Teaching and Educational Methods

Expanding Undergraduate Research Experience: Opportunities, Challenges, and Lessons for the Future

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Abstract
Research is a core activity at universities, but the largest group of people at most universities—the undergraduate students—frequently graduate without scientific research experience. In this case study, we highlight challenges to engage undergraduates in the research process and focus on three key issues: student interest, timing, and access. We then report on our experience of preparing and rolling-out a research internship program designed to overcome these three hurdles. We target: (1) students not interested in a career in research, (2) lower-division students with little to no classroom research experience, and (3) students who are underrepresented in economics and/or STEM based on their race/ethnicity or gender identity. We candidly discuss the benefits, costs, hurdles, constraints, and successes of the program's first cohort and make recommendations for others interested in curating similar programs at their own institutions.

Introduction

Research is the foundation of universities, providing the structure of the institutions and the status of their reputation, with rankings based on research productivity and grantsmanship. But research is an experience not typically afforded to the largest group of people at universities: undergraduate students. In fact, participation in research rarely extends beyond faculty and graduate students. Many undergraduate students are entirely unaware of the important role research plays within the university structure.

Undergraduate research experiences have a positive impact on the participating students, as well as faculty (Linn et al. 2015; Wagner 2015; Feyrer 2017; Hoyt and McGoldrick 2017). Despite these benefits, both faculty and students face challenges in creating and engaging in authentic research experiences for a multitude of reasons. Three such challenges are: student interest, timing, and access. First, many career-oriented students may eschew research experiences, as they feel there is limited applicability to their intended non-academic career objectives. Students may not realize that the applications of the skills learned doing research are extensive and valued on the job market (Petrella and Jung 2008; König 2022). Second, research opportunities are often not open to students until their final year at the university, leaving insufficient time for a faculty member to invest efforts in training an individual and integrating them into a research team. Evidence has shown that with the appropriate framing of the research experience, undergraduate students can be trained on the job in research methods and engage in meaningful research activities early in their academic careers (Awong-Taylor et al. 2016; Thiry et al. 2017; Casson et al. 2018). Third, many students lack access to opportunities for engaging in research as many of these opportunities are unpaid. Unpaid undergraduate research internships or assistantships can be exclusionary and may bifurcate students into groups of those who can afford unpaid work and those who cannot, leaving the students in the latter category "behind." Evidence suggests that students from minority groups that are underrepresented in economics and/or STEM are particularly affected by this divergence (Hurtado et al. 2009; Ahmad et al. 2019).

To address the gaps in undergraduate research participation, many universities have pushed to add research training into their undergraduate offerings. These opportunities can be grouped into four categories: courses in empirical research methods, course-based undergraduate research experiences (CUREs), competitive research programs, and external internship experiences. In the context of agricultural and resource economics, empirical research methods courses develop empirical analysis skills and cover topics including econometrics, identification, and regression techniques. CUREs come in many varieties and typically have students practice and perform the steps necessary to complete a targeted research project. Competitive undergraduate research opportunities, such as the Ronald E. McNair Achievement Program, provide mentored undergraduate research experiences where students engage in activities or projects which are conducted by undergraduate students, guided by a faculty member, and confirm or extend existing knowledge or create new knowledge. Finally, external internships connect students with research teams outside the university setting and vary widely in their research methods, required skills, and payment schemes.

While each of these formats delivers research exposure, each presents various shortcomings to many undergraduates. First, research methods courses or seminars typically provide training but lack the decision-making and knowledge generation of self-guided research. They are also commonly elective courses instead of required curricula. Second, CUREs afford accessibility to many students but lack authenticity due to their relatively large class sizes. The number of students served generates a tradeoff: to keep on track, the research design is typically chosen by the course instructor, meaning students make fewer impactful decisions in terms of steering research questions, data practices, or how hypotheses will be tested. Further, both research methods courses and CUREs also require students to pay for credit hours. Third, programs such as McNair Scholars target high-achieving students interested in pursuing doctoral studies. This excludes students interested in going into the job market directly from their undergraduate programs, which represent many undergraduate students. Further, this means that the doors to the mentored undergraduate research experiences offered by the McNair Scholars are closed to all but the most academically excellent students. Finally, external internship experiences present challenges to students who cannot obtain transportation to off-campus research work, cannot afford to perform unpaid research activities, or who do not hold competitive, firm-specific qualifications.

The motivation behind developing the internship described in this paper is to offer learning-based research experiences for undergraduate students. Our approach also aims to engage them in research driven by real-world problems, while addressing the challenges limiting undergraduate involvement in research, which are found in the four most common existing undergraduate research mechanisms. Further, the internship was also motivated by the explicit objective of increasing diversity in applied economics. Economics remains a white and male dominated field. As economists, we are cognizant of the constraints on both students and faculty to build authentic research experiences. These constraints may limit efforts to diversify higher education by excluding interested students in early stages of their academic career, creating a path of dependence that leads them away from academia. With the internship, we hoped to alleviate these constraints by providing paid undergraduate research experiences, with a guided structure for learning, building skills and confidence, throughout the course of a semester. By investing in students and encouraging them to engage in research early in their studies, we hope to make our profession more inclusive and diverse, opening doors to students who might otherwise be excluded from the experience (e.g., Hilsenroth et al. 2021).

