Analysis Plan

Project Name: Increasing Take-Up of the American Opportunity Tax Credit

Project Code: 1805

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Project Description

To promote college access and affordability, education tax credits help with the cost of college by reducing the amount of tax owed. The most generous Federal higher education tax credit, the American opportunity tax credit (AOTC), is a maximum annual credit of $2,500 per eligible student. Yet, many eligible students (or their families) do not claim the credit. Among eligible students, national estimates indicate that 46 percent of independent students and 56 percent of dependent students take up AOTC.[1]

The Office of Evaluation Sciences (OES) at the U.S. General Services Administration and the Research, Applied Analytics, and Statistics division of the Internal Revenue Service (IRS) collaborated to implement and evaluate a multimodal communication strategy to increase take up of AOTC among students at a Midwestern University (or their families) during the 2019-2020 academic year.[2] The communications-bundle aimed to increase awareness of AOTC and make it easier for students or their families to take the necessary steps to claim the credit.

Experimental Design and Sample

The experimental design includes a business-as-usual group and two communications-bundle groups. The University's Financial Services Office (the University) sent email notices when the Form 1098-T, which is the tax statement used to claim AOTC, became available to students in the business-as-usual group. The University sent the same Form 1098-T emails and 5 additional AOTC emails to students in the communication-bundles groups. Note that the University sends copies of e-mail messages—including the Form 1098-T and AOTC e-mails—to a student's authorized payer(s), typically a parent or guardian, when one or more is registered.

The communication-bundle groups were also mailed one letter about claiming the AOTC to their permanent address. The letter came from the IRS for students in the IRS letter and

[1] Guyton, John, Day Manoli, Brenda Schafer, Michael Sebastiani, and Nick Turner. "Credits for College." In *Proceedings. Annual Conference on Taxation and Minutes of the Annual Meeting of the National Tax Association*, vol. 110, pp. 1-20. National Tax Association, 2017.

[2] The communications bundle focused on AOTC take up during the 2019 tax year.

communications-bundle group and the letter came from the University for students in the University letter and communications-bundle group.

The sample includes students who were enrolled at the University between January and September 2019 and were expected to be eligible for AOTC.[3] We randomly assigned 50 percent of the sample to the business-as-usual group and 50 percent of the sample to a communications-bundle group. Among students randomly assigned to either of the communications-bundle groups, we randomly assigned half to the communications-bundle group sent the IRS letter (25 percent of the overall sample) and half to the communications-bundle group sent the University letter (25 percent of the overall sample). The planned sample and treatments are described in Table 1.

Table 1. Sample and planned treatments

Treatment Assignment	Description	Planned Sample Size
Business-as-usual	The University sends an email to students and (if applicable) authorized payers that the Form 1098-T is ready to download.	9,530
Communications-bundle group with IRS letter	*The business-as-usual communication:* The University sends an email to students and (if applicable) authorized payers that the Form 1098-T is ready to download. *The email communication bundle:* The University sends five AOTC emails to students and (if applicable) authorized payers in November-July 2020. *The IRS letter communication:* IRS sends one letter about claiming AOTC to students' permanent address (or current address if they have no permanent address listed).	4,776
Communications-bundle group with University letter	*The business-as-usual communication:* The University sends an email to students and (if	4,765

[3] The sample includes undergraduate students who are U.S. citizens and enrolled at the University at least half- time for one or more academic terms in 2019 (Spring 2019, Summer 2019, Fall 2019). Additionally, the sample excludes students with 120 or more transfer credits, graduate students (based on years of enrollment or enrollment in a non-degree program), students enrolled less than half-time each academic period, and students missing key information (i.e., Social Security Number).

	applicable) authorized payers that the Form 1098-T is ready to download. *The email communication bundle:* The University sends five AOTC emails to students and (if applicable) authorized payers in November-July 2020. *The USFSCO letter communication:* The University sends one letter about claiming AOTC to students' permanent address (or current address if they have no permanent address listed).	
Total communications-bundle sample		9,541
Total sample		19,071

Random assignment occurred within exact blocks with treatment probability consistent across blocks. Blocks were created based on (a) whether a student was registered in Fall 2019, (b) whether a student had registered an authorized payer, and (c) a year in school measure that also accounts for status as a first-time or transfer student at the University. (See imported variables section for additional details on the blocking variables.)

Study Aims and Outcomes of Interest

Primary Aim

The primary aim of this project is to measure the impact of the communications-bundle, pooling together the IRS and University letter groups, on AOTC take up.

