do so until October because you need the cash flow to meet a production operating note payment. Use the cash and futures prices in the spreadsheet on the class web site. You will calculate basis in this first problem set and use it to work hedges in the second problem set.

A.   You want to evaluate the two futures contracts for your production hedge which expire closest to but not before harvest. You need basis information for both contracts because you will evaluate both in the next problem set. Which two contracts could be used for the production hedge? (Do not worry about holding the contract into the delivery month.) _____ & _____.

B.   You have 25 years of data from 1998 to 2022. Use only 17 years of price data (2006-2022) and estimate the average basis level for each futures contract that would be used in calculating the forward price for the production hedge. Also, calculate the standard deviation of basis from the same data. Show your data and work in a spreadsheet. Use the example below. Follow the rounding rules.

Year	Calendar Month	Cash Price	Futures Price from contract month <u>MONTH</u>	Basis
2006	month	$#.##	$#.##	$#.##
2007	???	$#.##	$#.##	$#.##
...	...	...	...	...
2022	"	$#.##	$#.##	$#.##
			Average Basis	$#.##
			Std. Dev.	$#.##

C.   You also consider a storage hedge. You will use one of the three contracts which expire closest to but not before marketing the grain from storage. You need basis information for all three contracts

because you will evaluate all three in the next problem set. What three contract months could be used for the storage hedge? _____ , _____ & _____ .

D.   Use only 17 years of price data (2006-2022) and estimate the average basis level for each futures contract that could be used in calculating the forward price for the storage hedge. Also, calculate the standard deviation. Show your data and work in a spreadsheet. Print and attach your spreadsheets.

E.   Make a small basis table below and include the basis information for the relevant months. Include the average and standard deviation. (All of the cells will not be filled.)

	Potential Futures Contracts				
Calendar Month	MAR	MAY	JUL	SEP	DEC
Harvest Transaction Month _____ .					
Storage Transaction Month _____ .					

When, or if, you do this on your own then it is important to look at the data and see if the observations tell a similar story. It is always important to be thoughtful selecting when your sample begins and ends. You want the summary statistics to reflect the expected basis and risk for the coming year. It also may be important to drop observations that are most unlike and keep observations that are most like the supply and demand picture for the year within which you are making decisions. The following questions lead you through this exercise but do not go back and change your work in A-E.

F.   You have 25 years of price data in the spreadsheet. Calculate the basis for the harvest marketing calendar month and the two futures contracts under the production hedge. You should have 25 numbers for each of the two futures contracts. Draw a <u>line graph</u> of the basis across the 25 years. (Basis is the y-axis and year is the x-axis.) Include the basis for both futures contracts on one graph. Make sure you use formatting so the graph is readable and informative. You may need to rescale your y-axis. Label the axes. Label the series by including a graph legend.

Calculate the basis for the storage marketing calendar month and the three futures contracts under the storage hedge. You should have 25 numbers for each of the three futures contracts. Draw a <u>line graph</u> of the basis across the 25 years. Include the basis for all three futures contracts on one graph. Make sure you use formatting so the graph is readable and informative. Label the axes. Label the series. Print and attach the graph. Print this and the graph above on one page.

If you look at the data and read about market conditions, there were substantial changes in market conditions and in other economic conditions that might have impacted wheat markets. There is also substantial variation in weather conditions, both in the U.S. and in world wheat growing regions. The very end of 2006 was the beginning of the ethanol boom and the pull of acreage away from wheat to corn. In 2008 there was a world-wide shortage of wheat. There was also a tripling of energy costs that impacted transportation costs. Then in 2009 the world-wide recession hit along with the credit crisis. There were delivery problems with the hard-red winter wheat contract that were somewhat addressed after 2011. Recently, there is the war in Ukraine disrupting world wheat trade. (There is some applied research on the "convergence problem" and there were efforts by the exchange to address the issue with changes in the KC hard red winter wheat contract. Did you see those?)

Do not drop any observations from your calculations but you should see the reason for calculating basis beginning in 2006 through 2022. When you do this on your own then you need to ask the question: Are there any candidate years that are most different from other years because of policy changes, market events, economic events, weather, or anything else? Include discussion with your graphs.

G.　　　Next, you need examine price histories. Use the 25-year sample. You need an understanding of price history to understand risk. It is also useful to see if price tells you something about basis.