In this paper, we document such a mentored undergraduate research experience. We called our approach a Research Internship in Data Analysis and Applied Economics (henceforth “the internship”). This case study describes the design, execution, and lessons learned from a semester-long internship run by a faculty-directed research lab during the Fall 2022 semester. This novel introduction to applied economic research connected University of Arizona undergraduates (“the interns”), an Agricultural and Resource Economics (AREC) Master of Science (MS) student instructor (“the graduate student instructor”), and supervising AREC faculty (“faculty mentors”). The internship combined elements of the

four undergraduate research categories above to address the three challenges of interest, timing, and access.

This paper contributes a novel approach to developing a paid, on-campus internship experience to the agricultural and applied economics teaching literature. In this case study, we reflect on our experience to provide teaching resources, document the roll-out of this new undergraduate research program, demonstrate a targeted approach to delivering meaningful research experiences to underrepresented undergraduates, and evaluate the incentive structures instituted to invite and engage the participating parties. We candidly discuss the benefits, costs, hurdles, constraints, and successes in designing and implementing undergraduate research opportunities targeted to those from groups traditionally underrepresented in economics and/or STEM.

2 Institutional Background

2.1 The Lab

The lab in which the internship took place brings together researchers, thinkers, and learners, to foster a community of study on economic topics in applied international development. The lab is founded on the principles of Open Science and is committed to the practice of replicability, reproducibility, and transparency in all its research.

The lab is a vertically integrated project (VIP) at the university. VIPs are educational approaches that engage students in long-term, large-scale projects, led by faculty, but guided by other students. As such, an important principle of the internship is the VIP's peer-to-peer learning structure, implemented through trial-and-error and self-determination. The internship was structured to follow this tiered learning environment: students rely on one another to build learning. In the internship, they were guided by both graduate student and faculty mentors.

2.2 Hiring

By design, several elements of the internship sought to attract diverse students in terms of race, gender, year in school, and major. First, we wrote the job posting to highlight that the skills learned by conducting research are in demand by firms outside the research community. Second, we did not require any experience in economics or coding. This allowed us to attract students who had not yet taken upper-division courses in econometrics or data analysis. It also allowed us to build interdisciplinary teams with complementary strengths. Third, by paying interns we were able to involve students frequently excluded from unpaid research opportunities due to financial constraints. In the end, students gained experience in data-based research: a valuable skill for those looking to work as a data analyst, economist, or policy researcher after graduation. With these parameters, the objective was to hire six individuals to be divided into two teams of three interns. We envisioned a composition with each team including one experienced coder, one economist, and one "critical thinker." This final person could be from any major, with no coding experience necessary, but should demonstrate critical thinking skills and an interest in learning quickly and broadly.

In hiring, an advertisement was posted on the university's student job site (Handshake) on August 10, 2022. It expired thirteen days later, on August 23, 2022. Interested applicants were asked to provide a statement of interest of less than one page, as well as a resume. In the approximately two weeks in which the ad was posted, we received 130 applications: two from freshman, 11 from sophomores, 27 from juniors, and 90 from seniors. Students from six colleges and more than forty majors applied. Of some note is that we did not capture as many underclassmen as we had hoped. However, no applicants had previous research experience, and very few had experience analyzing data. Based on a review of all applicants, 13 interviews were conducted. Of these thirteen candidates, nine were seniors, three were juniors, and one was a sophomore. Interviews were all the same in format:

fifteen minutes each on Zoom. All students were asked the same set of questions: (1) With the opportunity cost of your time, what appeals to you about this internship over other internships or jobs? And, (2) What is your coding experience, if any? Give us an example of a project you've done.

2.3 Payment and Credit

Students were paid $3,000 during the semester. Due to the nature of the funding, we could not pay students hourly. Instead, they were paid in three lump sum stipends of $1,000 at the end of September, October, and November. Based on university policy, funds were paid directly to their bursar accounts.

Interns were also eligible to enroll for up to three-credits of internship credit, allowing students to use the experience for both financial and academic gains if they chose. Ultimately, three students enrolled in the internship program for credit.

3 Internship Structure

Once hired, undergraduate interns reported to twice-weekly meetings: one lecture with practicum conducted by the graduate student mentor under faculty supervision and one peer-only small-team research meeting. In keeping with the VIP structure, these different meetings facilitated peer engagement among students of various levels of exposure and expertise to research concepts and skills. Specifically, the more advanced graduate students met with the more green undergraduates to provide assistance and guidance based on experience. Then, undergraduate-only, unsupervised small group meetings built on self-determination, problem solving, and persistence skills.

The biweekly meeting structure also allowed us to leverage the approaches of research methods courses and mentored undergraduate research simultaneously. The lecture and practicum curriculum provided an overview of reproducible research, best coding practices, and causal inference following Nick Huntington-Klein's *The Effect* (Huntington-Klein 2022) and included readings and individual problem sets. The goal was to provide interns with an understanding of how applied economics research is conducted. In contrast, the goal of the small-team meetings was to provide structure for interns to engage in applied economic research. This involved each team developing their own research question, analyzing survey data from the World Bank, and translating their findings into a research poster. Throughout the internship, students gained experience in writing their own code for analysis (in either Stata or R) and gained experience in communication.

3.1 Participants

We hired eight students instead of the intended six. Due to personal circumstances, seven of the original eight students completed the internship. Of the hired students, seven were seniors and one was a sophomore. Students came from backgrounds in economics, business, applied economics, information science, environmental science, environmental studies and ecology and evolutionary biology. Five of the eight interns identify as women, and six of the eight identify as a recognized racial/ethnic minority and/or were a non-U.S. citizen/permanent resident.

A small team consisting of one graduate student instructor and three faculty members mentored the eight hired undergraduate interns. The faculty provided various perspectives, research skills, and areas of teaching specialty and included one tenured associate professor, one untenured assistant professor, and one professional-track professor of practice. The graduate student instructor brought data management skills to the internship but had no prior experience instructing a semester-long course.

