Extension Education

Cross-Hedging in the Classroom: Engaging Students in Developing Scholarly Extension Output

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Abstract
Topics covered by undergraduate agricultural economics courses often overlap with Extension educational needs. This paper describes an undergraduate class project that involved students in producing an Extension report. The project was designed as a collaboration between undergraduate instructors and Extension economists. The instructors targeted a set of concepts and skills for the students to practice, and the Extension economists advised the instructors on a particular issue using those skills relevant to local agriculture. This process resulted in analyzing the potential to cross-hedge peanuts with futures contracts from different commodities. Students were introduced to peanut marketing, cross-hedging, regression analysis, and how to write an Extension publication. In groups, students analyzed data and wrote a report. Group reports were evaluated by Extension economists, and one project was chosen to be published as a peer-reviewed Extension publication.

1 Introduction

Cooperative Extension provides practical training and education to agricultural producers. Many of the topics covered by Extension materials are also taught in undergraduate agricultural economics or agribusiness courses. Undergraduate courses, for example, commonly train students in enterprise budgeting or the principles of using futures markets for price risk management. Despite this overlap, agricultural economics undergraduates are often not included in the production or consumption of Extension materials.

This paper presents a model of collaboration between undergraduate agricultural economics instructors and Extension economists. The collaboration took the form of an undergraduate group project. Students used linear regression to determine cross-hedging possibilities for peanut producers and wrote an article summarizing the concepts and their findings to an Extension audience. The articles were evaluated by Extension economists, and one was selected and revised for publication as a peer-reviewed Extension article by the Alabama Cooperative Extension System (ACES).

The class project had two overarching objectives. First, the project was designed to introduce students to Extension economics. While Extension is one of the three missions of the land-grant system, many students are unaware of the work that Extension does. As the rural population continues to decline and the number of students with no agricultural background continue to enter agricultural or applied economics, fewer students have come into contact with Extension. As a result, fewer undergraduates become Extension specialists or educators (Taylor and Zhang 2019). Engagement with students potentially interested in careers in Extension may be crucial for training the next generation of Extension economists (Lawrence et al. 2019; Shear 2020). One way to engage with students is to integrate Extension with classroom education, as prior work has done (e.g. Loveridge 2003; Haines 2002). For example, Ebner et al. (2017) use a study-abroad service-learning course in which students learned about the mission of cooperative Extension, culminating in students delivering a series of Extension workshops on animal production. Experiential learning opportunities related to Extension agribusiness include producing enterprise budgets and business plans (Barnard 2003; Curtis and Mahon 2010a; Curtis and Mahon 2010b), studying price analysis through hands-on activities (Beck 1970), and evaluating economic impact (Fannin and LeBlanc 2007). Our class project built off these prior projects in that it sought to introduce undergraduate students to the types of problems Extension economists solve and to develop the ability to communicate results to a stakeholder audience, but with an added econometric exercise.

Our second objective was to present undergraduate students with a realistic data-driven decision faced by agricultural producers and allow them to explain a solution to a non-economist audience. Empirical applications are frequently used in economic education (e.g., Marshall and Underwood 2019; Hoyt 2021; Swinton 2021) and student training in data work is increasingly important for undergraduates in agribusiness (Elliott and Elliot 2020). To our knowledge, however, few course-based data activities have been published that teach agribusiness students about Extension activities that also result in the production of actual Extension output.

2 Project Description

The project entailed collaboration between two course instructors and two Extension economists as well as collaboration between students in two classes. The classes involved were an upper-level (junior and senior) course on Agricultural Prices with 36 students and a mid-level (sophomore and junior) course on Quantitative Methods in Agricultural Economics with 21 students. Eleven of the students were registered in both courses concurrently. Many of the students in Agricultural Prices had taken Quantitative Methods previously, so the project served as a review of their prior knowledge.

