Tulane Economics Working Paper Series

How Does the Price of College Affect Major Choice?

Emily E. Cook
Texas A&M University
ecook4@tamu.edu

Ruipu Gao
Tulane University
rgao4@tulane.edu

Working Paper 2411
October 2024

Abstract

We illustrate two ways in which the price paid for college tuition ("net tuition") may affect students' major choice: 1) a selection effect in which increased net tuition discourages attendance among students with high non-pecuniary returns to low-wage majors, and 2) a "switching" effect in which all students are more likely to choose a high-wage major when net tuition is high, because the marginal utility of consumption increases with net tuition. Using fixed-effects regressions on data from public colleges from 2000-2019 and an IV strategy based on state-level appropriations budgets, we estimate a $1,723 increase in the annual wage associated with college graduates' degree fields per a $1,000 increase in net tuition.

Keywords: major choice, net tuition, human capital
JEL codes: I22, I23, I26

How Does the Price of College Affect Major Choice?

Emily E. Cook
Texas A&M University

Ruipu Gao
Tulane University

October 26, 2024

Abstract

We illustrate two ways in which the price paid for college tuition ("net tuition") may affect students' major choice: 1) a selection effect in which increased net tuition discourages attendance among students with high non-pecuniary returns to low-wage majors, and 2) a "switching" effect in which all students are more likely to choose a high-wage major when net tuition is high, because the marginal utility of consumption increases with net tuition. Using fixed-effects regressions on data from public colleges from 2000-2019 and an IV strategy based on state-level appropriations budgets, we estimate a $1,723 increase in the annual wage associated with college graduates' degree fields per a $1,000 increase in net tuition.

Keywords: Major choice; net tuition; human capital
JEL No. I22, I23, I26

Emily E. Cook: Department of Economics, Texas A&M University. 2935 Research Pw, College Station, TX 77843. ecook4@tamu.edu
Ruipu Gao: Department of Economics, Tulane University. 6823 St. Charles Avenue. New Orleans, LA 70118. rgao4@tulane.edu

Acknowledgements: We are grateful to Elliott Isaac and William Dodds for helpful feedback. The work has also benefited from feedback from seminar participants at Tulane University and attendees at the Western Economic Association International conference (WEAI 2024).

1 Introduction

The choice of a college major is an important individual decision with consequences for public policy. A college major directly influences the type of employment opportunities and earnings an individual can expect. For example, according to the Occupational Outlook Handbook by the U.S. Bureau of Labor Statistics (2024), the median annual wage for computer and information technology-related jobs is just above $100,000, while the median annual wage for education-related positions is typically less than $80,000. While the college major decision clearly has implications for students, it is also an active area of policy interest in the US, motivated by a perception that future STEM workforce needs exceed supply. Examples of state and federal policies promoting education in STEM include the state of New York's STEM incentive program, which offers a grant for high school students meeting certain criteria who attend an in-state college to major in STEM (New York State Higher Education Services Corporation 2024), and the National Science Foundation's Directorate for STEM Education that provides support for initiatives that encourage STEM education at all levels (U.S. National Science Foundation 2024). Because college major choice is consequential for students and for policy, researchers have studied the determinants of college major choice, finding that a wide variety of pecuniary and non-pecuniary factors play a role (Altonji, Arcidiacono, and Maurel 2016).

We build upon the existing work by investigating whether increases in net tuition (tuition net of grant aid) may encourage students to choose majors associated with higher expected earnings. We motivate a link between net tuition and degrees awarded by field with a theoretical model based on work by Stater (2011). In the model, a student's utility of consumption increases as net tuition increases, because net tuition reduces consumption and we assume diminishing marginal utility of consumption. Students who choose a major with low expected wages but high non-pecuniary returns when net tuition is low may switch to a higher-wage major when tuition increases, because the marginal utility of consumption has increased. This is the "switching" effect implied by the model. Assuming students vary in non-pecuniary returns to different majors, the model also suggests a selection effect. The type of student who has high non-pecuniary returns to majors with low expected wages is less likely to attend college at all when net tuition rises, while the type of student with high non-pecuniary returns to high wage majors continues to attend college. For example, students with a strong preference for the arts may choose not to attend college when the cost of college increases, rather than switching to a major with higher expected wages, such as engineering. This mechanism drives a change in the composition of the student body in terms of preferences over fields.

