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Mental Health of PhD Students in US Agricultural Economics Departments

Xi Zhang, Di Fang, and Rodolfo M. Nayga, Jr.

In this study, we investigate the mental well-being of agricultural economics PhD students at 33 universities in the United States. Analysis of our survey data reveals that about 40% of respondents reported experiencing symptoms indicative of depression, anxiety, or suicidal ideation. Although most participants recognized the meaningfulness of their work, achieving a satisfactory work–life balance emerged as a prominent concern. Notably, stress levels were consistent across departments irrespective of their rankings. Furthermore, our examination uncovers some racial disparities: Hispanic and White students exhibited a higher prevalence of mental health issues but were more inclined to seek treatment, while Asian and Black students reported lower prevalence but faced challenges accessing support services.

Key words: higher education, inequality, mental health

Introduction

The pursuit of a PhD is a rewarding yet challenging journey, often accompanied by numerous stressors. In 2017, Bolotnyy, Basilico, and Barreira (2022) conducted a seminal study on mental health among PhD students in the top eight US economics departments. Their findings revealed a substantial prevalence of mental health issues among these students. Given that stressors can vary widely across academic disciplines (Lipson et al., 2016), our study focuses on agricultural economics—a field that shares similarities with general economics but differs in many key aspects. These include a more applied research focus, a student body with a majority of Asian students, and distinct adviser–student dynamics, as most students are funded by a specific adviser rather than through departmental sponsorships. We examine PhD students from all 33 PhD-granting agricultural economics departments in the United States, providing a comprehensive view of their mental health. This approach not only explores the impact of academic ranking on well-being but also offers a unique, post-COVID analysis of mental health in agricultural economics, representing the first comprehensive study of its kind in this field.

We conducted an online survey from September to November 2023, targeting all current PhD students at the 33 PhD-granting universities in the United States. Excitingly, we received responses

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We express our gratitude to Lisa House for her generous assistance and support in promoting our study. We also extend our thanks to the department chairs and graduate student coordinators from the surveyed universities for their valuable support throughout the survey process. We greatly appreciate Valentin Bolotnyy for his suggestions. This study was funded by the Department of Food and Resource Economics in the College of Agricultural and Natural Resources at the University of Florida. All authors declare no conflicts of interest. Our study was approved by the University of Florida under IRB202300858.

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Review coordinated by Liang Lu.

from every targeted university (see Table 1 for participating universities). Overall, we received 452 effective responses and achieved a response rate of 44.1%. The survey started with clinically validated questionnaires for mental health assessment and then asked specific questions about students' self-perceptions, PhD experiences, and demographic characteristics.¹

Our findings show that 29.9% of respondents reported experiencing symptoms of depression, 27.9% reported experiencing anxiety, and 14.4% reported experiencing suicidal ideation. Overall, 39.4% of participants reported symptoms of at least one of these three mental health conditions, and 8.8% experienced all three. Additionally, 14.8% of respondents had been diagnosed with a mental illness before starting their PhD programs, while an additional 13.3% were diagnosed during their studies. Moreover, 72% of the respondents who reported experiencing depression or anxiety did not receive any treatment and 14% had no clear idea about how to seek help.

We explored the factors associated with student mental well-being. The most significant factor mitigating the mental challenges faced by our students is academic performance, particularly perceived success in research. A 1-unit increase in perceived research success is associated with a 13-percentage-point decrease in the probability of experiencing depression. Close behind, another key mitigator is the perceived meaningfulness of work, with a 1-unit increase linked to an 11-percentage-point decrease in the probability of experiencing depression. Specifically, 70.6% of our respondents reported that their work provides some source of meaning most of the time or always—slightly lower than the general population but notably higher than the percentage reported among PhD students in top economics departments (Bolotnyy, Basilico, and Barreira, 2022). On the less favorable side, our surveyed students reported poor work–life balance: 61% of respondents reported working 6–7 days a week, 76% worried about work when not working, and 43% stated that work had prevented time with family or significant others. A 1-unit increase in poor work–life balance is associated with an 11-percentage-point increase in the probability of experiencing depression. Fortunately, financial difficulty, one important aspect of work–life balance, did not emerge as a significant contributor to poor mental health among PhD students. Another concerning factor is heightened feelings of loneliness, which appear to persist across programs regardless of university location. Finally, 80.5% of our respondents were satisfied or extremely satisfied with their adviser, and 87.5% reported experiencing little to no conflict with their main adviser. However, adviser satisfaction declined during key transition periods in PhD studies, specifically in the 2nd year and from the 5th year onward. Additionally, students reported low confidence in meeting their advisers' expectations and placed significant value on their advisers' encouragement, which influenced their perceived success in the program and the meaningfulness of their work.

In our analysis of mental health disparities among student subgroups, we found that stress is not limited to students in top-ranking departments. Students from lower-ranking departments (compared to the top ten) exhibited a similar or even higher prevalence of depression. Specifically, being a student in a department ranked 30 and below is associated with an 18.6-percentage-point increase in the probability of experiencing depression. Additionally, our findings revealed a nuanced racial disparity in mental health. Reporting Hispanic or White race is associated with a 15.5-percentage-point and a 13.5-percentage-point increase, respectively, in the probability of experiencing depression compared to their Asian and Black peers. In contrast, while Asian and Black students exhibited lower prevalence, they were less likely to receive treatment or have access to information about mental health support. The primary factors contributing to poorer mental health among White students are loneliness and work–life imbalance, whereas work–life imbalance is the main contributing factor among Hispanic students.

The prevalence of poor mental health among students in PhD programs is substantial. A global survey of current PhD students conducted by *Nature* in 2019 observed that 36% of respondents had sought help for anxiety or depression caused by their PhD studies (Woolston, 2019). In a global meta-analysis of 32 articles published between 1979 and 2019, Satinsky et al. (2021) revealed a

¹ Survey questions are available upon request.

pooled estimate of 24% for depression and 17% for anxiety among PhD students. After the onset of the COVID-19 pandemic, studies in Europe and India (e.g., Giner et al., 2022; Naumann et al., 2022; Shevlin et al., 2022; Aristeidou and Aristidou, 2023; Friedrich et al., 2023; Rahiman et al., 2023; Macchi et al., 2023) further substantiated the concerning mental health status of PhD students. Using administrative data to complement survey data, Keloharju et al. (2024) investigated PhD students' mental health through prescription records. Although these data indicated a lower prevalence of depression and anxiety among PhD students in Sweden, it supports the general finding that PhD studies casually affect mental health.

Our paper contributes to this ongoing literature by presenting the first evidence from all PhD-granting agricultural economics departments in the United States. Given potential variations in stressors and thus treatment across disciplines (Lipson et al., 2016), it is crucial to focus on assessing and improving student mental health within specific fields. A closely related paper by Bolotnyy, Basilico, and Barreira (2022) focused on the top eight US economics departments and found that 17.7% experienced depression and 17.6% experienced anxiety. Agricultural economic departments share some commonality with general economics, but they have unique characteristics. For instance, the more applied research focus can lead to greater mindfulness of work, enhancing job satisfaction and reducing stress (Hackman and Oldham, 1976). However, the location of many agricultural economics departments and the solitary nature of some agricultural research can lead to feelings of isolation and loneliness, exacerbating mental health issues (Rohde et al., 2016; Hish et al., 2019; Satinsky et al., 2021; Logel, Oreopoulos, and Petronijevic, 2021). Last, instead of departmental sponsorships, the distinctive dynamics between students and advisers in agricultural economics—where many students work closely with specific advisers—can influence both student attrition (Golde, 2005; Seay et al., 2008; Gardner, 2009) and mental health (Barry et al., 2018; Nagy et al., 2019).

Our research also adds to the literature dedicated to mental health disparities by offering evidence of different challenges facing various racial groups. Previous research centered on undergraduate students (Rosenthal and Wilson, 2008; Trammell, Joseph, and Harriger, 2023; Lin et al., 2023; Asher BlackDeer et al., 2023) and PhD students (Bolotnyy, Basilico, and Barreira, 2022; Macchi et al., 2023) has yielded mixed results, some finding no disparities and others noting a higher prevalence among minorities. This emphasizes the importance of conducting within-community analyses to understand mental health disparities. Our study provides new insights from the agricultural economics PhD community, revealing that Hispanic and White students experience higher rates of mental health conditions compared to Asian and Black students. Our results also show that fewer Asian and Black students experiencing depression or anxiety receive diagnoses and treatment. These findings are largely supported by broader trends observed in the general American population (Coleman et al., 2016; Brody, Pratt, and Hughes, 2018; Terlizzi and Villarroel, 2020).

Methodology

Sample Selection

We launched our survey in late September 2023; data collection ended in early November to safeguard our results from the influence of the holiday season (Peretti, 1980; Velamoor, Voruganti, and Nadkarni, 1999; Bergen and Hawton, 2007). We implemented a multifaceted outreach strategy to ensure a representative survey response. We contacted the chairs of the 33 departments that offer PhD programs and partnered with the Graduate Student Organization of the Agricultural & Applied Economics Association to distribute our sign-up form.² The students who expressed interest were then provided a link to the main mental health survey in a follow-up email. To boost the response

² Implementing an initial sign-up step allowed us to establish a screening process. This is important for data security. The detailed sign-up questions are available upon request.

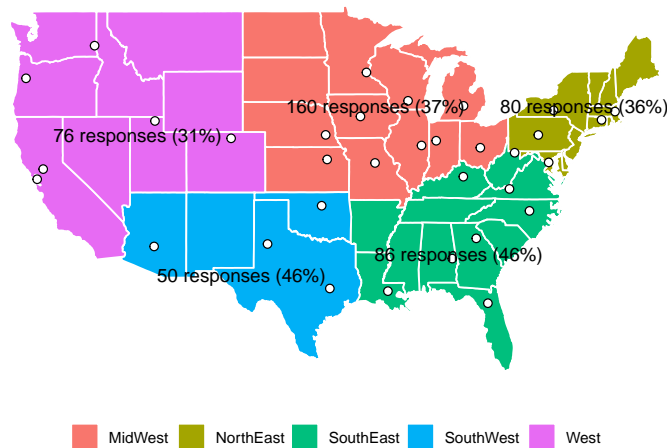


Figure 1. Responses by Geographic Region

Notes: This figure plots the number of responses and response rate by geographic regions, with white dots representing each surveyed university. We summarized the regions of the universities in Table 1: specifically, out of 33 universities we surveyed, 10 are located in the Midwest, 5 in the Northeast, 8 in the Southeast, 4 in the Southwest, and 6 in the West.

rate, we also extended individual invitations using publicly available information from university websites. A \$10 Starbucks card was provided as an incentive for completing the survey.

In total, we gathered 487 responses from the 1,026 PhD students across all 33 programs. After excluding four incomplete responses,³ as well as 31 responses that failed the attention check criterion (6.4%),⁴ we were left with 452 complete responses. This yields an estimated response rate of 44.1%, including responses from all 33 target agricultural economics departments.