3.2 Administration

The financial, digital, and physical structure of the internship was based on and expanded from the existing infrastructure of the lab. The faculty mentors and graduate student instructor agreed on a general structure for the internship curriculum before it began, planning out a weekly schedule with

Table 1: Semester Map.

Week Starting	Lectures	Practicum	Group Meeting Topics	Deliverables	Independent Activities	Readings[a]
5-Sep	What is a research-based internship? Introduction to applied economics research, setting internship expectations, sharing learning objectives.	What is Stata? What is a .do-file? What does it mean to code?	No small-group meeting first week. Research teams not yet formed.	Reflection, timesheet, and .do-file.	Write a Stata .do-file to load data from online repository.	Ch. 1
12-Sep	Introduction to research design, generating research questions, and developing hypotheses.	Introduction to COVID-19 data set and structure of data.	Creation of groups based on overlapping interests and complementary skills.	Reflection, timesheet, and list of five research topics.	Generate a list of research questions, topics, etc., that pique your interest ahead of group meeting.	Ch. 2
19-Sep	Describing variables quantitatively and qualitatively.	Introduction to GitHub and research transparency.	Choose research topic as a group. Set a working directory in Stata code.	Reflection, timesheet, setup GitHub site with pulls and pushes, and .stpr Stata project manager file.	Pull a branch in GitHub. Push a commit in GitHub. Create a Stata project manager workspace to organize files. Calculate the mean of a variable.	Ch. 3
26-Sep	Describing relationships between variables.	Generating new variables and creating graphs in Stata.	Establish small group meeting times, spell out small group objectives, etc.	Reflection, timesheet, and two Stata visualizations of COVID-19 data variables of interest.	Generate new variables using COVID-19 data. Identify related variables and choose a graph to visualize this relationship.	Ch. 4
3-Oct	Introduction to causal identification.	Means over sub-groups. Tests for differences in mean.	Examine differences in variables of interest	Reflection, timesheet, 10 hypotheses, # of t-tests with descriptions, and .do-file.	Do work assigned by group	Ch. 5
10-Oct	Causal diagrams and basic linear regression.	Running and interpreting a regression	Regress outcome on variables of interest.	Reflection, timesheet, regression output, and causal diagram with explanation.	Do work assigned by group	Chs. 6 & 13
17-Oct	Drawing causal diagrams to model cause and effect relationships between variables.	Including covariates in linear regression.	Examine how regression results change with addition of covariates.	Reflection, timesheet, and written critique of peer causal diagrams from previous week.	Do work assigned by group	Ch. 7

Table 1 continued.

Week Starting	Lectures	Practicum	Group Meeting Topics	Deliverables	Independent Activities	Readings[a]
24-Oct	Causal paths and closing back doors to bolster model identification.	Estimating fixed effect (FE) regression models.	Run FE regressions.	Reflection, timesheet, and updated causal diagram of research question related to COVID-19 data.	Do work assigned by group	Chs. 8 & 16
31-Oct	Finding front doors to bolster model identification.	Estimating an event study model.	Run event study regressions.	Reflection, timesheet, short essay explaining your research question as regression equation with explanation of variables.	Do work assigned by group	Chs. 9 & 17
7-Nov	Treatment effects models.	Estimating a Difference-In-Differences (DID) model.	Run DID regressions.	Reflection, timesheet, and .do-file translating previous week's regression into code.	Do work assigned by group	Chs. 10 & 18
14-Nov	Sharing research group status update on research question modeling.	Office hours for coding and debugging	Settle on estimation approach for team poster.	Reflection, timesheet, and updated .do-file with revised regression strategy.	Do work assigned by group	
21-Nov	Question and answer session to address coding and modeling challenges.	Office hours for coding and debugging	Create tables and figures of results for team poster.	Reflection and timesheet.	Do work assigned by group	
28-Nov	Final updates and questions to prepare final submission of posters.	Office hours for coding and debugging	Produce team poster.	Reflection and timesheet.	Do work assigned by group	
5-Dec	Submission of final posters.	Office hours for coding and debugging		Reflection timesheet and final poster.	Do work assigned by group	

[a]Huntington-Klein, N. 2022. The Effect: An Introduction to Research Design and Causality. New York: Chapman & Hall.

topics and deliverables (see Table 1). They also built out the GitHub repository students would use to post their code and created a shared Google Drive to share materials and host internal content. Following the team communication style of the Lab, a Slack channel was launched to allow speedy communications

and addressing of questions among all participants.

The faculty mentors and lab graduate students downloaded and organized the data set, which would be used by the interns for their research project. By providing a data set, we hoped interns would be able to focus on their research question and project, rather than on cleaning data. The data set included data from five countries in Sub-Saharan Africa: Burkina Faso, Ethiopia, Malawi, Nigeria, and Uganda, collected monthly from May 2020 through June 2021. The data were collected as part of the World Bank's High-Frequency Phone Surveys on COVID-19. The data addressed many topics, including COVID-19 behaviors, as well as agriculture, health, food security, income, and more. More detail on the data is available in Josephson, Kilic, and Michler (2021).

The graduate student instructor managed the course content delivered to students and designed the deliverables due at the end of each week. Each week, the graduate student instructor and at least one faculty mentor met to check in and plan lessons. This structure allowed the graduate student instructor to receive feedback about lecture and practicum design and delivery before each full group meeting. Under the guidance of the faculty mentors, the graduate student instructor was able to receive credit for instruction of a course, a bonus from the structure of this research internship experience design.