Using institution-level data from the Integrated Postsecondary Education Data System (IPEDS) for the years 2000-2019, we examine the link between average net tuition at the institution level and the degrees awarded by field. Our baseline results are from a panel regression that controls for factors fixed at the institution- and year- level. In the same regression, we include controls for university quality and for economic conditions in the state. Because net tuition could be changing with unobserved demand conditions—which are potentially also correlated with major choices—we use an instrumental variable based on state budgets for appropriations to public institutions, motivated by work that links state appropriations budgets to tuition levels (Bound et al. 2019, 2020; Webber 2017; Cook and Turner 2022). The instrument is the total state appropriations budget divided by total full-time enrollment in public institutions in the state. Because our instrument is only relevant for public institutions, we focus on public institutions throughout our analysis.

Fixed-effects regressions with university- and state-level controls show a slightly positive but insignificant relationship between the average wage in the chosen major and the net tuition level: for each \$1,000 increase in net tuition, the annual wage increases by \$69. When we use the instrumental variable approach, we estimate a larger effect: an increase in annual wage of the chosen major of \$ 1,723 for each \$1,000 increase in net tuition. We categorize majors into several groups to examine what major fields drive these aggregate changes in the wage of the chosen major. We use the same fixed-effects and IV regression framework with the percentage of degrees awarded in each of six fields as the outcome variables. The instrumental variables results show that when net tuition increases, the share of students majoring in Business and Communications increases by 0.629 percentage points and for STEM, 1.133 percentage points. As these are high-paying fields, this aligns with the hypothesis that high net tuition causes students to major in high-paying fields. However, the share majoring in Education also increases by 0.673 percentage points, which is in opposition to that hypothesis. Nonetheless, the field of education does have high job security, so the result suggests that higher net tuition levels cause students to consider not only lucrative majors but also those that offer stable and secure career prospects. We see reductions in the share of Social Science and Humanities majors and Health majors with increases in net tuition, and essentially no change for Arts and Architecture. We implement a robustness check to examine whether the economic recession during 2008 to 2011 distorts our results. We do not find substantial difference between our main findings and the results without the recession years.

Given the importance of the college major decision for both individual students and public policy, a large body of work has studied the determinants of major choice. Some of this work documents how pecuniary factors influence students' choice of college majors (Beffy, Fougere, and Maurel 2012; Blom, Cadena, and Keys 2021; Long, Goldhaber, and Huntington-Klein 2015). Other studies demonstrate the importance of preferences and social factors in determining major choice (Wiswall and Zafar 2015; Anelli and Peri 2015; Leppel, Williams, and Waldauer 2001).

Prior evidence also shows that state scholarship programs can affect major choice. Castleman, Long, and Mabel (2018) found a positive impact of need-based financial aid through the Florida Student Assistance Grant (FSAG) on STEM course and degree completion among students who are academically prepared to pursue STEM in college. Based on the administrative records from the University System of Georgia (USG), David L Sjoquist and John V Winters (2015a) found that the HOPE scholarship in Georgia reduced the likelihood of getting the STEM degree. These studies feature clear identification of causal effects of grant programs, but their findings apply narrowly to these specific state programs. David L. Sjoquist and John V. Winters (2015b) uses individual-level data from across the US along with state-level variation in merit aid programs to study the effects of merit aid programs, and find that merit aid programs reduce STEM completion. The difference between the need- and merit-based aid programs may be due to differing renewal requirements for maintaining the scholarships.

Others have examined the effects of loans on major and occupation choice. Rothstein and Rouse (2011) used a natural experiment involving a financial aid policy change at an elite university to show that student debt motivates college graduates to choose higher-salary occupations. Minicozzi (2005) found that large loans induces students to have a high initial wage as soon as they graduate from college, but their wage growth is slow after 4 years of graduation.