In Figure 1, we plot responses by geographic region, and Table 1 summarizes the responses received by universities. The Southeast region had the highest response rate (46.3%), while the West had the lowest (30.6%). Table A1 further summarizes student demographics of the received responses. The majority of participants (89%) fall within the 23–34 age range, with 11% at least 35 years old. Gender distribution is fairly balanced, with slightly more female respondents (52%). Regarding race, 63% identified as Asian, 25% as White, 7% as African American, and 5% as Hispanic. Additionally, 6% reported having a disability, 10% identified as LGBTQ+, and 27% were first-generation college students. Compared to the overall population of agricultural economics PhD students,⁵ our respondents are more likely to be White and less likely to be in the 5th year or beyond in their PhD program. Below, we further discuss adjustments made to the reported prevalence of mental health conditions based on various assumptions about the student population.

Compared to respondents from top economics departments in Bolotnyy, Basilico, and Barreira (2022), our respondents differ in several ways. Our sample is less male (52% vs. 65% in economics) and predominantly Asian (63% compared to 61% White in economics). A higher proportion of our participants reported having a disability (6% vs. 1.6% in economics). Additionally, our respondents are older, more likely to be married, more likely to have children, and more often first-generation college students. Later, we discuss how these sample differences may influence the prevalence of mental health issues relative to their sample.

³ These responses lacked sufficient demographic information and were deemed ineligible for further analysis, though these respondents exhibited even higher reported levels of mental illness relative to completed responses.

⁴ We included an attention check question between self-perception and PhD program experience. Specifically, we gave students explicit instructions to select “strongly agree” for that specific question. 31 responses failed to adhere to our instructions and were thus excluded from further analysis.

⁵ Detailed information about the population of agricultural economics PhD students was obtained either through the department chair or by scraping data from each department’s website.

Table 1. Responses by University

University	Number of Responses	Number of PhD Students	Response Rate (%)	Rurality (RUCC code)	Region
1 Texas A&M University	34	73	46.6	3	SW
2 University of Illinois Urbana-Champaign	26	57	45.6	3	MW
3 University of Florida	26	33	78.8	2	SE
4 University of Maryland	25	45	55.6	1	NE
5 University of California-Davis	24	90	26.7	1	W
6 University of Minnesota	24	70	34.3	1	MW
7 Michigan State University	23	51	45.1	2	MW
8 Ohio State University	21	47	44.7	1	MW
9 University of Massachusetts-Amherst	21	25	84.0	1	NE
10 University of California-Berkeley	20	60	33.3	1	W
11 University of Georgia	20	40	50.0	3	SE
12 Pennsylvania State University	17	55	30.9	3	NE
13 North Carolina State University	15	34	44.1	1	SE
14 Purdue University	14	34	41.2	3	MW
15 Iowa State University	14	65 ^a	21.5	3	MW
16 University of Nebraska-Lincoln	14	23	60.9	2	MW
17 Washington State University	14	44	31.8	4	W
18 University of Wisconsin-Madison	13	47	27.7	2	MW
19 Virginia Tech University	12	29	41.4	3	SE
20 Cornell University	11	74 ^a	14.9	3	NE
21 Oklahoma State University	10	23	43.5	4	SW
22 Oregon State University	9	21	42.9	3	W
23 Colorado State University	7	27	25.9	2	W
24 Kansas State University	6	28	21.4	3	MW
25 University of Connecticut	6	25	24.0	1	NE
26 University of Missouri	5	12	41.7	3	MW
27 West Virginia University	5	10	50.0	3	SE
28 Arizona State University	4	6	66.7	1	SW
29 Auburn University	4	29	13.8	3	SE
30 Louisiana State University	2	7	28.6	2	SE
31 Texas Tech University	2	6	33.3	2	SW
32 University of Kentucky	2	6	33.3	2	SE
33 Utah State University	2	6	33.3	3	W
Total	452	1,026	44.1		

Notes: The table summarizes each university's response rate and the rurality of its location, ranked by the number of responses received in our study. Responses that failed the attention check (31, 6.4%) have been excluded. The number of PhD students in each department was either shared by the department chair or derived from the department's website. ^a indicates that the university has a combined department of economics and agricultural economics. A university's rurality is coded based on the 2013 Rural-Urban Continuum Code (RUCC), with higher codes indicating more rural areas. The university region is indicated in the last column, with abbreviations as follows: "SW" for Southwest, "MW" for Midwest, "SE" for Southeast, "NE" for Northeast, and "W" for West.

Measurement of Mental Health Status

Depression (PHQ-9)

We implemented the widely-recognized nine-item patient health questionnaire (PHQ-9), a clinically validated tool to assess depression (Kroenke, Spitzer, and Williams, 2001). The PHQ-9 consists of nine questions about various aspects of mood, sleep, interest, guilt, energy, concentration, attention, psychomotor slowing, and suicidal ideation. Respondents are asked to indicate the frequency with which they have experienced each symptom, with four options: “not at all” (0 points), “several days” (1 point), “more than half the days” (2 points), and “nearly every day” (3 points). The final score is obtained by summing the responses to all nine questions, with a maximum of 27 points. In clinical practice, a PHQ-9 score exceeding 10 is indicative of depression.⁶

Anxiety (GAD-7)

We used the seven-item generalized anxiety disorder questionnaire (GAD-7) to detect anxiety (Spitzer et al., 2006). The seven questions of the GAD-7 measure the severity of various signs of anxiety, including nervousness, inability to stop worrying, excessive worry, restlessness, difficulty relaxing, easy irritation, and fear of something awful happening. The GAD-7 asks about the frequency of each symptom with options ranging from “not at all” (0 points) to “nearly every day” (3 points), similar to the PHQ-9. In clinical practice, a GAD-7 score exceeding 10, out of a maximum of 21, is indicative of anxiety.⁷

Suicidal Ideation (ninth item of the PHQ-9)

Item 9 of the PHQ-9 asks “Over the past two weeks, how frequently have you experienced distressing thoughts about being better off dead or harming yourself in any way?” Respondents can choose from the following response options: “not at all,” “several days,” “more than half the days,” or “nearly every day.” In clinical practice, any response other than “not at all” indicates the presence of suicidal ideation (Rossom et al., 2017).

Loneliness (ULS-8 and ULS-3)

We employed the eight-item short form of the UCLA Loneliness Scale (ULS-8) to measure loneliness (Hays and DiMatteo, 1987). Items 3 and 6 assess low levels of loneliness, while items 1, 2, 4, 5, 7, and 8 indicate high levels of loneliness. Responses indicating high loneliness correspond to “never” as 1, “rarely” as 2, “sometimes” as 3, and “always” as 4. The scoring scale is reversed for questions indicating low loneliness. Consequently, the ULS-8 loneliness score ranges from 8 to 32. For comparison with Bolotnyy, Basilico, and Barreira (2022), who used a shorter three-item version of the scale, we recalculated our responses in the ULS-3 version. This version comprises questions 1, 4, and 5 from ULS-8, yielding scores ranging between 3 and 12. In both measurements, a higher score indicates higher loneliness.

RAND Meaningfulness of Work

We evaluated the perceived meaningfulness of work using questions from the RAND American Working Condition Survey (Maestas et al., 2015), which comprises six questions that explore the extent to which work allows individuals to fully use their talents, make a positive impact on

⁶ A score of 0–4 is indicative of minimal depression, 5–9 mild depression, 10–14 moderate depression, 15–19 moderately severe depression, and >20 severe depression.

⁷ A score of 0–4 is indicative of minimal anxiety, 5–9 mild anxiety, 10–14 moderate anxiety, and >15 severe anxiety.

society, achieve personal accomplishment, offer aspirational goals, derive satisfaction from a job well done, and a feeling of doing useful work. Each question is rated on a 5-point Likert scale, with “1” indicating that the work never provides these aspects and “5” indicating that the work always provides these aspects. A higher score indicates a higher perceived meaningfulness of work.

RAND Work Issues

We assessed students’ work–life balance using five questions from the same RAND survey. Students were asked how often they worried about work when not working, were too tired for activities in private life and household chores, had difficulty making ends meet financially, and had work prevent time with family or significant others. Each question was rated on a 5-point Likert scale, with “1” indicating that these scenarios never happened and “5” indicating always. A higher score indicates a poorer work–life balance.

Empirical Model

Since our outcome variable is categorical, indicating whether a student has experienced any mental health conditions, we use a multivariate logistic regression model:

$$(1) \quad \ln\left(\frac{p(X)}{1 - p(X)}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p,$$

where X is the whole set of covariates X_1, X_2, \dots, X_p , which may include university fixed effects, individual student characteristics, and factors associated with mental health status. The covariates included will be specified for different analyses. $p(X)$ represents the prevalence of a mental health condition that depends on X . The coefficients of interest, β_1 to β_p , are easier to interpret when transforming the left-hand of equation (1) into an odds ratio:

$$(2) \quad \text{OddsRatio} = \frac{\frac{p(X_1, X_2, \dots, X_i+1, \dots, X_p)}{1 - p(X_1, X_2, \dots, X_i+1, \dots, X_p)}}{\frac{p(X)}{1 - p(X)}} = e^{\beta_i},$$

where i is any number between 1 and p , and e^{β_i} represents the change in the odds ratio of the prevalence of a mental condition associated with a 1-unit change in X_i . We also reported the average marginal effects (AME) to facilitate the interpretation of the magnitude of the coefficients:

$$(3) \quad \text{AME}_i = \frac{\partial p(X)}{\partial X_i} = \frac{\beta_i e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p}}{(1 + e^{-(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p)})^2}.$$

We calculate the AME by plugging in the estimated coefficients, $\hat{\beta}$, and each individual’s characteristics, X , and then averaging across all individuals. The interpretation of the AME with respect to X_i is the change in the probability of experiencing a mental health condition for a 1-unit change in X_i .

Results

Prevalence of Mental Health Issues

Table 2 summarizes our findings with respect to the prevalence of each mental health issue evaluated in our study, providing a clearer comparison with relevant benchmarks from the literature.