Secondary Aims

The study also includes a number of secondary aims. These secondary aims include:

1. Exploring whether messenger effects from who mailed the letter—the IRS or the University—generate different effects on AOTC take up or other secondary outcomes of interest.
2. Exploring whether there are heterogeneous treatment effects of the communications bundle(s) (e.g., independent and dependent students for tax purposes).
3. Exploring the effects of the communications-bundle(s) on intermediary outcomes (e.g., filing taxes, when taxes are filed, college credits attempted) and downstream outcomes (e.g., refund amount, other aid distributed, progress towards degree, academic performance).[4]

[4] Downstream outcomes on progress towards a degree—which we plan to measure using credits earned, and continued enrollment or graduated—are of particular interest, because earlier experimental and quasi-experimental evidence finds that AOTC does not increase college enrollment (see for example, Bulman & Hoxby, 2015 and Guyton et al., 2017).

4. Exploring the treatment-on-treated effects of the communications-bundle.

Finally, the study coincides with the onset of the COVID-19 pandemic in the United States. As a result, the University and the IRS change many of their procedures and policies. For example, the University switched to virtual learning in March 2020 and the school implemented grading modifications for Spring 2020. Most courses continued to be online in Fall 2020 and the University implemented additional grading modifications. The IRS changed the 2019 tax deadline from April 15, 2020 to July 15, 2020. Moreover, the Coronavirus Aid, Relief, and Economic Security (CARES) Act was passed on March 27, 2020. As a result, many students in the sample were likely eligible for aid through the CARES Act through Economic Impact Payments and Higher Education Emergency Relief (HEERF) Funds. [5]

Despite these challenges, the random assignment of students to business-as-usual and communications-bundle groups means that the pandemic, and the policy response to it, should not differently influence students in expectation. However, these events could shape students' responses to the communication-bundle or take up of these other sources of aid.

To the extent to which data are available, we plan to situate our findings within this broader context. For example, we plan to explore whether the communications-bundle impacted students' Economic Impact Payments, which the IRS distributed based on tax filing information in TY 2018 and TY 2019, and take up of HEERF aid, which the University distributed to students on a first-come first-served basis during Spring 2020, Summer 2020, and Fall 2020. We also plan to explore the extent to which eligibility for and take up of these different forms of Federal aid are associated with students' progress towards a degree and other education outcomes.

Data and Data Structure

This section describes variables that will be analyzed, as well as changes that will be made to the raw data with respect to data structure and variables.

Data Source(s):

The primary data sources are described in Table 2.

Table 2. Data Sources

Data Source	Data
The University	Academic measures and email interaction measures (pending availability)
OES	Random assignment and blocking measures (generated from University data)
IRS	Tax measures and enrollment at other colleges

[5] https://home.treasury.gov/policy-issues/cares

	and universities

Outcome Variables to Be Analyzed

Planned outcomes to include in the OES Abstract

Primary outcome
A dichotomous indicator for claimed AOTC during tax year (TY) 2019 is the primary outcome of interest, which we will report in the OES Abstract.

Secondary outcomes
In the OES abstract, we also will report two secondary outcomes of interest:

- AOTC credit amount (0 to $2,5000); and
- Credits earned at the University in January 2020 - December 2020 (i.e., Spring 2020, Summer 2020, and Fall 2020 academic periods).

Planned outcomes to be analyzed for other publication

We list planned tax-related outcomes, mostly observed in IRS administrative data, in Table 3 and planned education-related outcomes, mostly observed in administrative data from the University, in Table 4.

Table 3. Planned tax-related and aid-related outcomes

Outcome	Description
Included in OES abstract:	
AOTC take up	Dichotomous indicator for claimed AOTC in TY2019 (primary outcome)
AOTC credit amount (secondary outcome)	AOTC credit amount (0 to $2,500)
Secondary tax-related outcomes:	
AOTC refundable credit amount	AOTC refundable credit amount (0 to $1,000)
Form 1098-T outcomes	• Dichotomous indicator for Form 1098-T for TY 2019 sent to the IRS;[6] • Educational expenses reported on Form 1098-T for TY 2019 and TY 2020; • Dichotomous indicator for zero dollars in reported

[6] If observable in the administrative data, another outcome variable to be analyzed is whether the student attached the Form 1098-T to their tax return.