The faculty mentors handled many of the course-credit, attendance, and housekeeping tasks as the instructor-of-record for credit-seeking interns. They opened each full group meeting, addressed behavioral concerns, and tackled difficult conversations about attendance and attention. By addressing many of the tasks outside of course content, the faculty mentors provided space for the graduate student instructor to focus on course material and delivery. The presence of faculty members also lent credibility and conveyed a seriousness about the internship's topics. This approach provided documented credit hours to faculty mentors to demonstrate a commitment to student engagement beyond normal course loads for annual review and promotion purposes.

3.3 Learning Objectives and Topics

The internship blended together data management and data cleaning skills developed in the Applied International Development Economics (AIDE) Lab, with causal inference methods introduced in Huntington-Klein (2022) and real-world data from the World Bank's High-Frequency Phone Surveys on COVID-19. Each topic was chosen in collaboration between the faculty advisors and graduate student mentor. Then, lectures led by the graduate student mentor introduced the topics, which leveraged the experience and expertise the MS student gained from previous AIDE-lab projects and served as a connecting tier between the undergraduate interns and faculty members. Specific details and the interconnections between lectures, readings, practicums, and deliverables are presented in Table 1.

The topics followed the following general structure:

1. Learn to use GitHub, file paths, and statistical software.
2. Decide on a general research topic and specific research question, forming a testable hypothesis.
3. Summarize and create visualizations of variables, based on their research question.
4. Identify target variables and refine research questions, based on learning and data curation, as well as the summary and visualization of variables.
5. Learn about and create causal diagrams using directed acyclic graphs (DAGs) and consider their application to specific hypotheses.
6. Infer appropriate regression models from the DAGs for testable hypotheses.
7. Defend research questions and create posters, presenting to the other groups, as well as the graduate student and faculty mentors.
8. Revise and finalize posters for submission as final semester projects and capstone internship products.

To access the learning objectives each week, students were assigned a set of deliverables that corresponded with the previous week's topic. This allowed the students time to work independently, with their peers, and with the graduate student mentor in office hours before submitting work for critique. Deliverables included code files, output logs, visualizations, and short writing assignments, depending on the week. Along with the week's deliverable(s), students provided a time log and a reflection journal. These reflections allowed the faculty adviser to identify issues in understanding, hold individual interns accountable for research team contributions, and open lines of communication directly between the undergraduates and faculty.

The interns had various levels of experience with data management and econometric modeling when they started the internship. To align the knowledge across all interns, while promoting information sharing, the course design was structured to deliver a uniform introduction, including examples, for all students. The interns simultaneously learned about best practices for coding and data analysis while applying them to data collected by the World Bank. As many students were not familiar with coding generally or coding in statistical software, students were first introduced to setting up file paths, loading in data, and interpreting variables through summary statistics and data visualizations. After the first month of the internship, interns had created their own GitHub sites, downloaded and started coding in Stata, and begun producing summary statistics and data visualizations using the World Bank data.

After building these foundational skills, students were given the opportunity to explore the data. After gaining familiarity with the data and considering various research topics, students were next asked to constrain their possible set of research questions based on the data. The graduate student and faculty mentors gave feedback about the suitability and feasibility of the research questions. Within their small groups, students pitched their ideas, and each group voted to adopt a topic and research question. However, the very real, frustrating challenges of conducting applied economic research were also part of the process.

For example, one group of interns (Team 2) united around testing the food insecurity on crop mix during COVID-19 for all five sub-Saharan countries in the World Bank data. However, when they ran crop mix summary statistics by country, they realized there was significant missing data with regards to crop mix (Figure 2). This replicated the challenges of professional research in the internship setting because the students realized that they were limited by the quality and nuances of the data. Under the guidance of the graduate student guidance (who intimately knew the limitations of the data), the students decided to focus on Uganda, the country with the highest-quality, available data.

After the students had coalesced around a research question, they moved on to drawing and refining DAGs and determining the specifics of their research design, in a process modeled on a pre-analysis plan (PAP). This matched with the material drawn from Huntington-Klein (2022) about causal inference and DAGs, blending theory and real data, and illustrating the challenges of doing so.

The DAG portion of the internship pushed the students to blend modeling decisions with the constraints of the World Bank data. First, each student independently drew their own DAG to represent their research question. Then, the next week, group members critiqued one another's DAGs and then developed a single, best DAG to carry forward as a team. Given the limited number of covariates and an abundance of confounders, Team 1 concluded that they would pursue a difference-in-differences identification strategy because they could not adequately control for time-varying confounders using the other covered empirical strategies with the data (Figure 1). During this stage, the students in both groups discerned the pros and cons of different models and developed arguments to defend their chosen approaches while acknowledging limitations.

THE UNIVERSITY OF ARIZONA College of Agriculture & Life Sciences

Insight into How Access to Staple Affect Food Security in Pre and Post COVID-19

Introduction

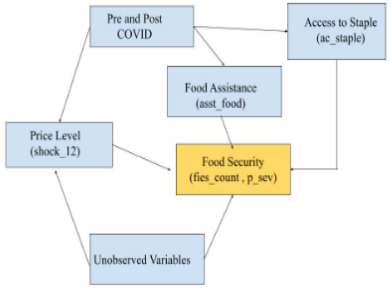
- The COVID-19 pandemic had inescapable impacts on the livelihoods of citizens in developing countries.
- LSMS surveys collected by the world bank across 5 Sub-Saharan Africa in 2019 provide a benchmark for living standards. After the start of the pandemic high frequent phone surveys were implemented following participating households through the pandemic.
- The combined LSMS and high-frequency phone surveys provide a useful panel to compare living standards before and after the pandemic.
- A measure of particular importance is of measures of food security, knowing whether there was a significant change in said standard helps better inform a better understanding of poverty