Table 2. Prevalence of Mental Health Issues

Mental Health Issue	%
Depression	
Agricultural economics PhD students in our study	29.9
Benchmark 1: PhD students in 14 economics departments in Europe (during COVID)	27.3
Benchmark 2: PhD students in 8 top economics departments in USA (pre-COVID)	17.7
Benchmark 3: meta-analysis from 16 global studies on PhD (pre-COVID)	24.0
Anxiety	
Agricultural economics PhD students in our study	27.9
Benchmark 1: PhD students in 14 economics departments in Europe (during COVID)	25.9
Benchmark 2: PhD students in 8 top economics departments in USA (pre-COVID)	17.6
Benchmark 3: meta-analysis from 16 global studies on PhD (pre-COVID)	17.0
Suicidal ideation	
Agricultural economics PhD students in our study	14.4
Benchmark 1: PhD students in 14 economics departments in Europe (during COVID)	17.3
Benchmark 2: PhD students in 8 top economics departments in USA (pre-COVID)	11.3
Three mental conditions in combination	
Either of the three illnesses, Agricultural economics PhD students in our study	39.4
All of the three illnesses, Agricultural economics PhD students in our study	8.8
Diagnosis of mental conditions before PhD	
Agricultural economics PhD students in our study	14.8
Benchmark 1: PhD students in 14 economics departments in Europe (during COVID)	14.7
Benchmark 2: PhD students in 8 top economics departments in USA (pre-COVID)	13.1
Diagnosis of mental conditions during PhD	
Agricultural economics PhD students in our study	13.3
Benchmark 1: PhD students in 14 economics departments in Europe (during COVID)	9.7
Benchmark 2: PhD students in 8 top economics departments in USA (pre-COVID)	11.9
In treatment	
Agricultural economics PhD students in our study	19.7
Benchmark 1: PhD students in 14 economics departments in Europe (during COVID)	12.4
Benchmark 2: PhD students in 8 top economics departments in USA (pre-COVID)	14.9
Untreated among those experiencing depression or anxiety	
Agricultural economics PhD students in our study	72.0
Benchmark 1: PhD students in 14 economics departments in Europe (during COVID)	80.8
Benchmark 2: PhD students in 8 top economics departments in USA (pre-COVID)	74.8
Unsure how to seek help among those experiencing depression or anxiety	
Agricultural economics PhD students in our study	14.0

Notes: The table summarizes the percentage of agricultural economics PhD students whose scores meet certain critical thresholds, compared to several benchmarks using the same set of measurements. Benchmark 1 is from a working paper by (Macchi et al., 2023) that examines the mental health of PhD students across 14 economics departments in Europe. Benchmark 2 is from Bolotnyy, Basilio, and Barreira (2022), who studied the mental health of PhD students in the top eight US economics departments. Benchmark 3 (Satinsky et al., 2021) is from a meta-analysis based on 16 published papers on a global scale. Depression and anxiety show those scoring 10 or higher on the PHQ-9 and GAD-7, respectively. Suicidal ideation refers to those reporting contemplating suicide or self-harm on at least several days in the last 2 weeks, as captured by item 9 from PHQ-9.

Depression

In our sample, 70.1% of our respondents reported minimal or mild depression, 18.1% moderate depression, 7.7% moderately severe depression, and the remaining 4% severe depression. Overall, 29.9% of survey responses are clinically indicative of depression. Ettman et al. (2020) found that 8.5% of American adults experienced depression between 2017–2018; this number escalated to 27.8% during the COVID-19 pandemic in 2020. A more relevant benchmark by Bolotnyy, Basilico, and Barreira (2022) examined the mental health of PhD students from the top eight US economics departments using the same screening tool. They reported that 17.7% experienced moderate to severe symptoms of depression before the pandemic. Their follow-up study across European universities during the pandemic revealed that 27.3% of surveyed PhD students experienced depression (Macchi et al., 2023). Although our survey was conducted after the official end of the pandemic, the prevalence of depression reported by our agricultural economics PhD students surpasses the results from all previous benchmarks.

Anxiety

The average GAD-7 score in our study is 6.99. Specifically, 72.1% of respondents reported minimal or mild anxiety, 16.6% reported moderate anxiety, and the remaining 11.3% reported severe anxiety. In total, 27.9% of respondents in our study have clinically indications of anxiety. A 2020 CDC report (Terlizzi and Villarroel, 2020) revealed that 7.4% and 6.4% of American adults aged 18–29 and 30–44, respectively, exhibited symptoms of anxiety in 2019. Previous studies on economics PhD students found that before the COVID-19 pandemic, 17.6% of PhD students in the top eight US economics departments reported experiencing anxiety (Bolotnyy, Basilico, and Barreira, 2022); during the pandemic, 25.9% of students in 14 economics departments in the European universities reported anxiety symptoms (Macchi et al., 2023). Once again, the prevalence of anxiety among the participants in our study surpasses these established benchmarks.

Suicidal ideation

Among our survey participants, 14.4% indicated a response other than “not at all” when asked about the frequency of distressing thoughts about being better off dead or harming themselves, suggesting signs of suicidal ideation. This percentage exceeds the 11.3% observed among top economics PhD students in the United States before the COVID-19 pandemic (Bolotnyy, Basilico, and Barreira, 2022) but is lower than the 17.3% reported among European economics PhD students during the pandemic (Macchi et al., 2023).

Depression, Anxiety, and Suicidal Ideation in Combination

Our findings indicate that 39.4% of respondents in our study experienced at least one of the three mental health conditions, and 8.8% experienced all three conditions.⁸

Diagnosis

Apart from the three mental health conditions examined, our survey revealed that 14.8% of respondents had received a mental health diagnosis before enrolling in the PhD program. This is higher than the 13.1% reported in top US economics departments and similar to the 14.7% in

⁸ The three measurements capture different aspects of mental health and show a positive correlation. In our sample, the correlation between depression scores exceeding 10 and anxiety scores exceeding 10 is 0.64, while the correlation between depression scores over 10 and the presence of suicidal ideation is 0.44. Additionally, the correlation between anxiety scores over 10 and suicidal ideation is 0.31.

14 EU economics departments. Post-enrollment, 13.3% reported a new diagnosis, higher than the 11.9% in top US departments and 9.7% in 14 EU departments.⁹ Our findings here—the prevalence confirmed by professionals—reinforce our previous self-reported results on depression and anxiety, showing that the prevalence of mental health conditions among our respondents exceeds that of other benchmarks.

Treatment

Additionally, 19.7% of our respondents were currently undergoing treatment, higher than the 14.9% in top US departments and 12.4% in 14 EU departments. Similarly, among those reporting symptoms of depression or anxiety in our study, 72% were not receiving professional treatment, which is less than 80.8% in top US economics departments and 74.8% in EU economics departments. However, we do observe that 14% of our respondents experiencing depression or anxiety were uncertain about how to access mental health support.

Overall, these findings suggest that agricultural economics PhD students in our sample exhibited a high prevalence of mental health issues but were actively seeking diagnosis and treatment. If students who received professional treatment experienced lower levels of depression, anxiety, or suicidal ideation, the prevalence of mental health conditions among our PhD students could be higher than what we have reported.

Heterogeneity in Prevalence

Department Ranking

To examine differences in the prevalence of mental health issues across departments, we apply the multivariate logistic regression specified in equation (1). Unlike other analyses in our paper, we exclude university fixed effects here to enable comparisons across universities. Instead, we incorporate university characteristics, including academic ranking, faculty size, female faculty size, geographic region, and rurality. Additionally, we control for individual student demographics (including PhD program year, race, disability status, gender, sexuality, marital and child status, living alone or not, and first-generation college student status) to isolate the association between mental health issues and department ranking. To assess the academic ranking of each department, we rely on the IDEAS/RePEc (2023) ranking. Responses are categorized into four groups based on their department's academic ranking: Ranking 1–10 (156 responses), Ranking 11–20 (140 responses), Ranking 21–30 (69 responses), and Ranking 30+ (87 responses).

Contrary to the belief that PhD students from top-ranked academic departments may face elevated stress levels and subsequently poorer mental health, our findings indicate that the prevalence of mental health issues is consistent across departments of varying ranks. In fact, respondents from lower-ranking departments may even show a higher prevalence of these issues. As illustrated in Figure 2a, students from programs ranked 30 and below exhibit a (marginally) significantly higher prevalence of depression, with the odds being 156% greater, translating to an 18.6-percentage-point increase in the probability of experiencing depression.

Student Demographics

We conducted a thorough examination of the correlation between various student demographics and mental health, considering factors such as gender, sexuality, race, disability status, parental status, living arrangements, relationship status, first-generation college status, and year in the PhD program.

⁹ As the EU study was conducted during the COVID-19 pandemic, the lower percentage of diagnoses may be due to limited access to professional help rather than a lower willingness to seek help among PhD students.

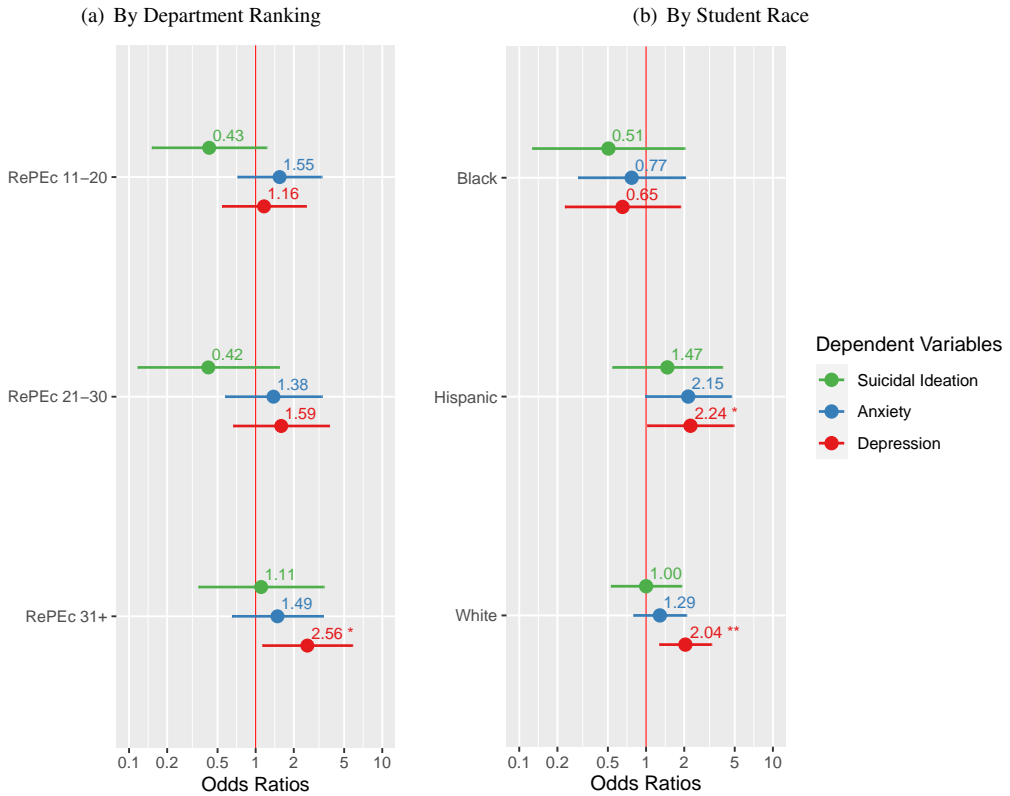


Figure 2. Heterogeneity in the Odds of Mental Health Issues

Notes: This figure illustrates the odds of depression (in red), anxiety (in blue), and suicidal ideation (in green) based on department academic ranking (left panel) and student race (right panel). Dots represent estimated coefficients, horizontal lines indicate the 90% confidence interval. The red vertical line positioned at 1 is the odds of the base reference group, which refers to responses from departments with RePEc rankings 1-10 for the left panel, and responses self-identified as Asians for the right panel. In the left panel, we apply the Logit model from equation (1) and control for individual student demographics and department characteristics (faculty size, female faculty size, geographic location, and rurality of the university). In the right panel, we control for university fixed effects and student demographics (excluding race), including PhD program year, disability status, gender, sexuality, marital and child status, living alone or not, and first-generation college student status. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.

