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Hedging with Futures: An Experiential Learning Game

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Abstract
Hedging is often an integral concept in agricultural futures and marketing courses as well as extension marketing workshops. Textbook and chalkboard examples offer students of these courses the ability to understand the concept and learn the mathematics. However, this mode of instruction is less intuitive and does not have a real-world feel. The purpose of this paper is to present an interactive hedging game that was developed to provide students with a more realistic hedging experience that improves the understanding of the mechanics of hedging. Under the premise of an eastern Nebraska corn producer using actual data, a spreadsheet was designed that displays market information to the students who then must make decisions about the number of futures contracts to trade. Pre- and post-game results indicate a positive learning outcome, and students responded favorably when asked if the game enhanced their understanding of hedging.

1 Introduction

Courses related to futures markets and risk management are commonly available at colleges and universities. Within the realm of agriculture colleges, this course is typically offered within the agricultural economics or agribusiness curriculum. While course content and concepts may vary, a common objective is the purpose and functionality of hedging with futures. Also, university extension specialists often offer programming on marketing and risk management to farmers. Hedging theory and chalkboard examples provide an understanding of the concept, but the application and practical aspect of hedging is difficult to achieve in a classroom setting.

Simulated trading market experiences offer students of futures marketing courses the ability to make trades and learn about the mechanics of the futures marketplace—for example, margin accounts, commission, and trading gains or losses. Still, these experiences are typically in the vein of speculation since students are simply buying and selling futures contracts and often with limited rhyme or reason.

The American Association for Agricultural Education National Research Agenda's fourth research priority area is "Meaningful, Engaged Learning in All Environments" (Edgar, Retallick, and Jones 2016). This type of framework is not a new phenomenon in college pedagogy. Experiential learning, active learning, game playing, and many other hands-on exercises that are utilized in classrooms have been employed for decades (a useful, but likely incomplete, set of resources related to the examination and history of these can be found through: Boehlje and Eidman 1978; Blank 1985; Knobloch 2003; Andreasen 2004; Caudle and Paulsen 2017).

Given the lack of a hands-on opportunity, an experiential/interactive learning experience was desired with regard to agricultural hedging and price risk management. The purpose of this article is to outline the development and application of an in-class hedging game created that puts students in the role of an agricultural producer making decisions about futures market positions, which relate to production and cash marketing.

2 Hedging Game: Overview

Futures market hedging is the act of establishing an opposite futures market position of equal size to that of the cash market position (Purcell and Koontz 1999). The hedging game places students into the role of an eastern Nebraska corn producer. It utilizes historical data for Omaha cash corn prices (available from USDA, Agricultural Marketing Service recorded by the Livestock Marketing Information Center, LMIC), December corn futures (from the Chicago Board of Trade via LMIC), and Washington County, Nebraska corn yields (from USDA, National Agricultural Statistics Service 2015). Prices and yields used within the game were from 1998 to 2014. The game was built in the fall of 2015, and prices and yield were normalized to this time frame so that year specific price or production outcomes would not be prevalent (this is described in further detail later).

At the start of the class period, students are provided with the game setting (appendix A), which is often provided in the prior class period or via an online classroom in an effort to be more efficient with time. Prior to the start of the game (optional), pre-emptive questions are asked in an effort to assess learning outcomes whereby the same questions are asked after the game concludes. The game is set in eastern Nebraska, since the data stem from that location, and a farm size of 1,000 acres is used to simplify calculations. Students are informed that they are to make decisions about the number of futures contracts to trade at three periods during a growing season (planting, crop emergence, and mid-summer). At each time period, a chart that depicts the futures market price for the December corn contract, dating back to the start of the calendar year, with the current available price explicitly noted is provided to the students (Figure 1—top left, bottom left, and top right panels, respectively). Students are then offered the opportunity to take a position in the futures market at the given price, but this is not required.[1] Harvest follows the mid-summer period, which is the end of the crop year and offers all final outcomes—actual cash price, final futures price, and actual yield (Figure 1—bottom right panel). At this point, all open futures positions are liquidated. Actual cash and futures revenue and profit (losses) are calculated. This procedure is repeated for additional crop years until the lecture period nears its end. Approximately seven minutes are reserved at the end to wrap up the game, ask post-game assessment questions (optional), and answer student's questions related to the game concepts.