2.1 Learning Objectives

The end goal of the project was for students to write an Extension publication that explains cross-hedging and uses real-world data to make recommendations for Alabama farmers. Through the written report, students demonstrated the ability to:

1) Describe cross-hedging concepts;
2) Interpret ordinary least squares regression coefficients and diagnostics (especially R^2);
3) Use knowledge of cross-hedging and regression to provide action-oriented recommendations for farmers; and
4) Write for a less technical audience of stakeholders.

2.2 Project Preparation

The two course instructors and two Extension economists first compared course syllabi with Extension needs. Possible project topics were narrowed down based on the feasibility of students completing the project in one semester, and the team decided to focus on testing possible ways to use futures contracts to mitigate spot market peanut price risk.

Row-crop producers can use several tools to manage price risk, including forward contracts, crop insurance, and hedging. Hedging of agricultural commodities usually involves selling contracts in the futures market for the commodity in question to protect against crop prices falling before harvest. Futures markets, however, do not exist for all crops. Peanuts - a major crop in Southern agriculture - is an example of a crop without a futures market. While producers of crops without a futures contract cannot hedge their crop directly, they can cross-hedge, or hedge using the futures contract for another commodity. To determine whether a commodity would be appropriate for cross-hedging, producers need to examine the relationship between the cash price of the crop and the futures price in question. The evaluation of whether a commodity's futures contract is potentially a valid cross-hedge can be done with linear regression, a tool regularly taught to undergraduates in agribusiness programs.

To evaluate the possibility of cross-hedging for peanut producers, students need a series of cash market peanut prices over time and a series of prices for at least one futures contract over the same period of time. The Extension team provided weekly peanut prices covering 2006–2021. The peanut prices represent the current price paid by first handlers and were obtained from the National Agricultural Statistics Service.[1] In addition, the Extension team regularly collects prices for the nearby futures contracts for wheat, corn, and soybeans for a weekly report for Alabama producers ("Profit Profiles"). Thus the Extension team was able to provide a weekly series of nearby wheat, corn, and soybean futures prices over the same period of time. For tractability, the team decided to restrict the data to weekly prices in the years 2017–2018.

Prior to implementing the project, the course instructors randomized students to project groups. Each group consisted of 4–5 students and had at least one student from each class. The students were given the email addresses and names of the other group members.

2.3 Project Implementation

Implementation of the group project proceeded in three stages.

2.3.1 Stage 1: Student Preparation

Students were given materials introducing them to cross-hedging and to regression analysis. This material consisted of three guest lectures and one reading assignment. One Extension economist gave a guest lecture on peanut production and marketing to the Agricultural Prices course, and a recording of that lecture was made available to students in both classes. In addition, the Agricultural Prices instructor recorded a lecture on cross-hedging, and the Quantitative Methods instructor recorded a lecture on regression analysis. The recordings were made available to students in both classes. Finally, the students were directed to read a section on cross-hedging from Peterson (2018).

2.3.2 Stage 2: Data Work

After being introduced to the basics of peanut marketing, cross-hedging, and regression analysis, the students were given an Excel worksheet with 2017–2018 weekly cash peanut, wheat futures, corn futures, and soybean futures prices. The students were also given a worksheet with step-by-step instructions on how to use the dataset to obtain information necessary for making cross-hedging decisions. In particular, the students were instructed to create new columns consisting of the first differences of each price series. They were then instructed to use the first-differenced prices in a simple ordinary least squares regression using Excel. The students were finally instructed to use the regression R^2 to evaluate the effectiveness of each potential cross-hedge and the regression coefficient to calculate the optimal hedge ratio and the number of futures contracts they would need to hedge their entire expected harvest (600,000 pounds).

2.3.3. Stage 3: Report Writing

The data work gave each group the information needed to provide a set of recommendations for farmers. In the final stage of the project, the groups were given instructions on how to write a brief Extension article. Specifically, the students were told that their report had to:

a. Introduce farmers to the idea of cross-hedging using futures contracts.
b. Explain how to determine the best contract.
c. Describe the results for determining the best contract.