To mitigate potential confounding factors at the university level, we included university fixed effects as covariates in the logistic regression models described in equation (1). Specifically, our findings reveal (marginally significantly) higher levels of suicidal ideation for respondents in their 5th year and beyond and increased anxiety for those with disabilities compared to those without. No notable differences in mental health were observed across gender, sexuality, first-generation college students, or PhD students with children.¹⁰

Race

A noteworthy racial disparity in mental health did emerge. As depicted in Figure 2b, Hispanic and White students experience elevated levels of anxiety, suicidal ideation, and significantly higher rates of depression relative to Asians and Black students. Specifically, Hispanic students have 124% higher odds (or a 15.5-percentage-point increase in probability) of experiencing depression compared to Asian students, while White students have 104% higher odds (a 13.5 percentage-point

¹⁰ Detailed results are available in Table S1 in the online supplement (see www.jareonline.org).

Table 3. Prevalence of Mental Health Issues, Alternative Estimates

	Observed 1	Response-Rate Adjusted 2	Lower Bound 3	Upper Bound 4
Depression	29.6%	29.9%	13.2%	56.1%
Anxiety	27.9%	27.85%	12.3%	56.1%
Suicidal ideation	14.4%	15.4%	6%	56%
Any of the three	39.4%	39.2%	17.3%	56.1%

Notes: The table summarizes how the prevalence of mental health issues changes with alternative weights. Column 1 presents our observations from respondents, as reported in the main analysis. Column 2 reports estimates adjusted based on response rate, assuming that unresponsive students exhibit a similar prevalence as responsive students within the same university. Column 3 details the lower-bound estimates, assuming that all unresponsive students are below the critical threshold, and Column 4 outlines the upper-bound estimates, assuming that all unresponsive students are above the critical threshold. Depression and anxiety show those scoring 10 or higher on the PHQ-9 and GAD-7, respectively. Suicidal ideation refers to those reporting contemplating suicide or self-harm on at least several days in the last 2 weeks, as captured by item 9 from PHQ-9.

increase in probability) of experiencing depression. Furthermore, we observe a racial disparity in students’ engagement in diagnosis and treatment. Both before and after entering PhD programs, a significantly higher proportion of Hispanic and White students received professional diagnoses and treatment.¹¹ Further highlighting this discrepancy, among those experiencing depression or anxiety in our survey, a significantly higher percentage of White (47%) and Hispanic (46%) students received treatment compared to Asian (18%) and Black (0%) students. In sum, nuanced racial disparities in mental well-being emerge: Hispanic and White students show a higher prevalence of mental illness in both survey responses and previous diagnoses, but they also display a more proactive approach toward seeking treatment. In contrast, Asian and Black students appear to report lower mental illness prevalence, but there is a concerning trend suggesting a lack of emphasis on mental health care.

Robustness Check

Nonresponse Adjustment

To address potential response selection bias, we investigated how survey participation could have influenced the prevalence of mental health conditions in the population under different assumptions and summarized these alternative estimates in Table 3. Initially, we applied inverse response weighting, adjusting the prevalence based on each department’s response rate. The resulting changes were minimal: Depression decreased from 29.9% to 29.6%, anxiety dropped from 27.9% to 27.85%, and suicidal ideation increased from 14.4% to 15.4%. In the most pessimistic scenario, assuming all nonrespondents are mentally distressed, rates rise to 56.1% for depression and anxiety and 56.0% for suicidal ideation. Conversely, in the most optimistic scenario, assuming all nonrespondents are mentally healthy, depression, anxiety, and suicidal ideation rates fall to 13.2%, 12.3%, and 6%, respectively. Even with these lower-bound estimates, the prevalence of mental health conditions in our study is significantly higher than the representative estimates for the general US population.

Excluding Incomplete Responses

After filtering out responses with failed attention checks, we identified four incomplete responses with completion percentages of 39%, 45%, 55%, and 68%. These responses were deemed ineligible for further analysis due to insufficient demographic information. Before excluding these incomplete

¹¹ Before enrolling in their PhD program, 17% of Hispanic and 29% of White students had received mental health diagnoses, compared to 10% of Asian and 4% of Black students. After enrollment, 39% of White and 30% of Hispanic students received diagnoses, in contrast to 8% of Asian and 4% of Black students. 30% of Hispanic and 39% of White respondents were receiving professional treatment for mental health issues, compared to 12% of Asian and 8% of Black students.

Table 4. Average Marginal Effects of Experiencing Mental Illness by Factors (logit)

Factors	Δ Depression	Δ Anxiety	Δ Suicidal Ideation
	1	2	3
Aggravators			
Work–life balance			
Δ Worried about work when not working	0.11***	0.10***	0.05**
Δ Too tired for activities in private life	0.06**	0.08***	0.06***
Δ Had difficulty making ends meet financially	0.009	0.006	0.002
Loneliness			
Δ Loneliness	0.04***	0.03***	0.02***
Mitigators			
Academic performance			
Δ Perceived success in research	-0.13***	-0.08***	-0.06**
Δ Perceived success in coursework	-0.05**	-0.02	-0.01
Meaningfulness of work			
Δ Satisfaction of work well done	-0.11***	-0.09***	-0.04
Δ Opportunities to fully use your talents	-0.07**	-0.06*	-0.005
Adviser satisfaction			
Δ Adviser satisfaction	-0.05**	-0.02	-0.03*
Social events			
Δ Frequency of happy hour with faculty	-0.03	-0.07***	-0.01

Notes: The table summarizes how the probability of experiencing mental illness changes with a small increase in each factor using a logit specification. The dependent variables are dummy variables indicating whether a student experiences depression (column 1), anxiety (column 2), and suicidal ideation (column 3). In all estimations, we control for student demographics, as outlined in Table A1, and university fixed effects. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.

responses, we observed that these respondents reported higher levels of depression and anxiety compared to those who completed the survey.¹² This observation aligns with the hypothesis that students experiencing greater stress might be more likely to discontinue the survey midway.

Including Responses with Extreme Duration

Completed responses passing the attention check exhibit a response duration ranging from 5.4 to 219.63 minutes, with an average of 19.4 minutes. To address concerns about response duration impacting mental illness prevalence, we divided responses into 10 equal bins based on duration and presented the distribution of depression and anxiety scores for responses in each bin.¹³ Special attention is given to responses in the first bin (extra-short duration, <9.87 minutes) and the tenth bin (extra-long duration, ≥29.6 minutes); however, minimal variation in the prevalence of depression and anxiety was observed across these and other time bins.

Key Associated Factors

After examining the mental health status of our PhD students, we further investigate key factors associated with their mental well-being, including academic performance, loneliness, perceived meaningfulness of work, work–life balance, adviser satisfaction, and department atmosphere.

¹² Although these four incomplete responses lacked demographic information, they did include comprehensive answers regarding depression and anxiety. Analysis of this subset reveals higher levels of mental illness. The average PHQ-9 score for incomplete responses is 10.5, compared to an average score of 7.5 for complete responses. Similarly, the average GAD-7 score for incomplete responses is 11, surpassing the average of 7.0 observed in complete responses.

¹³ See Figure S2 in the online supplement.

Specifically, we employ the model outlined in equation (1), introducing one key factor at a time, while accounting for university fixed effects and all individual student characteristics (i.e., gender, sexuality, race, disability status, parental status, living arrangements, relationship status, first-generation college status, and year in the PhD program). The associations are reported as AME, reflecting the change in the probability of experiencing each of the three mental health conditions with a 1-unit change in the corresponding factor. These results are summarized in Table 4, with the factors ranked according to the magnitude of their associations.

Poor Work–Life Balance

Through the survey, we explored students' work–life balance across three dimensions: weekly working days, daily leisure hours, and responses to work–life balance questions adapted from the RAND American Working Condition Survey. Our findings reveal that 61.5% reported working 6–7 days a week, with 54% having 2 hours or less per day for leisure activities. The challenges of poor work–life balance are further underscored by responses to the RAND American Working Condition Survey questions: 76% reported worrying about work when not working “most of the time” or even “always,” 49% felt too tired for personal activities, 45% felt too tired for household jobs, 35% reported had difficulty making ends meet financially, and 43% reported that work hindered their time with family or significant others. These percentages are significantly higher than those reported by PhD students in the top eight US economics programs (Bolotnyy, Basilico, and Barreira, 2022), especially the percentage feeling too tired for personal activities, which more than doubled (49% vs. 21%). Furthermore, our regression analysis, incorporating these work–life balance factors, student demographics, and university fixed effects (Table 4), reveals that higher levels of depression, anxiety, and suicidal ideation are associated with higher frequency of reporting worry about work when not working and those who feel too tired for personal activities. Specifically, a 1-unit increase in the frequency of worrying about work when not working is associated with an 11-percentage-point increase in the probability of experiencing depression, a 10-percentage-point increase in anxiety, and a 5-percentage-point increase in suicidal ideation. Additionally, a 1-unit increase in the frequency of feeling too tired for personal activities is associated with a 6-percentage-point increase in the probability of experiencing depression, an 8-percentage-point increase in anxiety, and a 6-percentage-point increase in suicidal ideation. Financial difficulty, however, does not appear to be a significant contributor.

We then examined whether poor work–life balance could be a contributing factor to the racial disparity in students' mental health. To efficiently report our regression estimates, we calculated an average work–life balance score based on the five work-issue questions of the RAND American Working Conditions Survey.¹⁴ This aggregated work–life balance score ranges from 1 to 5, with an average of 3.34 in our data. Column 1 in Table 5 presents the coefficients of racial disparity before incorporating any associated factors, providing a baseline for comparison with the other columns. As noted in the previous section, we observed that White and Hispanic students have a higher prevalence of depression compared to Asian students, our base group. In Column 3 of Table 5, when the interaction between work–life imbalance and race is taken into account, the signs of both Hispanic and White students change from positive to negative, suggesting that Hispanic and White students without work–life imbalance might exhibit a lower prevalence of depression compared to Asians, our base group. However, the significantly positive interaction terms between work–life imbalance and Hispanic and White indicates that work–life imbalance would intensify the prevalence of depression more among Hispanic and White students. In summary, poor work–life balance emerges as a contributing factor to the high prevalence of depression among both Hispanic and White students.

¹⁴ We also tested including all five questions and their interactions with student race, and the results were similar.