Model

A difference-in-differences model compares differences in a household's access to a staple crop and food security before and after the pandemic's start. Controlling for non-monetary food assistance and shock in the price level of staple crops.

$$y_{it} = \beta \boldsymbol{x_i} + \partial POST_t + \delta(x_i * POST_t) + z_{it} + v_{it} + \epsilon_{it}$$

- y_{it} Food security outcomes of households over time
- $\boldsymbol{x_i}$ Binary independent variable; measures whether an individual was Unable to access staple crop
- $POST_t$ Binary indicator for determining values either being before or after the start of COVID-19
- z_{it} Binary control asking whether a household has been affected by an increase in the price of a major food item consumed
- v_{it} Binary control asking whether a household had received food assistance



Research Question

Research Question: How did a household's access to a staple crop affect their food security change before and after the start of the pandemic?

Results

At the country level, access to staples significantly worsened food security outcomes before and after the pandemic's start.

The difference in access outcomes after the start was nearly the same, indicating that lower access to staples contributed to lower food security.

Controlling for food assistance and change in the price level, those who lacked access after the start of the pandemic experienced greater food insecurity.

Wanting to deepen our understanding of access related to food security, we expanded the access variable to include more than just one staple crop. The only countries with appropriate data were Ethiopia and Burkina Faso.

Similar model was used with the exclusion price level due to a lack of data.

A new access variable was created by adding the values of three major crop variables households were asked to create a new access score variable

All Countries

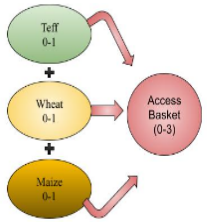
VARIABLES	(1) fies_count
1.post	-2.291***
	(0.133)
1.ac_staple	-2.124***
	(0.146)
0b.post#0b.ac_staple	0
	(0)
0b.post#1o.ac_staple	0
	(0)
1o.post#0b.ac_staple	0
	(0)
1.post#1.ac_staple	-2.095***
	(0.212)
1.shock_12	-5.461***
	(0.115)
1.asst_food	-0.791***
	(0.179)
Constant	11.63***
	(0.0881)
Observations	5,631
R-squared	0.554

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

VARIABLES	(1) fies_count
1.post	1.296
	(1.702)
ac_eth	-0.103
	(0.702)
0b.post#co.ac_eth	0
	(0)
1.post#c.ac_eth	0.532
	(0.738)
1.asst_food	-1.944
	(1.537)
Constant	0.570
	(1.674)
Observations	2,526
Number of hhid	1,223
R-squared	0.012

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Access Refinement



VARIABLES	(1) fies_count
1o.post	-
ac_bf	-1.286***
	(0.392)
1o.post#co.ac_bf	0
	(0)
1o.asst_food	-
Constant	13.70***
	(0.358)
Observations	116
Number of hhid	92
R-squared	0.318

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Discussion and Questions for Future Research

- Results for Ethiopia and Burkina Faso indicate no relationship between access to staples and food security.
- At the regional level ability to access a staple crop significantly increased food security
- Lack of coefficients for the secondary regressions could be due to a lack of data for said countries.
- Further research at the country level could be done to better understand differences across the region.

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References

Huntington-Klein, N. (2022). *The effect: An introduction to research design and causality*. CRC Press.

Rudin-Rush, L., Michler, J. D., Josephson, A., & Bloem, J. R. (2022). Food insecurity during the first year of the COVID-19 pandemic in four African countries. *Food Policy*, *111*, 102306. https://doi.org/10.1016/j.foodpol.2022.102306

Figure 1: Final Poster, Created by Intern Group 1.