First, draw a <u>line graph</u> of the cash market price history and the futures market price history for the JUL contract. Use the whole sample – every month and year. This is the first graph and there are two lines.

Second, draw a <u>line graph</u> of JUL basis history across the whole sample – every month and year. This is the second graph and there is one line. Put these two graphs on one page.

Third, draw an <u>XY plot</u> with cash price on the x-axis and JUL basis on the y-axis using the whole sample – every month and year. Remove the line that connects all the points because you have a lot of points. An XY plot is also called a scatterplot.

Describe the relationship between price and basis in 1998-2005 and then describe the relationship between price and basis in 2013-2022. What years had the lowest prices and the weakest basis? What years had the highest prices and strongest basis? (How about changing colors of points for those three-time periods on the XY Plot?)

H.　　　Calculate the mean and standard deviation for CO cash prices using the 17-year sample. Calculate the mean and standard deviation for CO cash prices using only the harvest month. Calculate the mean and standard deviation for CO cash prices using only the storage month. Calculate the mean and standard deviation of the year-to-year price change at harvest.

This paragraph is an optional part of question H. Using the Histogram tool in Data Analysis tool pack within Excel, plot the histogram of CO cash wheat prices. You need to specify a "bin range" for the histogram. Use a low of $2 to a high $10.75 with intervals every $0.25. Does it look Normal?

I.　　　Calculate the correlations between the cash prices and each of the futures contracts using the 17-year sample. Calculate the correlations between the cash prices and the two futures contracts considered during the harvest month. Calculate the correlations between the cash prices and the three futures contracts considered during the storage month.

J.　　　Calculate the following probabilities using the NORM.DIST function in MSExcel. The price values below are the "x"s to be evaluated using means and standard deviations you have calculated above. Round the 0-1 probabilities to the third decimal place so you should report ##.#%. Write out the function and its arguments and the result in your document.

What's the probability of wheat being below $4.00/bu. and what's the probability of wheat being above $7.00/bu. anytime during the year? What are these two probabilities for the month of July?

What's the probability of the harvest wheat price changing -$1.00/bu. and what's the probability of the harvest wheat price changing +$1.50/bu.?

What's the probability of basis for the JUL contract being weaker than -$0.90/bu. What's the probability of JUL basis being stronger than $0.00/bu.? Both are for at harvest.

K.   Last, you need to calculate some measures of price risk to compare to your basis risk measures.

To measure risk, you have to start with an expectation. You must use two objective measures of next year's expected price. There is also a third but optional objective measure.

Assume that you expect CO wheat prices to be $5.55 per bushel at harvest. So, for example, in 2007 the harvest price was $5.00 so the amount you are incorrect – or the expectation error – is –$0.55. You need to do these calculations for the most recent 17 years, estimate the mean and standard deviation of the expectation errors. This will be a measure of harvest cash price risk.

Assume that you expect CO wheat prices this harvest year to the same as last harvest year. So, for example, in 2007 the harvest price was $5.00 and the actual harvest price in 2006 was $4.32 so the amount you are incorrect – or the error – is +$0.68. Do these calculations for the most recent 17 years, estimate the mean and the standard deviation of the expectation errors. Again, this is a measure of risk.

This paragraph, and only this paragraph, is optional for question K. Assume you expect CO wheat prices this harvest to be a function of last year's price used in a linear regression model. Use the appropriate function in Excel. Be sure to read the help menu. The function can be used to predict each year's price based on last year's price. Use the 17-year sample to estimate the regression model and do the expectation and risk calculations for the most recent 17 years, calculate the error, and estimate the mean and the standard deviation of the expectation errors.

Next, and this is not optional, calculate the price change between harvest month and storage month for each year using the 17-year sample. Estimate the average of these changes. (Ignore the inconvenient fact that it might be negative.) Assume that you expect this year's storage month price to be this year's harvest month price plus the average price change. Calculate the error and estimate the mean and standard deviation of the errors.

Put your estimates in a table that is structured as follows and include that table in your document.

	Mean Error	Standard Deviation
Cash Market Risk: Expect $5.55		
Cash Market Risk: Expect last year's price		
Cash Market Risk: Model using Excel Function – Optional		
Price change from July to October		
Storage Market Risk: July cash price plus average price change		

What is riskier: hedging or the cash market? You must support your conclusion with evidence. Does it matter if you are looking at production hedges or storage hedges? What objective information are you using to draw this conclusion – in other words, why? Include your answer below your table.