Table 5. Factors Associated with Racial Disparity in Depression (logit) (N = 451)

	1	2	3
Black or African American	-0.43 (0.64)	2.99 (2.72)	-3.65 (3.52)
Hispanic or Latino	0.81* (0.48)	2.08 (1.97)	-7.68* (4.26)
White	0.71** (0.29)	-2.84* (1.71)	-4.81*** (1.86)
Loneliness		0.21*** (0.04)	
Loneliness×Black or African American		-0.17 (0.14)	
Loneliness×Hispanic or Latino		-0.07 (0.10)	
Loneliness×White		0.22** (0.09)	
Work–life imbalance			0.85*** (0.19)
Work–life imbalance×Black or African American			0.77 (0.86)
Work–life imbalance×Hispanic or Latino			2.12* (1.11)
Work–life imbalance×White			1.52*** (0.50)
Student demographics	yes	yes	yes
University fixed effects	yes	yes	yes

Notes: The table summarizes the estimated coefficients from a logistic regression analysis examining factors contributing to racial disparities in depression. The dependent variable is a dummy variable indicating whether a student’s depression (PHQ-9) score is above the threshold. The independent variables include the race of students, their feelings of loneliness measured using the eight-item UCLA loneliness scale, average scores of five questions from the RAND work issues, and their interactions with students’ race. In addition to these independent variables, we also control for student demographics (gender, sexuality, disability status, parental status, living arrangements, relationship status, first-generation college status, and year in the PhD program), and incorporate university fixed effects. The number of observations decreased from 452 to 451 after excluding the sole student who identified as Native Hawaiian or another Pacific Islander due to statistical considerations. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.

Loneliness

Our respondents reported elevated levels of loneliness, measured using the eight-item short form of the UCLA Loneliness Scale (ULS-8). Our study’s average score was 17.69 on a scale ranging from 8 to 32. Compared to loneliness levels reported in top economics departments by Bolotnyy, Basilio, and Barreira (2022), our respondents scored at least 30% higher.¹⁵

Given that we surveyed 33 universities, we considered the potential impact of the rurality of their locations. To determine whether increased loneliness is inherent to graduate study in agricultural economics irrespective of location, we assessed the rurality of each university using the 2013 Rural-Urban Continuum Codes (US Department of Agriculture, 2013). These codes categorize areas at the

¹⁵ For comparability, we recalculated our responses using the ULS-3 version, generating scores between 3 and 12 based on questions 1, 4, and 5 from ULS-8.

county level based on population size, with higher code numbers indicating more rural locations.¹⁶ Among the 33 universities in our survey, 9, 8, 14, and 2 universities are located in code 1, 2, 3, and 4 areas, respectively, with detailed information for each university summarized in Table 1. In our study, the average loneliness scores increased slightly with the rural code, with average scores of 6.89, 6.76, 6.94, and 7.17 in code 1, 2, 3, and 4 areas, respectively. These scores are at least 30% higher than the 5.2 reported by students in top economics departments, regardless of the rurality of the university location. Therefore, the heightened level of loneliness among our respondents is unlikely to be attributable to the rurality of the university location.

When integrated into logistic regression analyses for each mental health issue, controlled for student demographics and university fixed effects, loneliness showed a significant positive association with mental illness. On average, a 1-unit increase in loneliness was associated with a 4-percentage-point increase in the probability of depression, a 3-percentage-point increase in anxiety, and a 2-percentage-point increase in suicidal ideation.

Finally, we examined whether loneliness might help explain the mental health disparities among racial groups. To explore this, we incorporated loneliness, students' race, and their interaction terms into a logistic regression model of students' mental health in Table 5. Compared to the baseline results in column 1, the introduction of loneliness and its interaction with race in column 2 shows a notable shift: The coefficient for White students changes from 0.71 to -2.84 . This suggests that White students who do not experience loneliness exhibit even lower levels of depression than Asian students. However, the positive and significant interaction term between loneliness and White race suggests that the prevalence of depression increases more for White students with rising feelings of loneliness compared to other racial groups.

Academic Performance

The mental well-being of college students is notably influenced by academic success (Grøtan, Sund, and Bjerkeset, 2019). We asked about PhD students' perceived success in coursework, research, and teaching, utilizing a 5-point Likert scale. Our findings reveal that higher perceived success in both research and coursework correlates with lower levels of mental health issues, and the association is more pronounced for perceived success in research than in coursework. Specifically, each 1-unit increase in perceived research success is associated with a 13-percentage-point decrease in the probability of depression, an 8-percentage-point decrease in the probability of anxiety, and a 6-percentage-point decrease in the probability of suicidal ideation. A 1-unit increase in perceived coursework success is associated with a 5-percentage-point decrease in the odds ratio for depression.

Meaningfulness of Work

The meaningfulness of work is crucial for work engagement, which has been shown to help prevent mental health issues (Stubb, Pyhältö, and Lonka, 2012). In our study, 70.6% of our respondents reported their work offers some sources of meaning always or most of the time. This percentage is lower than the 80% reported for working Americans aged 25–35 (Maestas et al., 2015), which is understandable given that our study focuses on PhD students, while theirs includes all working Americans across various education levels. Research suggests that individuals with higher education may experience lower levels of work meaningfulness, which is also the pattern shown in Maestas et al. (2015). However, among studies focusing on PhD students, our respondents reported higher perceived meaningfulness than PhD students in top economics programs (Bolotnyy, Basilico, and Barreira, 2022). Specifically, 43% of our students reported that their work provides opportunities to

¹⁶ Based on the 2013 Rural-Urban Continuum Codes (US Department of Agriculture, 2013), code 1 refers to counties in metro areas of 1 million population or more, code 2 refers to counties in metro areas of 250,000 to 1 million population, code 3 refers to counties in metro areas of fewer than 250,000 population, and code 4 refers to nonmetro counties with urban populations of 20,000 or more.

make a positive impact on society always or most of the time, compared to 20% for PhD students in top economics programs. And 46% of our students feel that they are doing useful work always or most of the time, compared to 26% of top economics PhDs.

Interestingly, we found that students from different academic rankings perceive the meaningfulness of their work differently.¹⁷ When asked whether the work utilizes their talents, provides a sense of personal accomplishment, or goals to aspire to, students from top-tier universities reported higher levels. However, when asked about the work's social impact, feeling of doing useful work, or overall satisfaction of work well done, students from lower-ranked departments reported higher levels. This may explain why our students reported a higher level of work meaningfulness. Bolotnyy, Basilico, and Barreira (2022) focused solely on top economics programs, where students primarily derive meaning from intellectual challenges, similar to our students in top-ranked programs. In contrast, our students from programs outside the top 10 also experience meaningfulness through the application of their research—an aspect closely linked to the applied research focus in the field of agricultural economics.

To further explore the link between the meaningfulness of work and students' mental health, we regress all six measures of meaningfulness on mental health using equation (1), controlling for student demographics and university fixed effects (see Table 4). Our findings indicate that finding opportunities to fully utilize students' talents and deriving satisfaction from a job well done are two key aspects negatively correlated with students' mental health issues.

Adviser Satisfaction

Our results indicate a positive student–adviser relationship in general, with a high level of satisfaction (averaging 4.2 out of 5) and minimal conflicts (95% reported no or minimal conflicts).¹⁸ The excitingly high adviser satisfaction we observed, compared to the findings in top economics departments from Bolotnyy, Basilico, and Barreira (2022), is quite consistent across student demographics and department rankings.¹⁹ This may be related to the student–adviser dynamics in the field: While economics departments often rely heavily on departmental sponsorship, agricultural economics students are frequently funded by individual advisers, which may foster a closer student–adviser relationship. However, students in their 2nd year and those in their 5th year or beyond report significantly lower adviser satisfaction, suggesting a decline during these transition periods—from coursework to research and from student roles to faculty roles.

This satisfaction rating was incorporated into our regression analysis on mental health along with student demographics and university fixed effects. Our estimates indicate that for each 1-unit increase in adviser satisfaction, the probability of experiencing depression decreased by 5 percentage points and the probability of suicidal ideation decreased by 3 percentage points (see Table 4).

Despite the generally positive relationship, our study reveals some complexity: Students exhibit low confidence in their ability to meet their advisers' requirements and place significant value on their encouragement. When we ask students how successful they feel in their coursework and research relative to various benchmarks, most reported feeling successful often or always. However, a lower percentage felt this way when comparing themselves to their peers, and the percentage was lowest when considering their adviser's expectations.²⁰ Additionally, the adviser's view is ranked highest in improving the perceived meaningfulness of work for PhD students, even surpassing the meaningfulness derived from publication.²¹

To understand how adviser satisfaction affects student mental health, we asked students detailed questions about their interactions with their advisers. Using equation (1), we regressed each aspect

¹⁷ Refer to Figure S5 in the online supplement.

¹⁸ Out of the 452 responses analyzed, 401 (88.7%) students reported having a main adviser.

¹⁹ See the online supplement for a detailed discussion of adviser satisfaction across subgroups.

²⁰ See Figure S6 in the online supplement.

²¹ See Figure S7 in the online supplement.

Table 6. Mediators for Adviser Satisfaction on Depression (N = 290)

	1	2	3	4	5	6	7
Overall adviser satisfaction	-0.364** (0.156)	-0.319* (0.176)	0.013 (0.237)	-0.253 (0.205)	-0.131 (0.202)	-0.070 (0.201)	-0.181 (0.189)
Email availability		0.145 (0.183)					
In-person availability		-0.292 (0.186)					
Provision of positive feedback			-0.512** (0.222)				
Provision of constructive feedback			-0.078 (0.235)				
Assisting research				-0.174 (0.209)			
Supporting conference presentation					-0.662*** (0.253)		
Supporting seminar presentation					0.232 (0.252)		
Provision of job suggestions						-0.480** (0.209)	
Share job search experiences							-0.332* (0.192)
Student demographics	yes	yes	yes	yes	yes	yes	yes
University fixed effects	yes	yes	yes	yes	yes	yes	yes

Notes: The table presents the estimated coefficients from a logistic regression analysis examining factors mediating the association between adviser satisfaction and depression among 3rd-year and beyond PhD students. The number of observations decreases from 452 to 290, as we focus on PhD students in the research phase (3rd year and beyond). Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.

of the interaction and the overall adviser satisfaction on students’ mental health together, while controlling for student demographics and university fixed effects. The results are summarized in Table 6. Factors that nullify the originally significant association between adviser satisfaction and student mental health serve as mediators. Notably, for students in their dissertation phase (3rd year and above), the inclusion of the frequency of positive, constructive adviser feedback nullified the previously significant correlation between overall adviser satisfaction and depression. This suggests that when holding these aspects constant, adviser satisfaction has no direct association with a student’s mental health. Interestingly, positive feedback emerged as a more robust mediator than constructive feedback in both magnitude and significance. This reinforces our previous findings that adviser encouragement is crucial for PhD students. Additional mediating factors include advisers’ helpfulness in assisting research projects, supporting conference and seminar presentations, providing job suggestions, and sharing job search experiences.

Department Atmosphere

Concerns persist regarding departments’ dedication to addressing students’ mental health challenges. Our survey revealed that 21.2% of respondents “disagreed” or “strongly disagreed” with their department’s supportiveness toward mental health, and 27.2% “disagreed” or “strongly

disagreed" that students feel encouraged to discuss potential mental health challenges openly, suggesting the existence of mental health stigma. We found that students who reported a higher frequency of social events with faculty members experienced a significant and notable (7-percentage-point) decrease in the probability of anxiety—A reduction not observed with the frequency of professional events.