The two studies most closely related to our work are Shin and Milton (2008) and Stater (2011). Shin and Milton (2008) use a single year of IPEDS data to perform cross-sectional analysis examining how total enrollment in a few specific majors responds to changes in tuition. The estimates do not account for unobservable differences across institutions that may affect both tuition and enrollment by field. Stater (2011) analyzes the effect of tuition and financial aid on college students' first-year choice of major using student-level from three large large public universities. The advantage of this approach is the ability to control at the student-level for demographics and academic preparedness. However, this approach did not control for selection on unobservables that could drive aid amounts and college major choices. Also, because the analysis is limited to several specific institutions, it is not clear to what extent the results are applicable to other contexts. We contribute to this literature by implementing a national study using fixed-effects to control for unobserved cross-sectional differences across institutions and an instrumental variables approach to account for the potential of unobservables (e.g. demand shocks) that could cause within-institution correlation between net tuition and major choice over time.

2 Mechanisms

To illustrate two mechanisms by which rising net tuition may affect major choice, we present a modified version of the model from Stater (2011). A student's utility of choosing major m, $U_m(a_{im}, z_m)$, is increasing in expected future consumption, z_m, and non-pecuniary returns a_{im}, which may vary across majors and students. Expected future consumption, z_m, is increasing in wage returns to each major and decreasing in net tuition. The non-pecuniary factor a_{im} includes students' aptitude or preference for choosing major m. Because these non-pecuniary benefits to each major are different for each student, some students will have high a_{im} for majors that also generate high wages, while for other students there will be a tradeoff between high-wage majors and those with high non-pecuniary returns. In addition to the assumption that $U_m(a_m, z_m)$ is increasing in a_m and z_m, we also assume diminishing marginal utility of each factor. Thus when net tuition increases, the decrease in total utility is smaller for those majors with high earnings potential.

Figure 1a shows utility across two example majors for two types of students.The x-axis orders Major 1 and Major 2 in terms of increasing expected earnings; that is, Major 1 always has the lowest expected earnings and Major 2 always has the highest expected earnings. We normalize the utility level of not attending college (the "outside option") to zero, so that a person who cannot attain utility higher than zero across all majors will not attend college. We illustrate two types of students who vary in their non-pecuniary preferences for majors. Type I preferences are illustrated with the dashed line. For this type, the non-pecuniary and pecuniary benefits of the two majors are positively correlated, and the student therefore has a strong preference for Major 2. For Type II, illustrated with the solid line, the student's non-pecuniary and pecuniary benefits are negatively correlated and the student's current choice is Major 1. Note that Type II's total utility of college attendance will never be as high as Type I's, because Type II cannot attain both high wage returns and high non-pecuniary returns in the same major, while Type I can.

Using this simple model, we illustrate two mechanisms—a selection effect and a "major-switching" effect—which could generate a relationship between net tuition and the chosen major. The selection mechanism refers to the idea that increases in net tuition may affect the likelihood of college enrollment differently for students with different preferences over majors. If increases in net tuition make it less likely that students of certain types attend college, it will affect the composition of the student body across types. Recall that in Figure 1a, Type I students are able to attain higher total utility from college relative to Type II, because Type I's have strong non-pecuniary returns to high-paying majors. When net tuition increases, Type II students are therefore more likely to give up attending college at all relative to Type I students. This change is illustrated in Figure 1b, where the black line changes to the red line due to the rise in net tuition.

The "switching" mechanism refers to the idea that students who might choose a low-paying major when net tuition is low may instead choose a higher-paying major when net tuition is high. This can occur when marginal utility of consumption is diminishing, so that loss of consumption value at already-low values of consumption has a large negative effect on total utility. Figure 1c displays the mechanism. We focus on those students who initially want to choose Major 1. When net tuition increases, expected consumption declines for all majors, but due to the diminishing marginal utility of consumption, the negative effect on utility is larger for majors where consumption is relatively low to begin with. In the figure, this is represented by the black line shifting to the red line. As illustrated in the figure, it is possible that students who initially had a slight preference for Major 1 may instead choose Major 2 in a world with high net tuition.