3 Hedging Game: Specifics

The data for the game stem from USDA, Agricultural Marketing Service cash prices for Omaha, Nebraska, USDA, National Agricultural Statistics Service corn yield for Washington County, Nebraska, and Chicago Board of Trade December corn futures prices from January to mid-November (i.e., harvest) of each year from 1998 to 2014. To alleviate potential across year price and yield discrepancies, prices were inflated to a more current time period (2015), and yield was trend adjusted to reflect 2014 technology. The former was accomplished by setting the base year as the most recent price year and indexing all other prices to that base. More specifically, the index formula is:

$$Index_t = \frac{Nominal\ Price_t}{Nominal\ Price_{base\ year}} \quad (1)$$

where the nominal price stems from the mean of reported cash and futures price in the specific year, t = *1998 to 2015*, and the selected base year was 2015.[2] Prices were then adjusted by dividing the nominal price for each year, t, by the calculated index value for the same year. Yield was adjusted based on the following OLS regression procedure:

[1] Prior to the spring 2019 semester, students were only allowed to take short positions with futures contracts, to maintain the truest sense of a short hedger. However, out of curiosity, I relaxed this restriction for crop years two through four in the spring 2019 term.

[2] These calculations are located in the supplemental spreadsheet: "Corn_Cash&Fut," row 2 for index calculations and "Corn_adj" for adjusted prices.