Conclusion and Discussion

We conducted a comprehensive study of mental health among PhD students across all 33 PhD-granting programs in agricultural economics in the United States, employing clinically validated questionnaires. Successfully gathering survey responses from every target department, we achieved an overall response rate of 44.1%. Our findings reveal concerning information about the mental status of our students: 39.4% of respondents reported symptoms of at least one of these three mental health conditions (i.e., depression, anxiety, and suicidal ideation) and 8.8% reported all three. The prevalence of depression and anxiety observed among our surveyed PhD students exceeds that documented in the general population, PhD students in top economics departments in the United States before the COVID-19 pandemic (Bolotnyy, Basilio, and Barreira, 2022), and PhD students of economics in European universities during the COVID-19 pandemic (Macchi et al., 2023). Moreover, these mental health conditions are not limited to top-ranked programs but are consistent across program rankings. There are also nuanced racial disparities: Hispanic and White students exhibited a higher prevalence of mental health issues but were more inclined to seek treatment, while Asian and Black students reported lower prevalence but faced challenges accessing support services.

We further investigated factors associated with students' mental health. Positively, 70.6% of students in our study reported a sense of meaningfulness in their work always or most of the time—nearly double that of students from top economics departments. This higher level of meaningfulness does not appear to stem solely from differences between top-ranked departments and others. Our data indicate that students across departments of varying academic rankings experience meaningfulness in distinct ways: For those in the top 10 programs, it primarily arises from intellectual challenges, while for students outside the top 10, it is more influenced by the practical usefulness of their work. This trend aligns with the applied research focus in the field of agricultural economics.

On the negative side, students reported significantly increased feelings of loneliness, which did not vary much by program location, suggesting it may be inherent to graduate study in agricultural economics. Additionally, poor work–life balance was evident, with 76% of students reporting worry about work when not working. These two factors are key mediators of poor mental health, especially among White and Hispanic students, who reported a higher prevalence of mental health issues. In contrast, financial difficulty—an important dimension of work–life balance—did not appear to be a significant contributor to poor mental health among our survey respondents.

Overall, a positive student–adviser relationship was reported consistently across academic rankings. This may be linked to the adviser funding dynamics, which is common in agricultural economics and thus may foster a more collaborative student–adviser relationship. However, we also observed a decline in adviser satisfaction during the 2nd year and from the 5th year onward, corresponding to key transition periods in PhD studies. And we found that adviser encouragement significantly impacts students' perceived meaningfulness of their work, their sense of success in coursework and research, and their mental health. Finally, there is a stigma around mental health that departments could address, as over 20% of respondents disagreed that their department is supportive of their mental health or encourages open discussion of mental health challenges.

Our findings highlight several key areas for consideration regarding graduate students' mental health. First, mental health challenges appear pervasive across academic departments, regardless of their ranking, suggesting that awareness initiatives should be widespread rather than confined to

top-tier programs. Notably, Hispanic and White students in our study exhibited a higher likelihood of experiencing depression—15.5 and 13.5 percentage points more, respectively, than students from other racial groups—indicating that mental health awareness and support may need to be tailored to address unique needs across different racial groups. Another area of concern is access to mental health resources. Our results indicate that among those experiencing depression or anxiety, 72% of respondents remain untreated, and 14% are unsure how to seek help. This issue seems particularly pronounced for Asian and Black students. Moreover, the student–adviser relationship can be crucial to students’ perceived success in coursework and research, their sense of meaning in their work, and their overall mental health. This support is particularly valuable during transitional periods, such as the 2nd year, when students shift from coursework to research, and from the 5th year onward, as they move from student roles toward faculty roles. Lastly, work–life balance appears to be a significant challenge among PhD students. Future research is needed to identify effective strategies for supporting this aspect of the graduate student experience.

[First submitted August 2024; accepted for publication November 2024.]

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Appendix A

Table A1. Number of Responses by Demographics

	No. of Responses	% of Responses
Year in PhD program		
1st	73	16%
2nd	82	18%
3rd	103	23%
4th	75	17%
5th+	119	26%
Age		
Younger than 22	1	0%
23–27	155	34%
28–34	247	55%
35 or older	49	11%
Race		
Asian or Asian American	284	63%
White	113	25%
Hispanic or Latino	30	7%
Black or African American	24	5%
Native Hawaiian or Other Pacific Islander	1	0%
Gender		
Woman	236	52%
Man	212	47%
Prefer not to say	4	1%
Sexuality		
Heterosexual	385	85%
LGBTQ+	47	10%
Prefer not to say	20	4%
Disability		
No	415	92%
Yes	26	6%
Prefer not to say	11	2%
Marital Status		
Single	149	33%
Married	147	33%
Long-term/committed	109	24%
Dating		
Casual	10	2%
Divorced	4	1%
Having children		
No	396	88%
Yes	56	12%
Live Alone		
No	296	65%
Yes	156	35%
First-generation college		
No	330	73%
Yes	122	27%
Total	452	100%

Notes: The table summarizes the demographic characteristics of the students who participated in our survey.

Online Supplement: Mental Health of PhD Students in US Agricultural Economics Departments

Xi Zhang, Di Fang, and Rodolfo M. Nayga, Jr.

Response Duration

In this section, we first plot the number of responses by response duration in minutes for completed responses passing the attention check, which is the sample we use for all our analysis. As shown in Figure S1, the response duration ranges from 5.4 to 219.63 minutes, with an average of 19.4 minutes. 84% of our responses fall within the 9–30 minute range, which is considered reasonable. To address concerns about response duration impacting mental illness prevalence, we divided responses into 10 equal bins based on duration, presenting depression and anxiety scores in box plots (see Figure S2). While attention is given to responses in the first bin (extra short duration, <9.87 mins) and the tenth bin (extra long duration, ≥ 29.6 mins), minimal variation was observed in both cases.

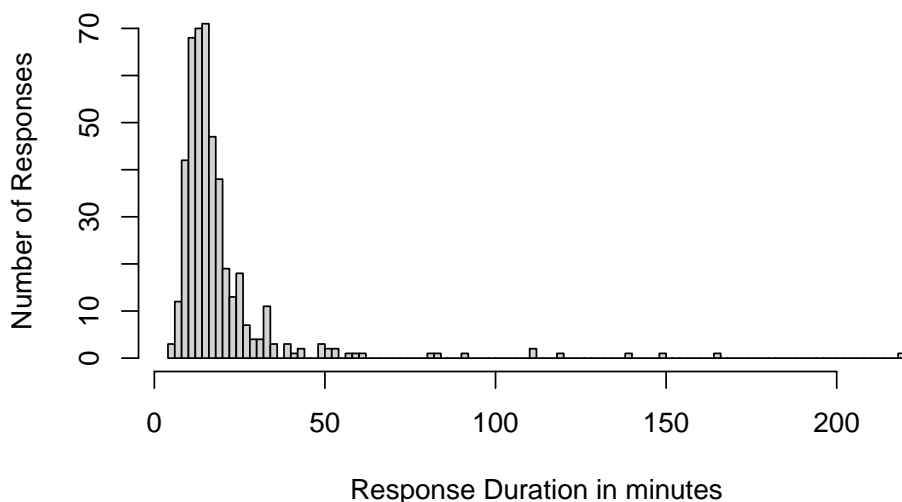


Figure S1. Number of Responses by Response Duration

Notes: The figure plots the number of responses by response duration in minutes.

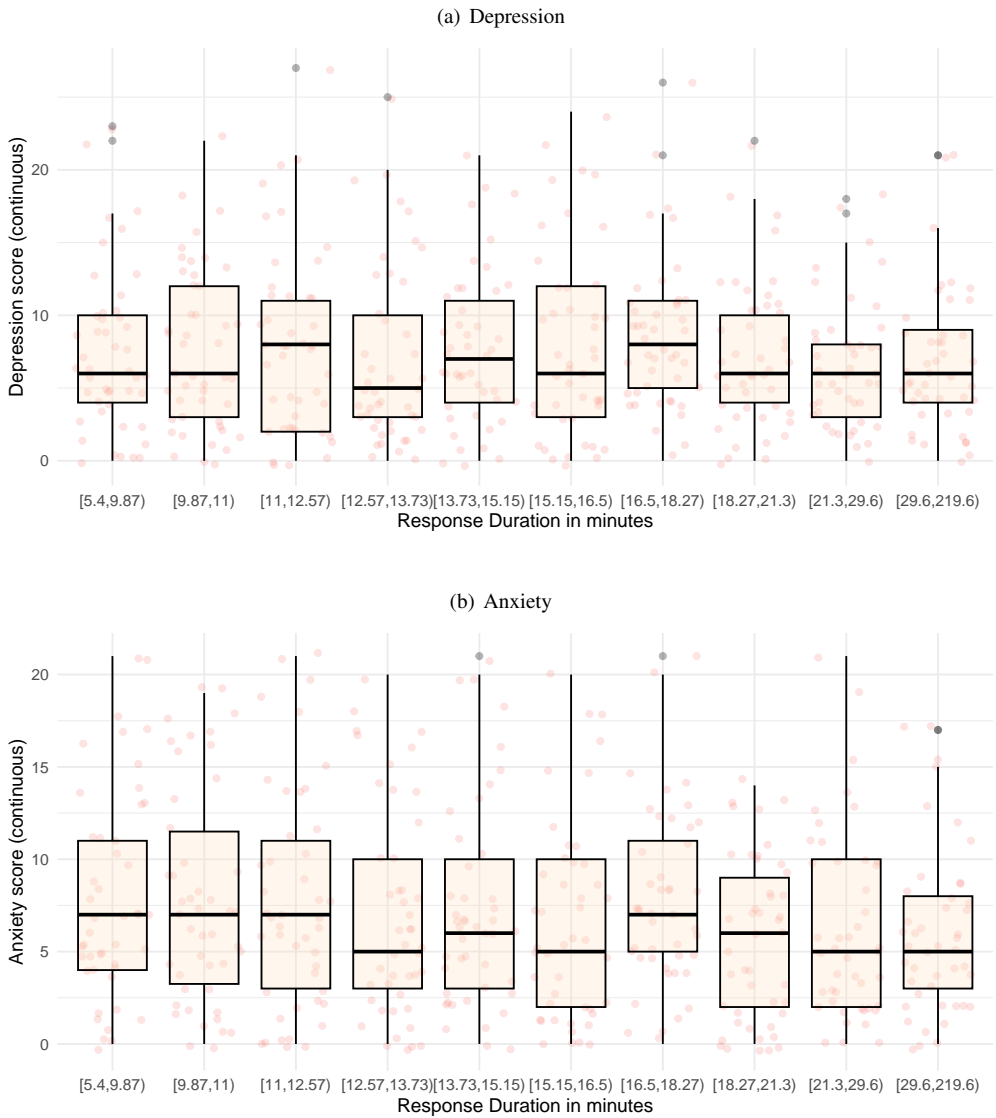


Figure S2. Depression and Anxiety Scores Across Response Duration in Each Decile

Notes: The figure plots the variation in depression (PHQ-9) and anxiety (GAD-7) scores across response duration in minutes, presented in Panel (a) and (b), respectively. All responses are equally divided into ten bins. The pink dots represent the depression and anxiety scores of all responses in each bin, and the grey dots are outliers. Additionally, the box displays a 95% confidence interval, with the mean indicated by the horizontal black line.