	educational expenses on Form 1098-T for TY 2019; and ● Dichotomous indicator for USFSCO related Form 1098-T behaviors (pending data availability): ○ Opened email notice that 1098-T was issued; ○ Clicked link in 1098-T issued email; and ○ Downloaded 1098-T
Higher education tax credit claim behaviors	● Dichotomous indicators for claiming any higher education tax credit: ○ Claimed Lifetime Learning Credit (LLC); ○ Claimed as a dependent for the Earned Income Tax Credit (EITC); and ○ Claimed LLC, AOTC, or claimed as a dependent for EITC; ● Higher education tax credit credit amounts: ○ AOTC refundable credit amount (0 to $1,000); ○ LLC credit amount; ○ AOTC or LLC credit amount; ○ Higher education or EITC credit amount; and ○ Dichotomous indicator for claimed maximum AOTC amount ● Qualified educational expense reported in TY 2019 for target student ● Claimed most generous education tax credit available (i.e., AOTC or LLC based on prior claim behavior)
Refund amount	Tax refund amount for TY 2019
Filing status in TY 2019	Dichotomous indicators for the following categories: ● Did not file taxes and was not claimed as a dependent; ● Claimed as a dependent; or ● Filed taxes as an independent tax filer (e.g., filed taxes as a single household or married filing jointly)
Mode of filing	Dichotomous indicators for filing taxes with the following categories: ● Used a paid preparer; ● Used free-filing software or IRS's Voluntary Income Tax Assistance (VITA); or ● Self-filed
Date of taxes filed	Continuous measure for date when filed taxes Dichotomous indicators for filed taxes before the following dates: ● Before January 31, 2020 (1098-T available); ● Before March 3, 2020 (expected receipt of AOTC letter);

	● Before April 15, 2020; ● Before July 15, 2020; or ● Before October 15, 2020; and ● Between April 15, 2020 and July 15, 2020.
Economic Impact Payment	Claimed as a dependent for purposes of the Economic Impact Payment. Independent tax filer for purposes of the Economic Impact Payment Economic Impact Payment amount Receipt of Economic Impact Payment
HEERF aid (pending data availability)	Submitted application for HEERF Funds: ● Ever submitted application for HEERF aid; ● Number of applications submitted for HEERF aid; and ● Submitted application for HEERF aid in Spring 2020, Summer 2020, and Fall 2020 Amount of HEERF Funds received: ● HEERF aid received in Spring 2020, Summer 2020, and Fall 2020; and ● Cumulative HEERF aid received in Spring 2020, Summer 2020, and Fall 2020
Federal higher education tax and stimulus aid[7]	Total federal cash aid for target student, as of the end of the Fall 2020 academic period at the University: ● Refundable higher education tax credit amount, Economic Impact Payment, and HEERF aid from the University; ● Refundable higher education tax credit amount and Economic Impact Payment; and ● Refundable higher education tax credit amount and HEERF aid from the University Total federal aid for target student, as of the end of the Fall 2020 academic period at the University: ● Higher education tax credit amount, Economic Impact Payment, and HEERF aid from the University; ● Higher education tax credit amount and Economic Impact Payment; and ● Higher education tax credit amount and HEERF aid from the University
Spillover effects on	Take up of AOTC and/or LLC in TY 2019 among other family

[7]Note that at the time of writing that analysis of HEERF aid are pending data availability. We anticipate being able to measure eligibility and take up of the Economic Impact Payment, but do not anticipate having access to data on FAFSA completion or other forms of financial aid.

siblings and family members	members who filed together in TY 2018 or TY 2017

Table 4. Planned education-related outcomes

Outcome	Description
Included in OES abstract:	
Cumulative credits earned in 2020	The sum of credits earned at the University in academic periods Spring 2020, Summer 2020, and Fall 2020.[8, 9]
Other secondary outcomes:	
Degree progress	
Continued enrollment	Dichotomous indicators for undergraduate enrollment at the University by academic period College enrollment in calendar year 2020 based on Form 1098-T data for TY 2020: ● Enrolled at any college or university; ● Enrolled at least half-time for one or more academic period at any college or university; and ● Reported educational expenses
Graduated	Earned a Bachelor's degree at the University by academic period
Combined continued enrollment or graduated measure	Dichotomous indicator for enrolled at the University or earned a Bachelor's degree at the University by academic period
Credits attempted	Course credits attempted at the University by academic period
Credits earned	Credits earned at the University by academic period
Credits awarded a letter grade	Credits awarded a letter grade at the University by academic period
Academic performance	
Grade point average	Grade point average, based on courses awarded a letter grade, at

[8] Note that our current understanding is the university does not hold interim academic periods between Fall 2019 and Spring 2020 (e.g., a course over winter break). If we learn of additional academic periods (either regularly scheduled or in response to the pandemic), we will include credits earned in those academic periods in this measure.

[9] Students awarded a bachelor's degree from the university in Fall 2019 or earlier will be excluded from this analysis.

	the University by academic period
Percent of credits earned	Credits earned divided by credits attempted at the University by academic period
Percent of courses passed	Courses passed divided by courses attempted at the University by academic period
Credits failed	Credits failed at the University by academic period
Withdrawn credits	Credits dropped or withdrawn at the University by academic period

Outcome periods for education-related outcomes

For each of the education-related outcomes described in Table 4, we will calculate the outcome for the following academic periods:

- Fall 2019;
- Spring 2020;
- Summer 2020; and
- Fall 2020.