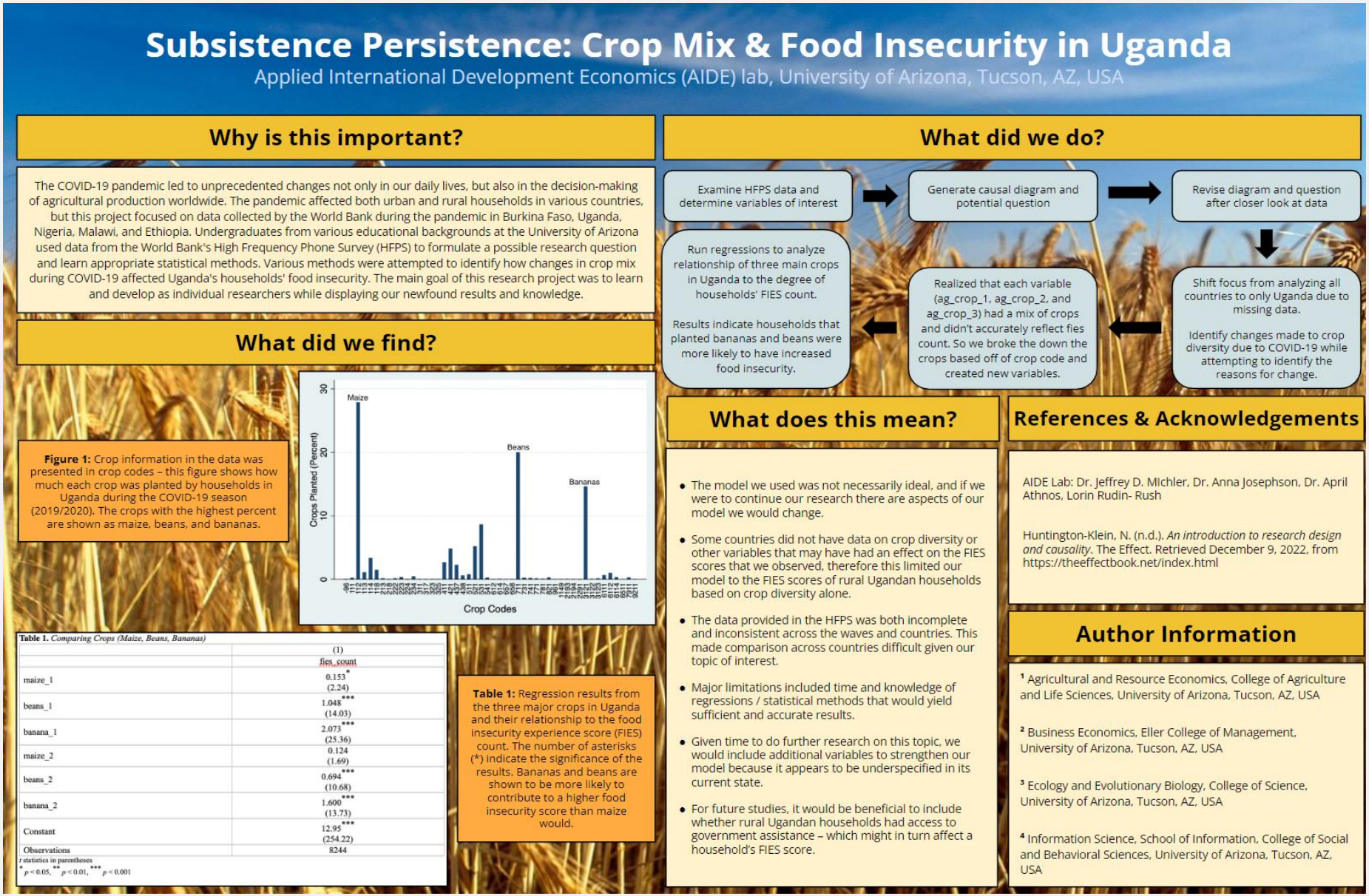

Figure 2: Final Poster, Created by Intern Group 2.

The bulk of the semester included time and space for student groups to work on coding their research design, generating and analyzing regression results, and exploring various methods for displaying and presenting their findings. Both student groups decided to present their results as posters. And so, this culminated in a research poster presentation, done by each group, on the last day of the internship experience. These posters now hang in the AREC department hallway. They are presented in Figure 1 and Figure 2.

3.4 Collaborative Worktimes

The learning objectives and topics were tackled during the mandatory Friday morning meetings that brought together all participants in the internship. This meeting time provided time and space for interaction between all three tiers of the VIP structure: the interns, the graduate student, and faculty mentors. The full group meetings consisted of one hour of lecture in theory, methodology, and best practices followed by one hour of hands-on coding practice, as described above. These meetings were approximately two hours in length.

At the onset of the internship, the interns possessed very different levels of experience with data management and econometric modeling. Every intern received a uniform introduction to the research topics and skills during Friday all-hands meetings, which they acquired and applied at different speeds and levels of confidence. These differences were useful and conducive to learning in a VIP because more experienced and adept students produced positive spillovers to their less experienced peers, and vice versa. During collaborative work times, those with experience were encouraged to share their insights with less-familiar students, reflect on their understanding, and update their approaches. Students encountering the topics and practicing skills for the first time asked questions that tested their graduate student mentor and undergraduate peers, deepening their comprehension. For particularly challenging questions, the faculty members provided a backstop of support for the graduate student.

Beyond Friday meetings, students were also expected to spend about four additional hours a week on internship-related activities to meet the minimum requirements of the stipend. Based on submitted time sheets, students typically spent about six hours each week, with some students spending more time on particularly challenging topics, but students did not systemically report working more than the expectation.

Additional internship worktimes included individual work and peer-only research team meetings. Individually, students received one to two chapters of reading from Huntington-Klein (2022), completed their own set of deliverables, and reflected on their experiences throughout the week and as shown in Figure 1. Collaboratively, students attended peer-only research team meetings to help them accomplish the tasks they were independently responsible for. These small-group meetings allowed interns to discuss their assigned readings, troubleshoot code, and develop their deliverables. During these small-group meetings, students sat with one another, typing and running their own code, throwing similar errors, and experiencing related issues. They grappled with their common challenges, helped one another revise lines of code, and built shared knowledge. The combination of solo and small-group work mimicked the structure of professional research activities that combine delegated tasks with collective decision-making and problem solving.

The weekly research team meetings were scheduled at different times depending on each group member's availability, but they typically took place on Tuesdays or Wednesdays. Additionally, the graduate student mentor offered office hours Wednesdays and Thursdays to support individuals and small groups ahead of Friday's full group meeting and facilitate access to the middle tier of the VIP. The faculty members met with the graduate student weekly and provided on-call additional support as needed.

4 Lessons Learned

As we discussed in the introduction, there are numerous challenges to building undergraduate research internships in which interns engage in research deeply enough to gain an authentic experience of what applied economic research looks like. We designed the Research Internship in Data Analysis and Applied Economics to try and address three specific challenges: student interest, timing, and access. In this section, we candidly assess the success of our attempt to address these challenges, as well as weighing the costs and benefits of our approach. Our aim is to consider how we could, would, and will change the internship moving forward in future semesters as well as provide a roadmap, including bumps and detours, for those looking to engage undergraduates in research.