[1] https://usda.library.cornell.edu/concern/publications/5t34sj58c?locale=en

d. Explain how to determine the optimal hedge ratio and the number of futures contracts to use.
e. Describe the results on the optimal hedge ratio and the number of futures contracts to use.
f. Explain how to determine whether a specific cross-hedge is a good strategy.
g. Describe the results on the best of the available futures contracts that provide an acceptable hedge.
h. Summarize what the results mean for peanut farmers seeking to mitigate price risk.

Reports were to be two pages of text, with additional tables or figures encouraged but not necessary. Grades were assigned based on both the accuracy of the analysis and the quality of the report. The two parts of the rubric are displayed in Tables 1 and 2.

Table 1. Rubric for Accuracy of the Analysis (10 points total)

	Correctly Identified	Not Correctly Identified but Steps Were Clearly Followed	Not Correctly Identified and No Evidence of the Steps
Best contract	2 points	1 point	0 points
Optimal hedge ratio	2 points	1 point	0 points
Optimal number of futures contracts to use	3 points	1 point	0 points
Whether to cross-hedge using futures at all	3 points	1 point	0 points

Table 2. Rubric for Quality of the Report (10 points total)

	Completely	Partially	Not at All
Report specifications were followed[a]	2 points	1 point	0 points
All items (a)–(h) are included	4 points (0.5 point for each item)	0.5-3.5 possible points	0 points
Explanations of the concepts are correct	2 points	1 point	0 points
Explanations of the concepts are understandable to a non-economist	2 points	1 point	0 points

[a]Two pages of Text, single-spaced, 12-point Times New Roman

2.4 Post-Implementation

Students were informed at the beginning of the semester that the Extension economists would choose one group's report to serve as the basis for a peer-reviewed published Extension article with ACES. The students were told that this would occur after grades were assigned and would have no impact on their project grades but would be a great item to display on a resume. After the instructors assigned project grades based on the rubric in Tables 1 and 2, student names were removed from the reports, and the instructors sent the anonymized group reports to the Extension economists. The Extension economists read through them and chose one group's report to be the start of an Extension publication through ACES. Together with the students, the Extension economists revised the report and submitted it to ACES for peer review and formal publication. After a round of reviews, the report was published on the ACES website (https://www.aces.edu/blog/topics/farm-management/marketing-tools-cross-hedging/).

3 Project Evaluation

We used a quiz to evaluate how well the project improved student understanding of cross-hedging (learning objective 1) and interpretation of regression coefficients and diagnostics (learning objective 2). Project grades based on the rubric allowed us to evaluate students' ability to provide appropriate recommendations to farmers (learning objective 3). At the end of the project, students were also able to provide written feedback. The subsequent reach of the Extension publication is an ongoing evaluation metric beyond the semester of the class as the article remains accessible on the ACES website.

3.1 Quiz

The course instructors designed a quiz that evaluated student knowledge of ordinary least squares regression and of cross-hedging. The quiz was given as an online assignment to all students both prior to the start of the project and after all groups' reports had been submitted. The same 14 questions appeared on the quiz both before and after the project. Appendix Table A1 provides a complete list of all questions. Quizzes were graded on completion (5 points for a completed quiz), and students were informed that the accuracy of their answers would not impact their course grades. After grades were assigned for the semester, the course instructors graded the quizzes. Since students were not assigned grades based on quiz accuracy, students could have put in very little effort and simply randomly chosen answers. We believe this is not a concern for two reasons. First, we are only interested in the pre- vs. post-project changes, not the levels of the grades. Students putting in no effort and randomly selecting answers would add to the noise of this comparison, but would likely not systematically bias the comparison. Second, grading a pre-project quiz on accuracy would penalize students for not knowing what they were not yet taught. This may also create perverse incentives for students to use outside resources to improve a pre-project quiz grade, contaminating any pre/post comparison. We believe the downsides of not providing course grades for quizzes based on accuracy far outweigh the additional noise in our estimates that this introduces.