In addition to term-by-term measures, we will also calculate cumulative measures that sum together outcomes over these academic periods to create cumulative measures. These cumulative measures will include:

- Spring 2020 - Summer 2020;
- Spring 2020 - Fall 2020;
- First enrollment at the University through Spring 2020;
- First enrollment at the University through Summer 2020; and
- First enrollment at the University through Fall 2020.

Our primary outcome period for education-related outcomes at the University is Spring 2020 - Fall 2020. However, when we examine the robustness of any observed effect on education-related outcomes, we will examine whether the intervention had effects on education-related outcomes in Fall 2019 and between Fall 2019 - Fall 2020.

Transformations of Variables:

Tax-related data

For reanalysis purposes, we plan to clean tax-related data in collaboration with RAAS. Transformations of variables will undergo code review that will include extensive commenting.

Properly claimed AOTC: A student who claimed AOTC, was enrolled at-least part-time for one or more academic periods (based on their Form 1098-T), had not previously claimed AOTC four

times, had not previously earned a Bachelor's degree, had a valid TIN, and whose reported income in TY 2019 was below the eligibility threshold.[10]

Education-related data

Continued enrollment at the University: A student will have a value of 1 for a given academic period if they attempted non-zero academic credits at the University. Otherwise, a student will have a value of 0.

Graduated: A student will have a value of 1 for a given academic period if they earned a Bachelor's degree in that academic period or a prior academic period. Otherwise, a student will have a value of 0.

Combined measure of continued enrollment or graduated at the University: A student will have a value of 1 if they attempted non-zero credits or earned a Bachelor's degree in that academic period or an earlier academic period. Otherwise, a student will have a value of 0.

Grade point average: Depending on the data structure, we may need to create grade point average (GPA) from grades received in courses attempted during the outcome period. In this case, GPA for a given outcome period will be defined as total GPA points divided by total credits attempted for a letter grade.[11]

Percent of course credits passed: Credits earned divided by credits attempted.

Percent of courses passed: Courses passed divided by courses attempted.

Cumulative measures: We will calculate the education-related measures described above for each academic period (e.g., Fall 2019, Spring 2020, Summer 2020, and Fall 2020). We will also create cumulative measures that are the sum of credits earned across multiple academic periods. For example, we will create the primary education-related measure of interest by summing credits earned between Spring 2020 and Fall 2020 academic periods.

Imported Variables:

Blocking measures

In addition to treatment assignment indicators and outcome variables, other imported variables include an exact blocking measure and tax-related baseline covariates that could not be included

[10]Because students may have qualified educational expenses that are not included on Form 1098-T, we will not make AOTC eligibility exclusion based on qualified expenses. Instead, we will examine the effects of the communications-bundle on reported qualified expenses.

[11] Letter grades will be equal to GPA points as follows: A+/A = 4.0 GPA points, A- = 3.67 GPA points, B+ = 3.33 GPA points, B = 3.0 GPA points, B- = 2.67 GPA points, C+ = 2.33 GPA points, C = 2.0 GPA points, C- = 1.67 GPA points, D+ = 1.33 GPA points, D = 1.00 GPA points, D- = 0.67 GPA points, and F = 0 GPA points. Note that during Spring 2020 and Fall 2020, letter grades of D should be recorded as Credit and letter grades of F should be recorded as No Credit.

in the blocking procedure due to data sharing restrictions. The exact blocking measure is a categorical variable created using the interaction of the following student characteristics:

- Registered at the University in Fall 2019;[12]
- Registered an authorized payer, which also serves as a proxy for claimed as a dependent for tax purposes; and
- A year in school and transfer student measure, which includes the following categories:
    - First-time first-years student in Fall 2019;[13]
    - Graduated 2019;[14]
    - Transfer students with less than 60 transfer credits (i.e., an Associate's degree);
    - Transfer students with 60 transfer credits or more (i.e., an Associate's degree);
    - Sophomore in Fall 2019 (excluding transfer students);[15]
    - Junior in Fall 2019 (excluding transfer students); and
    - Senior in Fall 2019 (excluding transfer students).

Additional covariates

Additional imported covariates to improve precision include dichotomous indicators based on the categorical variables described in Table 5.