4.1 Addressing the Three Key Challenges

First, the wording of our job posting generated significant interest. Applicants expressed an interest in learning how to code, analyze data, and formulate research questions so as to contribute to their future employment in industry. While this may have been cheap talk on behalf of students interested in only the stipend, many applicants lacked the skills we sought to foster. Of the interns we hired, only two of the eight mentioned pursuing graduate studies in their personal statement as part of the application. In contrast, at the time of this writing, five interns either enrolled in a graduate program or shared intentions of applying to graduate school. We are unsure if this shift in career interests by the interns should be seen as a success or failure. We would like to think that by offering opportunities to engage in research convinced the interns of the value of a career in research. But it is also possible that the experience convinced students that their undergraduate training was inadequate to make them competitive on the job market without additional schooling.

Second, we did a poor job of attracting students early in their academic career. Among applicants, 90 of the 130 students were seniors. Only two first-years and 11 sophomores applied. Seven of the eight interns we hired were seniors, and we had only one lower-division student. Some of the skewed distribution of class year is structural—lower-division students lack the institutional knowledge of where to find internships on campus, may not realize they could be competitive for the position, and may not understand the value of the opportunity. However, we also believe that by marketing to students in large general education, freshman- and sophomore-level courses during the first week of classes, as well as reaching out to student advisers, a larger, deeper, more diverse applicant pool can be cultivated.

Third, the ability to pay interns largely resolved the issue of access. While we do not have demographic data on the applicant pool, interns are diverse in terms of race/ethnicity as well as gender. From informal discussions with the interns, several interns stated that the only reason they applied and were able to accept the position is that we paid what was effectively more than double the minimum wage. That said, the limited number of hours (six a week) did have a detrimental effect. The family of one student experienced an unexpected loss in income, forcing the intern to quit after one month and take a different job that offered a lower hourly rate but more hours, so that the student could earn more money overall. And again, many applicants and interns who come from populations underrepresented in economic and/or STEM research would be unable to participate in the internship experience if they did not receive financial compensation for their work.

4.2 Unexpected Issues and Recommendations

Beyond the lessons learned in designing an internship experience to address the above challenges, we learned several practical and unexpected lessons. Some of these lessons overlap with methods courses and CUREs, while others resemble the challenges of external internship experiences. While some are idiosyncratic (i.e., unique to our institutional environment), we provide a brief overview of the issues we faced, so as to provide a roadmap of potential bumps and detours for those looking to create similar programs.

First, administrative tasks comprised an unexpectedly large portion of the day-to-day operations of the internships. While some administrative logistics were expected, there were more persistent elements than initially anticipated. Administrative tasks included approving work plans for credit-seeking students, setting clear expectations for attendance and engagement, ensuring timely delivery of intern payments, building the online infrastructure to house data and code, delivering timely communication, preparing lectures and practicum, attending group meetings, reviewing weekly timesheets and reflections, preparing the shared workspace for full group meetings, and establishing distance video communication to accommodate traveling interns. These tasks were divided among the faculty mentors and graduate student instructor based on availability, seniority, and experience. Many of these issues may be one-time "fixed costs" of setting up the internship experience, and so the average cost of running the internships may diminish over time. Additionally, large departments with more in-house administrators than our department may be able to off-load some of these administrative costs, leaving the faculty more time to dedicate to the content of the research internships. Regardless, we underestimated the time required to satisfy administrative tasks and the impact this has on time allocation to other components of the internship, as well as morale of the mentors. We recommend that mentors undertaking such a program prepare themselves for the time of these administrative tasks and ask for help from others, as needed and appropriate.

Second, we believe meeting times and internship attendance expectations should be set *before* hiring interns. We found many of the students who applied for the internship were incredibly busy: overloaded on course credits, working part-time jobs, traveling, and more. Some of this is to be anticipated as students have competing interests on their time. However, syncing and determining a mutually agreeable time for meetings meant the only time that worked for everyone was 8:00 a.m. on Friday mornings. This was a time which, frankly, no one enjoyed. We recommend setting a required attendance period before hiring.

Third, we were surprised that it was necessary to set very formal expectations around attendance. We expected students to treat the internship like a "real job" as one might with any other internship. However, due to the more course-adjacent properties of some meetings, students occasionally were inclined to treat attendance as optional (as they might with a class). We developed a formal attendance policy after the first month with students having to complete timesheets and turn in a short reflection on what they did that week. Because the attendance policy was developed partway through the internship, it was a challenge changing the culture and establishing mutual buy-in with some students. We recommend that any and all expectations about attendance, missing meetings, and additional requirements be established during the first full group meeting and then equally enforced.

Fourth, as with any job or course, resignations and drop-outs happen. After the first month, an intern had a family crisis that required them to leave the internship. Luckily, we had hired eight interns and created two teams of four. The departure of one intern left a team of three students. The three remaining students expressed that they felt at a disadvantage to the other team, having to complete the same amount of work with one fewer member. From the faculty perspective, we felt fortunate that we had hired eight interns instead of the initially planned six. With only six interns, a drop-out would have left a team with just two members—below what we would consider necessary for teamwork to develop in a research setting. We recommend that teams start large enough to address intern attrition without negative impacts on other team members.