We implement a paired sample t-test to determine whether the difference between pre- and post-test scores is significant. To implement the paired sample t-test, we code each response as 1 if the answer is correct and 0 otherwise. Therefore, the full score of the quiz is 14. The term d_{ij} is defined as the difference between any matched pair of responses x from student i to question j such that $d_{ij} = (x_{post,ij} - x_{pre,ij})$. The null hypothesis is that the population differences (μ_{d_j}) between the pre- and post-test to a single question j is zero. We test this null hypothesis against the one-sided alternative hypothesis that the difference in responses is positive (i.e., H_0: $\mu_{d_j} = 0$ vs. H_a: $\mu_{d_j} > 0$).

Table 3 displays the mean pre- and post-quiz scores as well as t-statistics of the paired sample t-test for each question, as well as the overall number of correct answers. The mean scores of all questions were higher in the post-test than in the pre-test; overall, the number of correct answers jumped from 9.881 pre-quiz to 12.04 post-quiz. The difference between the mean number of correct answers is statistically significant (t-statistic of 8.740). For 12 of the 14 questions, we reject our null hypothesis (H_0) in favor of the alternative hypothesis (H_a) that the class project is an effective tool for enhancing students' understanding of both linear regression and cross-hedging.

Table 3. Summary Statistics and Paired Sample *t*-Test Results (*N* = 42)

Topic	Question	Pre-Quiz Score (Mean)	Post-Quiz Score (Mean)	*t*-statistics
Regression	1.a	0.548	0.929	5.023*
	1.b	0.857	0.952	2.077*
	1.c	0.524	0.714	3.106*
	1.d	0.667	0.905	3.580*
	2.a	0.810	0.881	1.776*
	2.b	0.738	0.786	1.432
	2.c	0.714	0.929	3.343*
	2.d	0.571	0.762	3.106*
	2.e	0.690	0.786	2.077*
	3	0.548	0.714	2.864*
Cross-Hedging	4	0.690	0.905	3.344*
	5	0.762	0.833	0.724
	6	0.643	0.857	3.344*
	7	0.810	0.929	2.354*
Overall Score	1–7	9.881	12.048	8.740*

Note: *Statistically significant at 5 percent.

3.2 Rubric-Based Grades

There were 10 groups in the semester this project was implemented. Tables 4 and 5 show the number of groups out of 10 that received full points for each rubric component. Almost all groups identified the best contract and the optimal hedge ratio, and all groups were able to accurately inform farmers whether to use wheat, corn, or soybean futures contracts to hedge peanuts. Most of the groups included all of the necessary parts of an Extension report, and all groups were able to explain the concepts in language that is understandable to farmers without a background in agricultural economics.

Table 4. Number of Groups Receiving Full Credit for the Accuracy of the Analysis

	Number of Groups Out of 10 That Received Full Points
Best contract	9
Optimal hedge ratio	8
Optimal number of futures contracts to use	6
Whether to cross-hedge using futures at all	10

Table 5. Number of Groups Receiving Full Credit for the Quality of the Report

	Number of Groups Out of 10 That Received Full Points
Report specifications were followed[a]	8
All items (a)–(h) are included	9
Explanations of the concepts are correct	9
Explanations of the concepts are understandable to a non-economist	10

[a]Two pages of text, single-spaced, 12-point Times New Roman

3.3 Student Feedback

Students were given the opportunity to comment on three questions: (1) What did you like about the project?, (2) What could be improved for future semesters?, and (3) How well did your group work together? Twelve students submitted written feedback on the project. We include all student responses to the first two questions in the Appendix. We used the third question as a way to let students inform us of any interpersonal conflicts in their groups, and thus do not report this feedback.