Table 5. Additional tax-related covariates

Measure	Description
Claimed AOTC in prior years	Dichotomous indicators for: ● First-time eligible for AOTC based on 1098-T enrollment history; ● Never claimed AOTC; ● Claimed AOTC one to three times; or ● Claimed AOTC four or more times.
Filing status in TY 2018	We account for tax filing behavior in 2018 using the following mutually exclusive groups: ● Filed taxes as an independent tax filer; ● Claimed as a dependent; and ● Did not file taxes.
Modified adjusted gross	Following Guyton et al. (2018), we account for reported income

[12] To meet the study inclusion criteria an individual must have been enrolled at some point in 2019 (1/19-12/19). However, these individuals may no longer be enrolled at the university during the intervention period (11/19-4/20) (e.g., students who graduated in 2019, students who transferred schools or dropped out). Registered at baseline also is a proxy for having an active university email account.
[13] Note that all first-time first-year students in Fall 2019 are registered at baseline.
[14] Note that a minority of students who graduated in 2019 (~100 students) are registered at baseline, presumably as graduate students.
[15] Note that the sophomore group will include students who enrolled prior to fall 2019, but are still considered first-year students (based on their credits earned prior to Fall 2019).

income (MAGI)	interacted with TY 2018 filing status using the following mutually exclusive groups: ● Reported income less than $60,000; ● Reported income between $60,000-120,000; and ● Reported income greater than $120,000

In analysis of education-related outcomes, we will also include a baseline measure for average credits earned by academic year—including the summer academic period—prior to Fall 2019.[16]

Treatment compliance measures

Pending data availability, we will also import process measures used to measure treatment compliance, including email engagement information, such as dichotomous indicators for"

- Emails delivered;
- Emails opened; and,
- Email links clicked.

Note that data on whether a letter was deliverable or returned to sender is not available; however an email with similar content was sent at the same time that letters were mailed.

Transformations of Data Structure:

Tax-related data

For reanalysis purposes, we plan to clean tax-related data in collaboration with RAAS. Transformations of data structure will undergo code review that will include extensive commenting.

Education-related data

We anticipate that the education-related data will be structured at the student by course or term level, which will need to be aggregated to the student-level by academic period, or other time period of interest (as described above).

Data Exclusion:

Sample randomly assigned

To better understand the external validity of our results, we note that the random assignment sample excludes the following students:

- students who appear to always have been enrolled as graduate students (based on year in school variables) or who appear to always have been enrolled in non-degree programs;
- students with 120 or more transfer credit hours (the minimum hours required to graduate with a bachelor's degree);

[16] We use the academic year rather than the academic period to account for some students taking courses during summer periods.

- students enrolled less than half-time each term; and
- students missing Social Security Number and gender information.

Tax-related data
Tax credit, tax refund, Economic Impact Payment amount, and HEERF aid amounts claimed will be top coded at the maximum amount eligible to claim or receive. Other standard IRS procedures will be implemented for other potential data exclusions.

Education-related data
College credits attempted and earned will be top coded at 20 credits per academic period. GPA will be top coded at 4.0. Courses attempted and credits attempted measures will exclude withdrawn and dropped courses.

Treatment of Missing Data:

Tax-related data
Non-filers: Students who did not file their taxes and were not claimed as a dependent for tax purposes will be considered not to have claimed higher education tax credits.

Students who did not claim a higher education tax credit: Students who did not claim a tax credit (including non-filers), will be considered to have a zero dollar credit amount.

Education-related data
2019 Graduates: A known source of missing data for education-related outcomes is students who graduated prior to randomization, in spring or summer 2019 (N = 1,379). These students will have missing data for education-related outcomes and will be excluded from analysis of education-related outcomes. In practice, we will exclude random assignment blocks for students who graduated in 2019 (i.e., graduated in 2019 and registered authorized payer, and graduated in 2019 and did not register authorized payer).

Additionally, a subset of students who were seniors at the time of randomization will graduate during the Fall 2019 academic period, which is prior to our main outcome period for academic outcomes. These students will also be excluded from our primary specifications for education-related outcomes; however, we will conduct additional analysis that includes these students and the Fall 2019 academic period to better understand the robustness of our findings.

2020 graduates: Students who graduated during the outcome period (Spring 2020 - Fall 2020) will be included in education-related measures in post-graduation terms as follows.

> *Continued enrollment or graduated:* They will be assigned values in the same way as other students.

Other education-related outcomes: We will run this analysis as if students did not earn or attempt credits in academic periods after they graduated. Additionally, we will examine the robustness of our findings by bounding our estimates and excluding 2020 graduates from analysis.

Other non-enrolled students: Missing data from other non-enrolled students for education-related measures will be created as follows.

Degree progress measures: Missing credits attempted in an academic term will be interpreted as the student not being enrolled at the University in that academic period. As a result, missing values will be imputed to zero for the degree progress measures.[17]

Academic performance measures: We will run this analysis in three ways. In the first approach, we will exclude other non-enrolled students in the analysis of academic performance measures in academic periods where they are not enrolled. In the second and third approaches, we will attempt to bound the estimates by imputing outcomes.