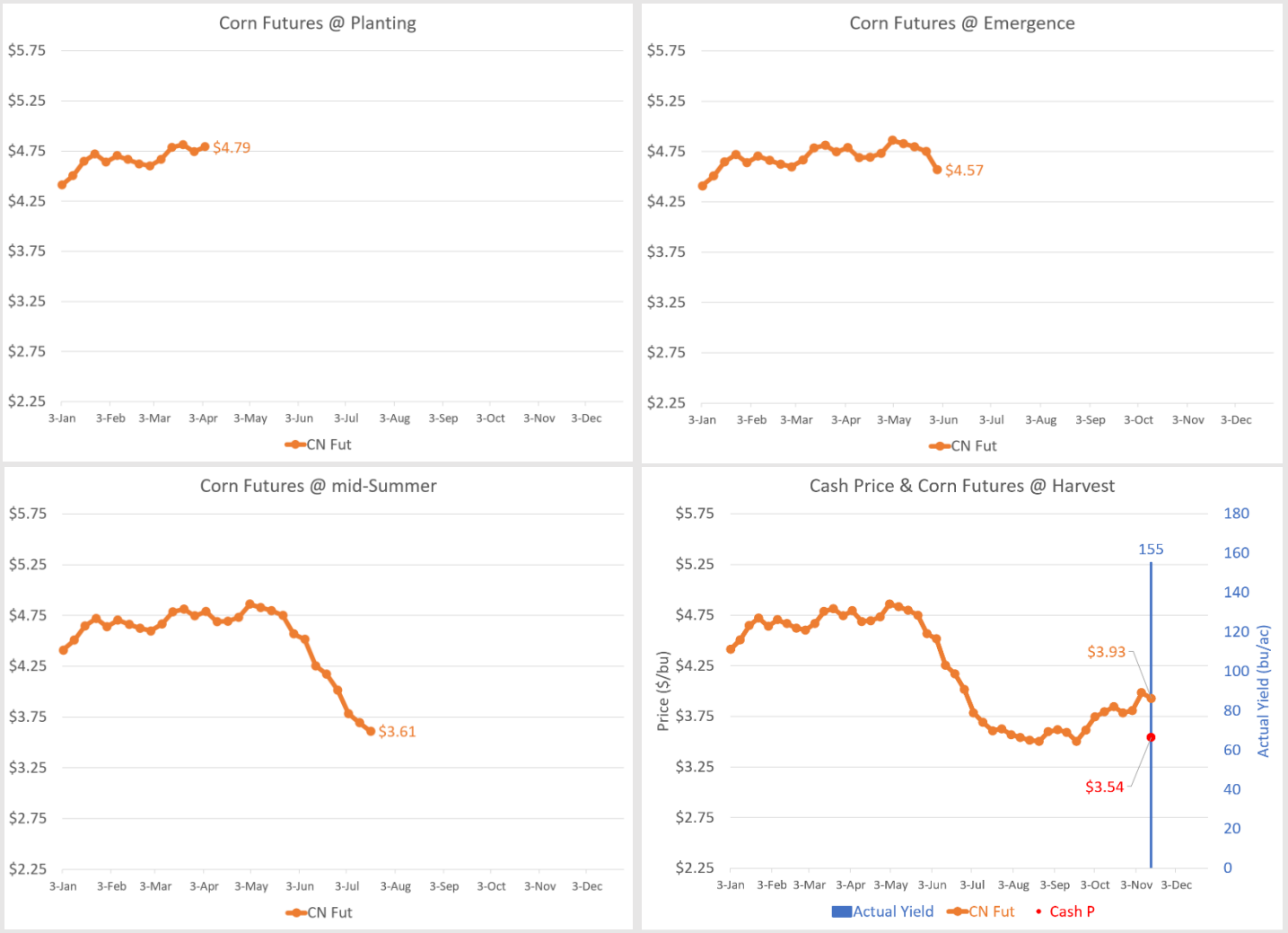

Figure 1: Charts of Futures Market Price Path for 3 within Growing Season Time Periods and the Final Harvest Period

Note: Top left panel is futures price at planting; bottom left is futures price at crop emergence; top right is futures price at mid-summer; and bottom right is harvest when all prices and yield are known with certainty.

$$Yield_t = \alpha + \beta Trend_t + \varepsilon_t \quad (2)$$

where yield data from 1960 to 2014 comprised the estimate; however, only 1998 to 2014 trend adjusted yields are incorporated into the game.[3]

Basis values are provided to students based on the typical *Cash Price* minus *Futures Price* derivation and stem from the six-week period surrounding the defined harvest period of mid-November. An average basis is offered to the students as an expected basis at the initial planting period so that an expected cash price can be formulated. Cost of production is included in the game to aid with the concept of management decision making and risk planning but does not have a well-defined framework. Costs for a game-specific crop year, *i*, are determined using the following procedure:

$$Cost_i = \max\left(85\% \times \overline{FP}_{planting} \times Random, median\ FP_{planting}\right) \quad (3)$$

[3] These results are located in the supplemental spreadsheet: "Yld Hist."

where, $\overline{FP}_{planting}$ is the average adjusted planting time futures price of the harvest contract for all years used, 1998–2015, and *Random* is a random number between 0.85 and 1.15. Costs have an upper bound of the median harvest contract futures price at planting.[4]

The teaching notes offer an explanation of how to conduct the game in-class. Additionally, supplemental videos provide more detail on the features of the game: specifically, a visual of how the in class game is conducted (video 1), an overview of the data and how these are incorporated into the game play (video 2), and the online form used for the student's submission of decision responses (video 3).[5]

4 Learning Outcomes

This game was created and introduced in the fall 2015 semester without a measure for learning outcomes. Beginning in Spring 2018, students were asked four questions before and after the hedging game (respectively, pre and post), and no changes were made to the questions. Overall results of the pre- versus post-game questions are provided in Table 1. The questions asked were:

Question 1: [Multiple Choice] A hedge can be placed … (a) only at the end of the planning period, (b) only at the beginning of the planning period, (c) only at specific intervals during the planning period, or (d) at any time during the planning period.

Answer: The correct answer would be (d), and the purpose of this question stems from the game setup, which only allows students to make periodic hedging decisions. It is important to reinforce during the game that these decisions are not beholden to specific intervals or only at the beginning or end.

Question 2: [True/False] Hedging decisions of buyers/sellers cannot be adjusted/altered until the end of the period.

Answer: The correct answer is False, and similar to the previous question, this is asked to ensure that participants understand that futures positions can be entered/exited at any time.

Question 3: [True/False] A producer who makes frequent use of futures, options, and forward contracts should have a higher expected price than a producer who always sells at harvest.

Answer: The correct answer is False, as hedging is not a way to increase profits but merely a price risk management tool.

Question 4: [True/False] Futures markets can always be used to lock in a profit.

Answer: The correct answer is False, while price risk can be mitigated with futures, basis risks could reduce the ability to *always* lock in profits.

Most students understand the mechanics of hedging and how an actual producer is able to use the futures market to hedge price risk as evidenced by the percentage of correct answers to the pre-game questions. I employ the game at the end of the semester (typically within the last week of class), so this

[4] These calculations are found in the supplemental spreadsheet: "4chart-1" (cells W4:W11).

[5] Videos can be found at: Video 1: Game Play at https://youtu.be/KlKe8NVEfqw; Video 2: Data and Other Background Information at https://youtu.be/7Saj0ccbP3o; and Video 3: Online Student Submission Form and Tabulation Sheet at https://youtu.be/OvHQiUCgWBw.