In general, students liked that it was a practical application of the course materials:

> *[The project] presented a practical way to use what we've learned.*
>
> *I liked how this applied to the real world, and we could use real-world examples to better understand both the futures and cash markets, as well as what we are learning is being applied to the real world.*

There were mixed feelings on the collaboration between students in two courses:

> *I liked the combination of two classes to work on the project.*
>
> *[What could be improved*?] *Having the project based solely off of one class.*

A source of frustration for some students in Quantitative Methods at the time was that students in the upper-level course did not recall the Quantitative Methods material. This made it hard for groups to figure out the best way to work together:

> *…it was difficult for some of my group members to remember things from other classes they had taken in previous semesters.*
>
> *Having some members only be in [Agricultural Prices] or only in Quant did bring some difficulties in how to divide the work and the level of understanding.*

3.4 Reach of Publication

Once the article was published on the ACES website, we were able to begin evaluating the outreach to stakeholders. There is a long history concerning the evaluation of Extension programming that can range from documenting efforts, describing the nature of those involved in the program, and determining the response to programming. This can be further distinguished into immediate and long-term impacts, some of which requires additional resources to obtain evidence for a particular program (Bennett 1976). We focused our evaluation on the reach of the publication, because publishing the article on the website was the final objective of the class project. Website content can be evaluated using pageviews, which is a count of the number of times a page was loaded in a browser. Pageviews are readily available information that can provide valuable metrics of impact (Karisch and Parish 2013; Patton and Kaminski 2010). During the first ten months the article was available there have been 639 pageviews, with a monthly peak of 120 pageviews during the eighth month after publication. This gives indication of the continued impact the class project has beyond the end of the class meeting. Evaluation of the reach of the article is an ongoing process as it continues to remain relevant in the future.

4 Modifications and Extensions

The project improved student understanding of cross-hedging and regression, while also introducing students to writing Extension publications. Almost all of the students who provided written feedback liked the practical application. Students in the group whose report was chosen to become an Extension publication worked closely with Extension economists to publish the report. Through this project, students were thus introduced to a small part of the work of Extension and the land-grant mission.

This project can be modified and extended in a number of different ways. Our application (cross-hedging peanuts with standard futures contracts) resulted in findings that some students found confusing - though many agricultural economists would not be surprised. Wheat, corn, and soybean futures contracts provide almost no protection against peanut price risk, and the published report advises farmers against using these contracts to mitigate peanut price risk. Thus, a simple modification of this project would involve using a commodity that has more cross-hedging potential with common futures contracts. Another modification of this project would be to include students from only one course. This is most feasible if that course covers all the topics necessary to complete the project or has the necessary prerequisites (e.g., quantitative analysis).

Outside of modifying the current project on cross-hedging, this teaching-Extension model of collaboration can be extended to many different topics of interest to agricultural producers. Undergraduate programs in agricultural economics and agribusiness cover topics that overlap with Extension programming, such as enterprise budgeting, commodity marketing, agricultural finance, and risk management. Undergraduate projects can be centered around producing Extension materials on these overlapping topics.

5 Conclusion

The undergraduate project presented here provides multiple opportunities for engaging undergraduate agricultural economics and agribusiness students in an active learning environment while also providing exposure to Cooperative Extension. Thus, the activity serves multiple pillars of the land-grant mission. We found that this activity improved student understanding of both regression analysis and cross-hedging. Students also generally enjoyed the chance to use the course material to contribute to real-world decision-making. Furthermore, the publishing of an Extension article expands the lifetime of the student project and potential impact on the targeted community.

Collaboration between teaching and Extension faculty can help bring greater exposure to the real-world application of classroom materials. This collaboration can also introduce students to the work of Extension. This paper presents one model of this collaboration in the form of a cross-hedging exercise; there are many other opportunities to apply this type of learning and application. Students also receive benefits beyond the classroom experience with potential outputs that can be listed on their resume and used to help secure future employment.

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