Descriptive Statistics, Tables, & Graphs

We plan to report descriptive statistics to the agency partner on take up of the higher education tax credits, Federal Aid from the CARES Act, and education-related outcomes. We also plan to report descriptive statistics on take-up of the communications-bundle e-mail treatments (i.e., open and click rates).

Statistical Models & Hypothesis Tests

This section describes the statistical models and hypothesis tests that will make up the analysis — including any follow-ups on effects in the main statistical model and any exploratory analyses that can be anticipated prior to analysis.

Statistical Models:

Randomization test

Before continuing with the analysis, we will check the initial randomization by conducting d *2* omnibus balance tests using observable characteristics—in particular, prior take up of AOTC, MAGI in TY 2018, baseline credits earned, and baseline average credits earned per academic year. We will run this analysis for assignment to the pooled communications-bundle treatment, as well as for the IRS letter communications-bundle treatment and the University letter communications-bundle treatment.

[17] We can supplement data on credits earned and attempted at the University with a more crude measure of enrollment at least part-time for one or more academic periods at other colleges and universities using Form 1098-T data. As a robustness check, we will examine how sensitive our findings are to including enrollment information during the 2020 calendar year, captured in the Form 1098-T data.

Primary specifications

Intent-to-treat effects

Our primary specification measures the causal intent-to-treat (ITT) effects of assignment to the pooled treatment—the communications-bundle with either version of the letter—or a version of the treatment—the communications-bundle with IRS letter or the communications-bundle with University letter—on outcomes of interest. To measure these effects, we will use covariate-adjusted OLS models that include the series of blocking variables and a handful of student-level covariates to improve precision.

Robustness checks and sensitivity analyses

As robustness checks, we will interact covariates and block variables with treatment assignment following Lin (2013).[18] In addition, when the outcome is a dichotomous indicator, like AOTC take up or enrollment, we will run an analogous logistic regression model to test the robustness of our findings. If results are different, our primary specification takes precedence for the OES Abstract.[19]

Standard error adjustments

Heteroskedasticity-consistent standard errors (HC2) will be used for all analyses.[20]

Research Question #1:

Does sending a coordinated communications-bundle about AOTC to enrolled or recently enrolled college students increase take up of AOTC?

To answer this research question we compare the likelihood that a student claims AOTC on their 2019 tax return among students sent the communications-bundle compared to students sent only business-as-usual communications. We will test this hypothesis using the following OLS regression:

$$(1)\quad Y_{ib} = \beta_0 + \beta_1(T_{ib}) + \pi Z'_{ib} + \alpha_b + \varepsilon_{ib}$$

where *i* indexes students in blocks *b*, and

Y_{ib}: is the outcome of interest;
T_{ib}: is an indicator for random assignment to a communications-bundle group;
Z'_{ib}: is a vector of student-level characteristics;

[18] Lin, W. (2013). Agnostic notes on regression adjustments to experimental data: Reexamining Freedman's critique. *Annals of Applied Statistics*, *7*(1), 295-318

[19] Freedman, David A. "Randomization does not justify logistic regression." *Statistical Science* (2008): 237-249.

[20] OES Guidance on calculating standard errors can be found at: https://oes.gsa.gov/assets/files/calculating-standard-errors-guidance.pdf

α_b: are block fixed effects ; and

ε_{ib} : is an error term.

The coefficient β_1 is the ITT estimate of the average treatment effect for being sent the communications-bundle (including either letter) compared with not being sent the communications-bundle. The null hypothesis is that $\beta_1 = 0$. Our primary outcome is a dichotomous measure for claiming AOTC in tax year 2019; however, we will also report the treatment effect on the amount of the AOTC tax credit in the OES abstract.

Blocking variables (α_b) capture:

- Whether a student was registered at the University in Fall 2019;
- Whether a student had a registered authorized payer; and,
- A student's year in school, which also accounts for status as a first-time or transfer student.

The vector of additional covariates (Z'_{ib}) to improve precision includes:

- Dichotomous indicators for history of prior take up of AOTC (i.e., first-time eligible for AOTC based on 1098-T enrollment history, never claimed AOTC, AOTC take up one to three times, and AOTC take up four or more times);
- Dichotomous indicators for tax filing behavior in TY 2018 (i.e., filed taxes as an independent tax filer, claimed as a dependent, and did not file taxes); and,
- Dichotomous indicators of income in TY 2018 (i.e., missing MAGI, reported MAGI less than $60,000; reported MAGI between $60,000-120,000; and reported MAGI greater than $120,000).[21]

Research Question #2:

Are there messenger effects on AOTC take up of being sent a coordinated communications-bundle with a letter from the IRS compared to being sent a coordination communications-bundle with a letter from University?