Heterogeneity by Demographics

In this section, we will first supplement our main analysis with a thorough examination of how associated factors vary by race. We regress student race on specific associated factors, controlling for university fixed effects and other student characteristics, including PhD program year, disability status, gender, sexuality, marital and parental status, living arrangement, and first-generation college status. Figure S3 highlights factors showing significant racial differences, while Figure S4 presents factors with no significant differences when compared to the reference group, Asians.

Our findings reveal that White students report a marginally lower level of loneliness compared to Asian students, while Hispanic and Black students show no significant differences in loneliness. Hispanic students report a higher frequency of losing work–life balance compared to Asian students, though this difference does not extend to Black or White students. Additionally, White students experience a significantly higher sense of work meaningfulness than Asian students, while Hispanic students report a slightly lower sense of meaningfulness, and Black students show no significant difference from Asians. In terms of self-reported productivity, interpersonal skills, success in coursework and research, and adviser satisfaction, we find no racial differences.

Next, we summarize the prevalence of mental health issues across demographics other than race, including gender, sexuality, disability status, parental status, first-generation college status, and year in the PhD program, along with the p-values testing the differences between subgroups. As shown in Table S1, women are more likely than men to experience depression and anxiety but are less likely to experience suicidal ideation. Depression is more prevalent among students with minority sexualities and first-generation college students. Students with disabilities report higher levels of depression, anxiety, and suicidal ideation. Students nearing the end of their PhD studies report the highest levels of depression, anxiety, and suicidal ideation, which may be due to stress from completing their degree and uncertainty about the job market.

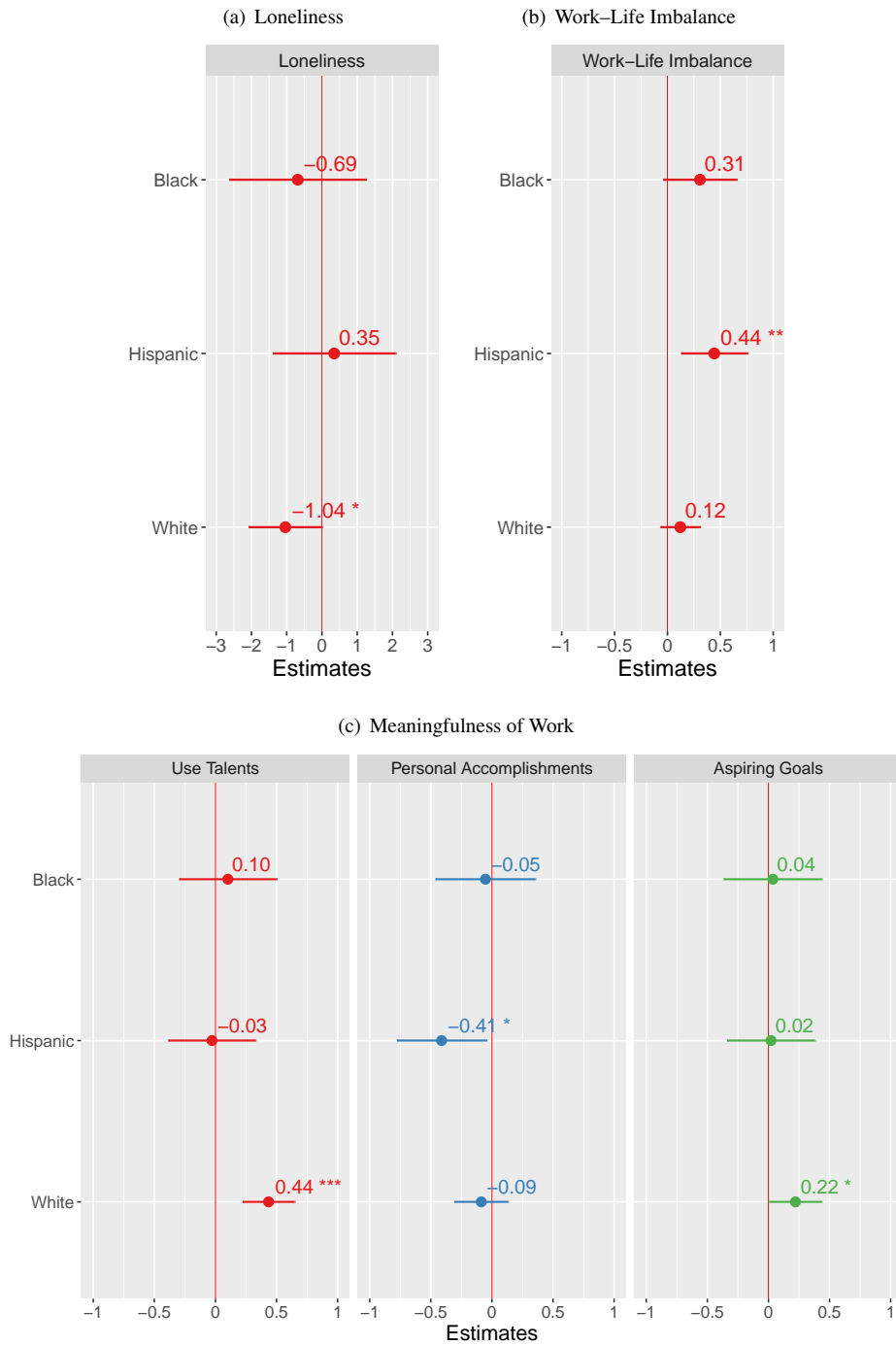


Figure S3. Key Associated Factors by Race

Notes: This figure plots the variation in students' self-reported metrics by race: loneliness in Panel (a), work-life balance in Panel (b), and various evaluation questions related to the meaningfulness of work in Panel (c). Asian students in our sample are the reference group. Across panels, we control for all other student characteristics, including gender, sexuality, disability status, parental status, living arrangements, relationship status, first-generation college status, and year in the PhD program. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.

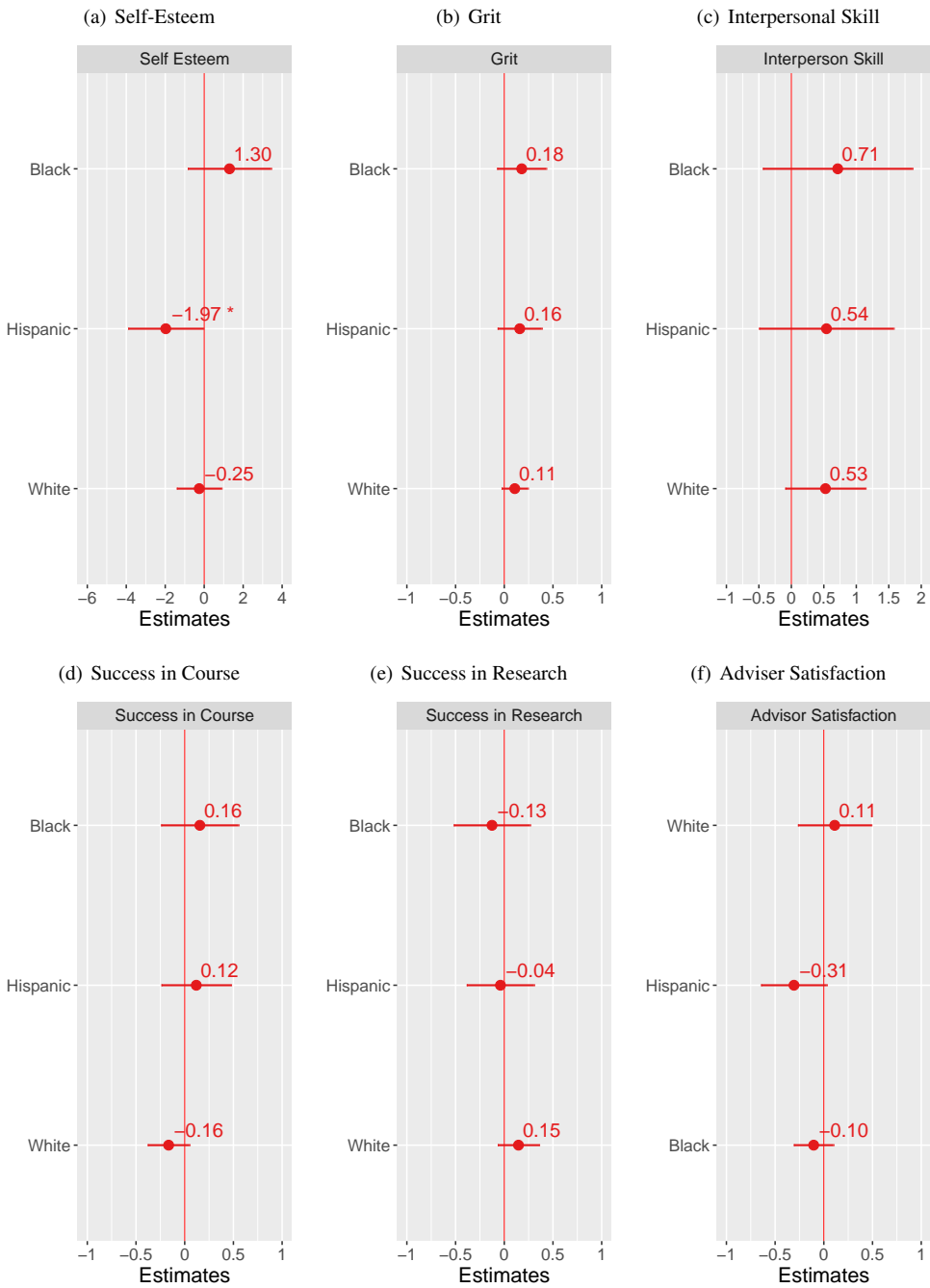


Figure S4. Other Associated Factors by Race

Notes: This figure plots the variation in students' self-reported metrics by race: self-esteem in Panel (a), grit in Panel (b), interpersonal skills in Panel (c), success in coursework in Panel (d), success in research in Panel (e), and adviser satisfaction in Panel (f). Asian students in our sample are the reference group. Across panels, we control for all other student characteristics, including gender, sexuality, disability status, parental status, living arrangements, relationship status, first-generation college status, and year in the PhD program. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.