Table 1. Hedging Game Pre- and Post-Question Overall Score Results

Question	Percent Correct (Pre)	Percent Correct (Post)	
Question 1	76.92%	86.32%	**
Question 2	79.49%	84.62%	
Question 3	48.72%	52.99%	
Question 4	72.65%	74.36%	

Note: *N* = 117 (spring 2018: 23 students in attendance; fall 2018: 49; spring 2019: 45)
Significance at the 5% level denoted by "**" and based on a pooled *t* test.

was expected given that the concepts have been taught for an extended period of time. Even so, the results of the pre- and post-game questions do point to a positive learning experience. Question 1, *"A hedge can be placed …"* resulted in a significant improvement after the game is played. As described in the notes and video, an emphasis is made to explain that a futures market (or any forward price) hedge can be initiated at any point in time that the market is open, which bears out in the pre- and post-game learning outcomes. Question 3, *"A producer who makes frequent use of futures, options, and forward contracts should have a higher expected price than a producer who always sells at harvest,"* resulted in the lowest number of correct answers both before and after the game, with a minor albeit insignificant improvement.

Further analysis of the pre- and post-game question learning outcomes are provided in Table 2, which uncovers individual outcomes as opposed to the aggregated results described in Table 1. Here each student's pre-game answer was compared with their post-game answer to determine the individual level of improvement. The left-most column describes students who incorrectly answered a question before the game, but then correctly answered after the game. Again, question 1 shows the most improvement. A point of encouragement, Question 3 revealed improved outcomes but tended to be wrong most often both before and after. On the other hand, more students regressed when answering Question 3, relative to other questions, in that they correctly answered it in the pretest but got it wrong in the posttest.

Students were also asked if the game increased their understanding of hedging. Responses to a five-point Likert scale response (strongly disagree to strongly agree) is provided in Figure 2. The majority of responses indicate a positive outcome with 81.2 percent of students indicating agree or strongly agree.

5 Summary

The concept of hedging is critical in futures marketing courses and for extension marketing and risk

Table 2. Hedging Game Pre- and Post-Question Individual Outcome Results

Question	Percent Improved	Percent Correct Pre and Post	Percent Wrong Pre and Post	Percent Regressed
Question 1	16.24%	70.09%	6.84%	6.84%
Question 2	10.26%	74.36%	10.26%	5.13%
Question 3	14.53%	38.46%	36.75%	10.26%
Question 4	8.55%	65.81%	18.80%	6.84%

Note: Students were grouped into one of the four categories (Improved, Correct Pre and Post, Wrong Pre and Post, Regressed). *Improved* indicates the student incorrectly answered the specific question in the pretest and subsequently correctly answered the specific question in the posttest. *Correct Pre and Post* indicates the student correctly answered the specific question on both the pre- and posttest. *Wrong Pre and Post* indicates the student's answer to the specific question was incorrect on both the pre- and posttest. Finally, *Regressed* indicates the student correctly answered the question in the pretest but incorrectly answered in the posttest. Percentages provide a measure of the total number of students in each group (*N*=117); across each row should sum to 100 percent (after accounting for rounding).