We will test this hypothesis using a less restricted version of the OLS regression in equation (1), where:

(2) $$Y_{ib} = \beta_0 + \beta_1(IRS_{ib}) + \beta_2(University_{ib}) + \pi Z'_{ib} + \alpha_b + \varepsilon_{ib}$$

where *i* indexes students in blocks *b*, and

Y_{ib} : is the outcome of interest;

[21] For education-related outcomes, we will also include a covariate for baseline average credits earned at the University per year. For students without a course history at the University values will be imputed to the average for the full sample and an indicator for imputed data will be included in the regression. Also note that the categorical covariates described are mutually exclusive, and one group will be dropped from the regression due to collinearity. All are included in the analysis plan for completeness.

IRS_{ib} : is an indicator for random assignment to with communications-bundle group with IRS letter;

$University_{ib}$: is an indicator for random assignment to with communications-bundle group with University letter;

Z'_{ib} : is a vector of student-level characteristics;

α_b: are block fixed effects for student enrollment and financial characteristics; and

ε_{ib} : is an error term.

The quantity $\beta_2 - \beta_1$ is an estimate of the difference in the average treatment effect for those sent a communications-bundle with University letter compared with those sent a communications-bundle with IRS letter. The null hypothesis is that $\beta_2 - \beta_1 = 0$. Again, our primary outcome is a dichotomous measure for claiming AOTC in tax year 2019. The covariates (Z'_{ib}) and block fixed effects (α_b) are the same as in equation (1).

Follow-Up Analyses:

For all analysis of tax-related outcomes, our primary specification will include all students in the random assignment sample. In addition, we will conduct sensitivity analysis to examine whether the effect differs when we define AOTC take up as properly claimed. If the statistical significance or direction of the effects differs between models, we will report both estimates in the OES abstract. Otherwise, we will report only the results from our primary specification.

Research Questions #3A and #3B:

3A. Does sending a coordinated communications-bundle about AOTC to enrolled or recently enrolled college students impact progress towards degree completion?

3B. Are there messenger effects on progress towards degree completion of being sent a coordinated communications-bundle with a letter from the IRS compared to being sent a coordination communications-bundle with a letter from University?

We test research question #3A using equation (1) and research question #3B using equation (2). We measure the ITT effects of the communications-bundle and type of communications bundle on progress towards degree completion using two measures that capture progress on the intensive margin—enrolled or graduated in Fall 2020—and extensive margins—cumulative credits earned between Spring 2020 and Fall 2020.

In the OES abstract, we will report the ITT effect on the pooled treatment (question #3A) for the credits earned measure. We will report the ITT effects of the individual treatments (question #3B) if there are differential effects by letter type on AOTC take up or differential effects on degree progress. We do not plan to report the other analysis for research questions #3A and #3B in the OES Abstract. Instead, we will report this analysis to the IRS and in other publications.

Note that for analysis of education-related outcomes, our primary specification includes a covariate for average credits earned per year and excludes students who graduated in 2019. As part of our analysis of heterogeneous treatment effects (described in more details below), we will interact treatment (or treatments) with the continuous measure of average college credits earned per year to explore whether the effects of the treatment differ based on prior rate of degree progress.

Additional analysis not included in the OES Abstract:

In addition to the ITT estimates of the average treatment effect of the communications bundle, we will also use an instrumental variables approach to measure the treatment-on-treated (TOT) effects of engagement with the communication-bundle emails (pending data availability).[22,23] We will define compliance or take up of the treatment in three main ways:

- (a) one or more communication-bundle email successfully delivered;
- (b) opening one or more of the communications-bundle emails; and
- (c) clicking on any of the links embedded in the communications-bundle emails.[24]

Assignment to treatment (T_i) will be used as the instrumental variable to predict engagement with the communications-bundle in the first-stage regression, then predicted engagement with the communications-bundle will replace treatment assignment in the main effects regression.

Research Question #4

Are there heterogeneous treatment effects of sending a coordinated communications-bundle on AOTC take up and educational outcomes?

We plan to examine heterogeneous treatment effects on primary tax and education outcomes among the following groups:

Follow up analysis:

- Students who registered an authorized payer compared to students who did not register an authorized payer; and
- Students claimed as a dependent in TY 2018, compared to students who filed their taxes as an independent tax filer in TY 2018, compared to students who did not file taxes in TY 2018.

[22] Bloom, Howard S. "Accounting for no-shows in experimental evaluation designs." Evaluation review 8, no. 2 (1984): 225-246.

[23] Angrist, Joshua D., Guido W. Imbens, and Donald B. Rubin. "Identification of causal effects using instrumental variables." *Journal of the American statistical Association* 91, no. 434 (1996): 444-455.