Table S1. Prevalence of Mental Health Issues by Subgroups

Subgroups	Depression	Anxiety	Suicidal Ideation
Gender			
Male	0.278	0.259	0.170
Female	0.318	0.297	0.119
p-value (male vs female)	0.362	0.381	0.126
Sexuality			
Heterosexual	0.291	0.283	0.143
LGBTQ+	0.383	0.277	0.128
p-value (heterosexual vs LGBTQ+)	0.227	0.926	0.773
First-generation College			
Yes	0.287	0.295	0.172
No	0.303	0.273	0.133
p-value (first-generation vs not)	0.739	0.643	0.322
Having Children			
Yes	0.214	0.304	0.143
No	0.311	0.275	0.144
P-value (having children vs not)	0.113	0.669	0.983
Disability			
No	0.284	0.263	0.14
Yes	0.423	0.5	0.192
p-value (disability vs not)	0.182	0.03	0.52
Year in the PhD program			
1st	0.301	0.274	0.096
2nd	0.256	0.232	0.171
3rd	0.311	0.282	0.097
4th	0.267	0.24	0.147
5th+	0.336	0.336	0.193
p-value (5th+ vs others)	0.311	0.119	0.1

Notes: The table shows the percentage of students scoring above the thresholds for depression (PHQ-9), anxiety (GAD-7), and suicidal ideation (Item 9 on the PHQ-9). P-values for t-tests are also reported, indicating the significance level of differences in mental health between each subgroup.

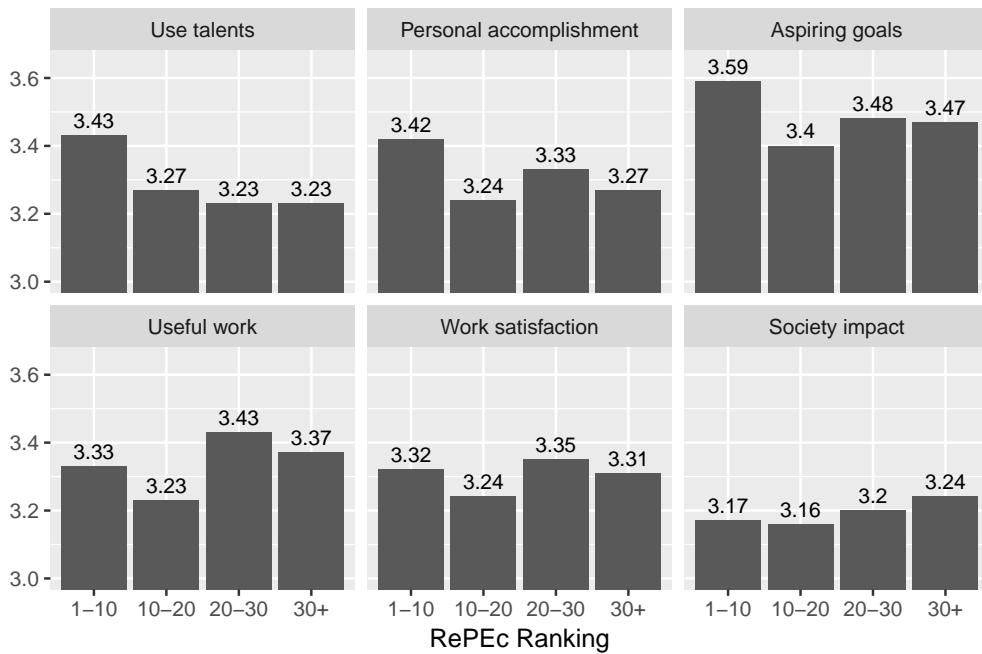


Figure S5. Perceived Meaningfulness of Work by Department Academic Ranking

Notes: This figure shows the average degree (scale 1-5) of perceived meaningfulness of work across six measures, categorized by the academic ranking of the student’s department measured based on the IDEAS/RePEc (2023) ranking.

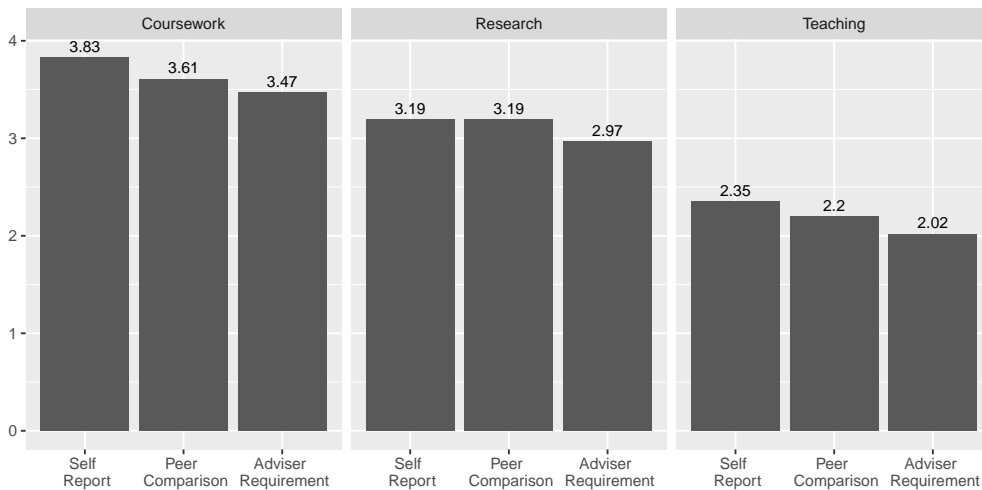


Figure S6. Perceived Success Compared to Different Benchmarks

Notes: The figure depicts the average perceived success in coursework (left panel), research (middle panel), and teaching (right panel), both in absolute terms and in comparison to peers and their adviser’s requirements.

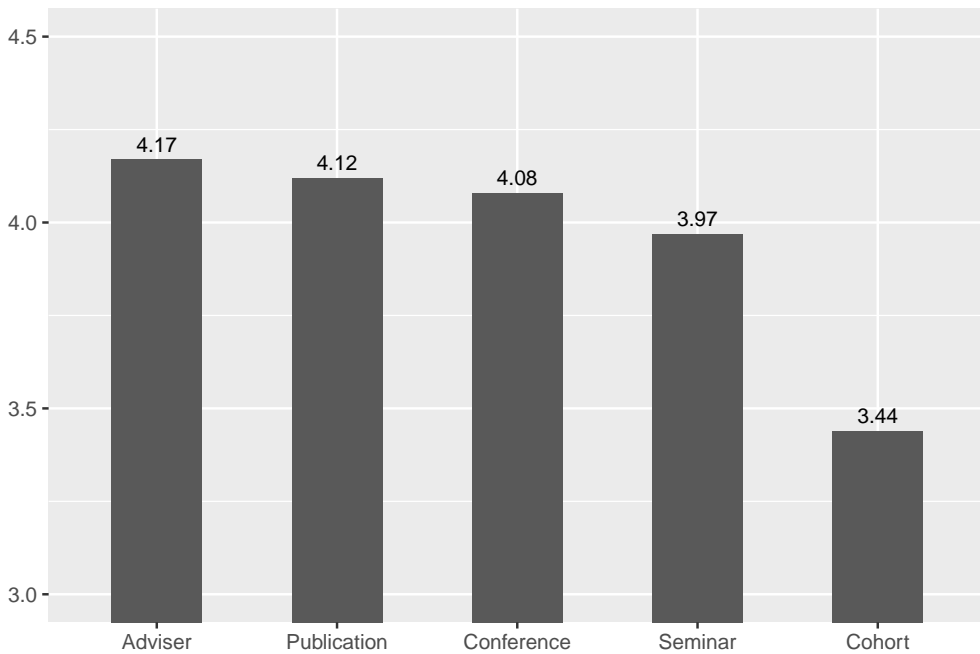


Figure S7. Source That May Help Improve the Perceived Meaningfulness of Work

Notes: This figure plots the average degree (scale 1-5) to which the above five sources may help students improve their perceived meaningfulness of work.

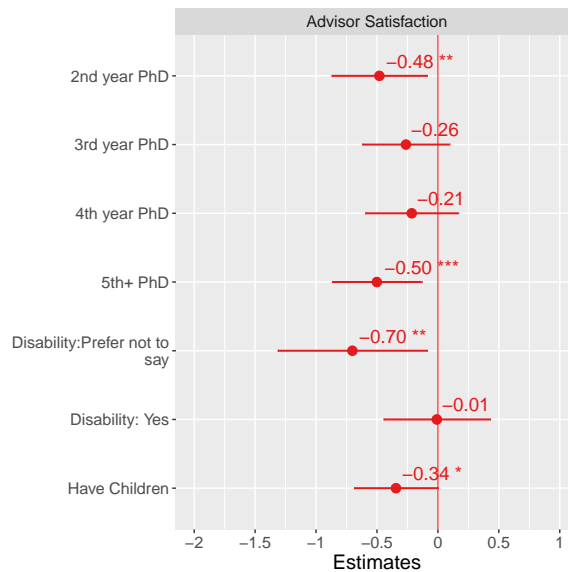


Figure S8. Adviser Satisfaction and Student Demographics

Notes: This figure plots the estimates of the student demographics that are significantly correlated with adviser satisfaction. The dots represent the estimates and the lines represent their 95% confidence intervals. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.

Adviser Satisfaction Across Subgroups

We reviewed all student demographics from our survey and regressed these characteristics on adviser satisfaction to determine whether a specific subgroup drives the overall high satisfaction. We found that adviser satisfaction does not vary significantly by students' program ranking, gender, race, sexuality, marital status, or whether they live alone. However, as shown in Figure S8, we found that satisfaction was significantly lower among 2nd-year students, those in their 5th year or beyond, students who selected "prefer not to say" when asked about disability, and those with children.

This pattern suggests that adviser satisfaction tends to decline during key transition periods—such as the shift from coursework to research (typically occurring in the 2nd year) and when students prepare to graduate and enter the job market (a primary focus for 5th-year and beyond students). This may also help explain why adviser satisfaction is higher in our study compared to the economics department. Below is a comparison of respondents by their PhD year: 1st year (16% in agricultural economics vs 19% in economics), 2nd year (18% in agricultural economics vs 20% in economics), 3rd year (23% in agricultural economics vs 15% in economics), 4th year (17% in both agricultural economics and economics), and 5th year and beyond (26 in agricultural economics vs 30% in economics). Since students in their 2nd and 5th+ years reported lower satisfaction in our analysis, the smaller proportion of these groups in our sample compared to the economics department (as reported by Bolotnyy, Basilico, and Barreira (2022)) may partly explain the higher adviser satisfaction we observed. However, the other two key differences—specifically, the higher percentage of respondents selecting “prefer not to say” regarding disability and those reporting having children—likely bias our adviser satisfaction estimate downward. These characteristics are associated with lower satisfaction, and since they are more prevalent in our sample compared to the economics sample, the overall satisfaction estimate may be lower than it otherwise would be.

In summary, we believe that differences in sample composition between agricultural economics and economics departments do not account for the higher level of adviser satisfaction observed in our study. Instead, the higher satisfaction appears to be an intrinsic feature of the agricultural economics program.

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