Fifth, mistakes happen even when one has worked to reduce their likelihood and created insurance policies to help insulate against them. One of the first activities we do with the interns is to teach them how to use GitHub to version control and preserve their code. Additionally, we teach them that the raw data is immutable and should never be changed or moved. Finally, data is kept on a cloud storage system synced across multiple machines. Despite this effort, one intern, in trying to get the cloud version of the data onto their local machine somehow "unpacked" the folder structure of the data so that the 3,000 plus

data files were no longer in a nested folder structure but all existed together in the main root directory. While the cloud storage system preserves deleted files and the raw files are available in the World Bank Data Library, there was no simple way to rebuild the folder structure and put all of files back into their folders. Folder structure is not something preserved in the cloud storage system's history or version control. Luckily, we had an older, off-line version of the folder structure and so were able to recreate the data structure, but the process still took a week of work on the MS student's part and delayed the progress of the interns' data work. In the future, we will create a copy of the data and place it into a dedicated folder for use by the interns to help ensure their work does not create issues or conflicts with our ongoing research projects. We recommend having offline backups of all resources used by the interns, even in cases where cloud software is used.

Sixth, a single semester is not sufficient time to cover everything related to the teaching and implementation of data analysis and applied economic research. Like any instructor teaching a course for the first time, we overestimated what could be covered and underestimated the time it would take for interns to master concepts such as DAGs for causal modeling or coding syntax. This is especially true if one is trying to involve lower-division students or students who have not previously engaged in research. Ideally, given the outline of the research experience we initially developed, the internship would last a full academic year. But a full-year internship creates its own logistical challenges, including a larger financial commitment, a larger time commitment, scheduling conflicts across two semesters, and higher rates of attrition. Like with teaching a course, this can only be learned through time and implementation, but we recommend that mentors adjust their expectations and cultivate flexibility with themselves and their interns, with respect to achieved learning outcomes.

5 Conclusion

Research is a core activity at universities, but the largest group of people at a university, undergraduate students, frequently complete their degree without ever engaging in authentic scientific research. In this paper, we highlight three challenges often posed as justification for faculty not engaging undergraduates in the research process: student interest, timing, and access. We also discuss the pros and cons of the types of undergraduate research experiences found at many universities. We then report and reflect on designing and rolling-out a research internship program designed to blend extant research approaches to help overcome these three challenges. We candidly discuss the benefits, costs, hurdles, constraints, and successes of the program's first cohort and how that has informed our preparation for a second cohort of interns. We put this forward as a case study for others interested in curating a similar team- and intern-based research experience with undergraduates at their university.

We believe the internship was successful in terms of getting students interested in conducting research and in providing access to those from groups traditionally underrepresented in economics and/or STEM. We had many students who applied, the majority of whom had no plan for graduate school or a career in research. Compensating the interns at above-market rates allowed students to participate who would typically be excluded because of financial constraints. We address unexpected issues with recommendations based on our experience of in curating meaningful engagement opportunities for undergraduate students, particularly underrepresented students. We hope that by sharing our approach and our reflections that our insights and recommendations facilitate the creation of both new and more effective undergraduate research programs in the future.

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References

Ahmad, A.S., I. Sabat, R. Trump-Steele, and E. King. 2019. "Evidence-Based Strategies for Improving Diversity and Inclusion in Undergraduate Research Labs." Frontiers in Psychology 10.

Awong-Taylor, J., A. D'Costa, G. Giles, T. Leader, D. Pursell, C. Runck, and T. Mundie. 2016. "Undergraduate Research for All: Addressing the Elephant in the Room." Council on Undergraduate Research Quarterly 37(1):11–19.

Casson, N.J., C.J. Whitfield, H.M. Baulch, S. Mills, R.L. North, and J.H. Venkiteswaran. 2018. "A Model for Training Undergraduate Students in Collaborative Science." FACETS 3(1):818–829.

Feyrer, J. 2017. "Undergraduate Research in the Dartmouth Economics Department." The Journal of Economic Education 48(4):306–309.

Hilsenroth, J., A. Josephson, K.A. Grogan, L.M. Walters, Z.T. Plakias, L.H. Palm-Forster, S. Banerjee, and T. Wade. 2021. "Past, Present, and Future: Status of Women and Minority Faculty in Agricultural and Applied Economics." Applied Economics Perspectives and Policy 44(1):71–91.

Hoyt, G.M., and K. McGoldrick. 2017. "Promoting Undergraduate Research in Economics." American Economic Review 107(50):655–659.

Huntington-Klein, N. 2022. The Effect: An Introduction to Research Design and Causality. New York: Chapman & Hall.

Hurtado, S., N.L. Cabrera, M.H. Lin, L. Arellano, and L.L. Espinosa. 2009. "Diversifying Science: Underrepresented Student Experiences in Structured Research Programs." Research in Higher Education 50:189–214.

Josephson, A., T. Kilic, and J.D. Michler. 2021. "Socioeconomic Impacts of COVID-19 in Low-Income Countries." Nature Human Behaviour 5:557–565.

König, J. 2022. "Postdoctoral Employment and Future Non-Academic Career Prospects." PLoS One 17(12): e0278091.

Linn, M.C., E. Palmer, A. Baranger, E. Gerard, and E. Stone. 2015. "Undergraduate Research Experiences: Impacts and Opportunities." Science 347(6222):1261757.

Petrella, J.K., and A.P. Jung. 2008. "Undergraduate Research: Importance, Benefits, and Challenges." International Journal of Exercise Science 1(3):91–95.

Thiry, H., T.J. Weston, S.L. Laursen, and A.-B. Hunter. 2017. "The Benefits of Multi-Year Research Experiences: Differences in Novice and Experienced Students' Reported Gains from Undergraduate Research." CBE – Life Sciences Education 11(3):260–272.

Wagner, J. 2015. "A Framework for Undergraduate Research in Economics." Journal of the Southern Economic Association 82 (2):668–672.

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