[24] At the time of writing, we are uncertain about the availability of these data. In the case that only aggregate information on open and click rates are available, we will measure the TOT effects using the Wald estimator. Unfortunately, we do not anticipate having similar data for the letter mailings, for example, undeliverable. However, to explore whether the treatment-on-treated effects differ based on compliance among students or authorized payers we will also define treated using measures based on emails sent only to students and based on e-mails sent only to authorized payers.

Exploratory analysis:

- Students who claimed AOTC in a prior year compared to students who had never claimed AOTC;
- Students who earned a Bachelor's degree prior to Fall 2019 compared to students who had not earned a Bachelor's degree as of Fall 2019;
- Students enrolled at the University at baseline compared to students who were not enrolled at baseline; and
- Students expected to graduate after 2020 compared to students expected to graduate in 2020 or 2019.

We will test for heterogeneous treatment effects using the ordinary least squares (OLS) regression in equation (1) and equation (2) , and adding interaction terms between the treatment (or treatments) and covariate of interest. If we find heterogeneous treatment effects on our primary outcome of interest, then we will also explore whether there are heterogeneous effects on secondary outcomes, and messenger effects on primary and secondary outcomes.

Inference Criteria, Including Any Adjustments for Multiple Comparisons:
For the hypotheses in the primary analysis on AOTC take up, we will infer that we cannot reject the null hypothesis if p-values are greater than .05 using two-tailed tests. Given that our primary analysis examines the effects of the bundle of communications (regardless of letter type), we will not adjust p-values for multiple comparisons when measuring the pooled treatment effect on the primary outcome of interest.[25]

Limitations:
Statistical power poses a limitation to our design and ability to understand potential null effects. Specifically, we may be underpowered to detect effects of the communications-bundle on education-related outcomes, which is further complicated by the uncertainty around college enrollment and academic performance during the COVID-19 pandemic. While this analysis is planned, the communications-bundle would likely need to have a strong effect on AOTC take up—or influence receipt of other forms of aid such as receipt of the Economic Impact Payment—to impact downstream education-related outcomes. We are managing this limitation by focusing our primary analysis on take-up of AOTC.

Similarly, we expect to be underpowered to detect a messenger effect on take-up of AOTC, since all students in the communications-bundle group were sent the same emails and only the sender of the letter differs between the communications-bundle with IRS letter group and the communications-bundle with University letter group.

[25]OES guidance on multiple comparisons adjustments can be found at: https://oes.gsa.gov/assets/files/multiple-comparison-adjustment.pdf

A final limitation is that some students included in the sample likely are not eligible to claim AOTC. In turn, these students are unlikely to claim AOTC which could dilute the effects of the intervention. Our research design attempts to mitigate this concern by:

- carefully consider the sample and filtering out ineligible students as much as possible;
- blocking to account for likely student eligibility when possible; and
- conducting sensitivity analysis based on eligibility status during the analysis phase (when eligibility status information will be more complete).

Exploratory Analysis:
Exploratory analysis will examine the effects of the communications-bundle on the tax-related and education-related secondary outcomes described above.

The distribution of higher education tax credits and the distribution of the Economic Impact Payment, depend on whether college students were claimed as a dependent for tax purposes.[26] Whether a student was claimed as a dependent influences who receives the payment (the primary filer or dependent) and the amount of the payment (up to $1,200 compared to $500). Because the differences in distribution and payment could influence students' college outcomes, we also plan to provide descriptive evidence on the stimulus and tax credit aid that a student was eligible for and claimed, the relationship between aid received and tax filing behaviors, and the relationship between aid received and education outcomes. Pending data availability, we will include receipt of HEERF aid in this analysis.

If we find that the communications-bundle treatment had a large effect on take up of higher education tax credits and/or other forms of Federal aid, then we will use the communications-bundle as an instrument to measure the effect of aid on educational outcomes. in a two-stage least squares regression. We will estimate the TOT effects using assignment to the communications bundle group as an instrument for take up of aid (Bloom, 1984; Angrist, Imbens & Rubin, 1996).

Finally, if we find large direct effects on AOTC take up among students assigned to the communications-bundle group, we plan to explore whether there are spillover effects of the communications-bundle on take up of higher education tax credits among other family members.

Link to an Analysis Code/Script:

Post-Commitment Adjustments

[In this section, record any adjustments made to the Analysis Plan subsequent to the Analysis Plan Commitment gate. For every adjustment, record its rationale, whether it was made before or after receipt of outcome data, and whether results can be reported as planned/confirmatory (versus exploratory).]

[26] https://www.irs.gov/newsroom/who-can-get-more-economic-impact-payment-money-for-children