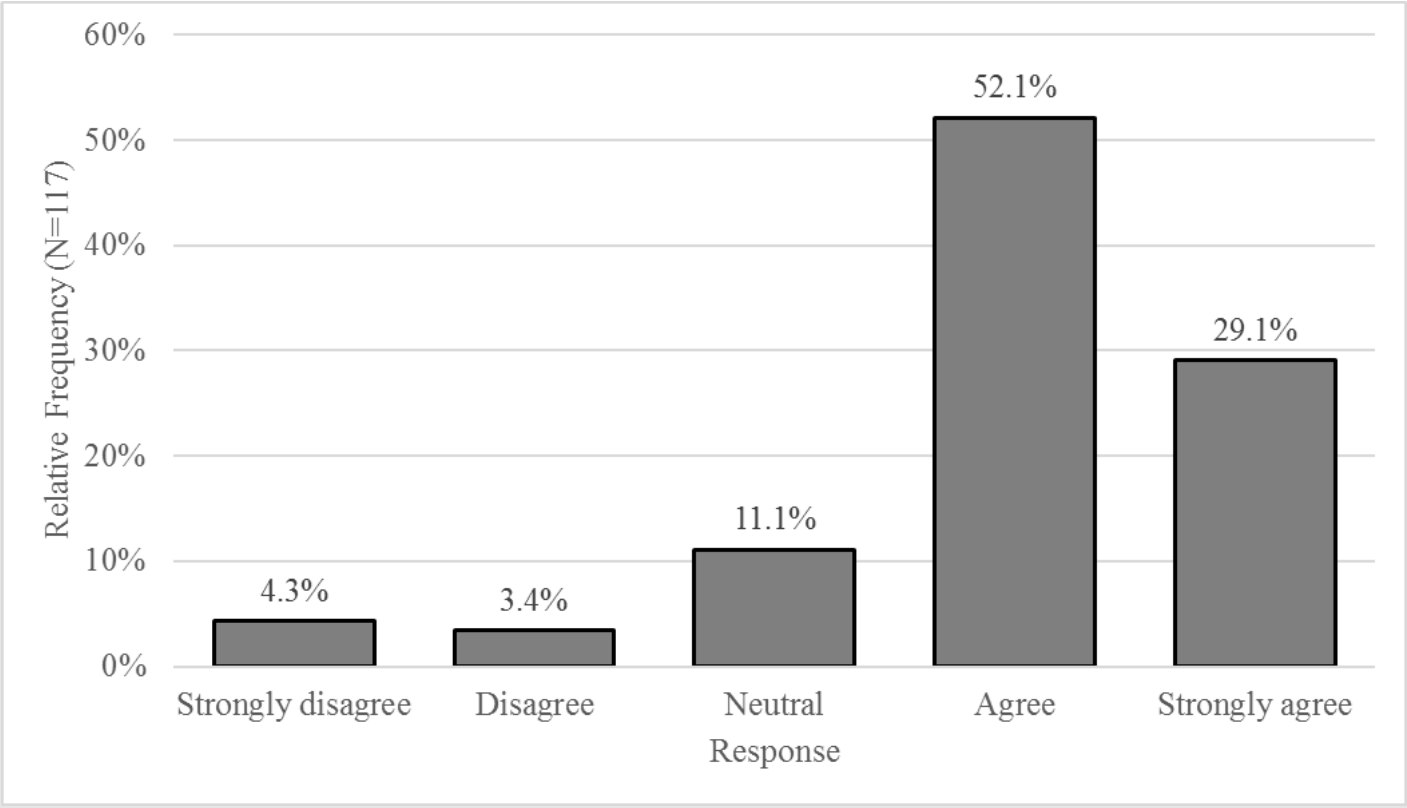

Figure 2: Student Response to the "*This exercise increased my understanding of hedging*" Question

management education. The concept may also apply to other market-related agricultural economics/agribusiness courses or extension education programming. Classroom examples and out-of-class assignments provide a mechanism for students to grasp the calculations and final outcomes; however, the reality of hedging is more difficult to convey. An in-class hedging game was created that offers instructors of these courses an opportunity for an experiential learning exercise with a "real-world" example brought into the classroom. Given that the game stems from a single computer that can be displayed on a large screen, the game transports easily for extension specialists offering training in the field (paper tabulations may be best suited for this form of application as opposed to online submission of decisions).

Results of pre- versus post-game questions indicate the opportunity does increase the knowledge of hedging mechanics and risk management attributes. The applicability of the game is another positive aspect, as students indicated the game benefited their understanding of the hedging process.

Possible future changes to the game include: (1) incorporate more instantaneous feedback to the student, (2) utilize the game periodically throughout the semester as opposed to once at the end of the term, and (3) incorporate basis hedging.[6] Quicker crop year results could be accomplished with an individual tabulation sheet (spreadsheet) provided to each student in advance. The number of students who own personal laptop computers or tablets that are able to access spreadsheet software (either Excel or Google Sheets) has grown to a degree that few, if any, would not fit this criterion. Therefore, having this as an additional tool would be easy to implement. The one drawback would be the swapping between the online submission form and the spreadsheet during the game. Utilizing the game periodically during the semester is simply a matter of reorganization of the course timeline and easily accomplishable. Basis hedging would be an extension of the game that has not been implemented and tested at this point; however, a modified student record sheet that includes this component is offered in

[6] Thanks to the reviewer for offering the suggestion of basis hedging.

appendix D, along with the sheet that I have previously used (instructions are included as a note with the record sheet).

Additional extensions for the game include: (1) more precision with respect to price and production, (2) increased reality by incorporating margin calls and transactions costs, and (3) improved information within each crop year—for example, crop progress and quality, updated cost of production, weather history and forecast, and market analysts' forecasts.

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