The selection and switching effects both suggest that net tuition may be correlated with major choice. In particular, we expect that when net tuition increases, students will be more likely to choose high-return majors. Our data and empirical strategy do not allow us to test the degree to which are findings are driven by the selection mechanism or the switching mechanism. Instead, we test whether the hypothesized link between major choice and net tuition exists and whether the direction of the effect is consistent with the mechanisms illustrated here.

3 Data Sources and Variable Construction

Our college data is from the Integrated Postsecondary Education Data System (IPEDS) from academic years 2000-01 through 2019-20, and our wage data by occupation are from the Bureau of Labor Statistics' (BLS) National Occupational Employment and Wage Estimates. In our sample, we include only four-year institutions. Our instrumental variables strategy is feasible only for public institutions, so we focus on these institutions throughout. In this section, we define the outcome variables used in the regression analysis and provide summary statistics for our analysis dataset.

3.1 Outcome Variables

We use two outcome variables to quantify the effect of changes in net tuition on major choice. The first is the major-weighted expected annual wage at the institution level, which we use to test whether students choose higher-earning majors when net tuition increases. Details of the construction of this variable are in subsection 3.1.1 below. The second is the percent of students graduating in each degree field. There are many potential degree fields, so in order to facilitate interpretation, we categorize degree fields into several different categories and report regression coefficients for each. The categorization is discussed in subsection 3.1.2. Note that because our only measure of major choice is final degrees awarded, we will not be able to examine major-switching in college.

3.1.1 Annual Wage

Our first outcome measure is the major-weighted college annual wage, which we construct by connecting IPEDS data on graduation by degree field with wage data by occupation from the Bureau of Labor Statistics (BLS). This weighted-average wage allows us to investigate whether increases in net tuition lead students to choose majors that lead to higher-paying careers *on average*, without having the classify majors into a small number of categories. While we also show an analysis where the outcomes are categories of majors, this specification is useful because it allows us to summarize the link between major choice and net tuition with a single regression coefficient.

Data about college major from IPEDS is coded by Classification of Instructional Programs (CIP), and data about occupation type in BLS is coded by Standard Occupational Classification (SOC) code. We use the crosswalk between SOC and CIP available from the National Center for Education Statistics to merge the detailed six-digit CIP codes and SOC-coded occupations. Then we calculate the weighted-average annual wage for each college as:

$$\Sigma_{c=1}^{J} P_{ict} \times y_{jt}, \tag{1}$$

where P_{ijt} denotes the proportion of students in institution i choosing major j (as measured by the six-digit CIP code); and y_{jt} denotes the annual wage from BLS for CIP code c in year t.

The CIP and SOC codes do not have a one-to-one mapping, so it is possible that one CIP-specified major is associated with several SOC occupations, and vice-versa. In our analysis, we use the majors as our baseline; that is, each major is assigned with several types of occupations. We obtain the annual wage for each major by averaging the annual wage across occupations within this major category, weighting by employment in each occupation. For example, according to the 2010 version of crosswalk, the major "Agricultural Economics" is associated with two occupations: "Economists" and "Agricultural Sciences Teachers, Postsecondary." The annual wage assigned to "Agricultural Economics" is the weighted average annual wage over"Economists" and "Agricultural Sciences Teachers, Postsecondary," where the weights are the employment in each SOC code.

3.1.2 Major Categories

Our second outcome variable is degrees awarded by field. The IPEDS database shows graduation by detailed (six-digit) Classification of Instructional Program (CIP) codes. There are hundreds of six-digit CIP codes, so it would be difficult to summarize and interpret regressions with degrees awarded in each detailed degree field as an outcome. Instead, we classify degree fields at a high level, resulting in seven different degree categories. The categories are Arts and Architecture; Business and Communications; Education; STEM; Social Science and Humanities; Health; and Vocational and Other. The classification of majors into categories is outlined in Table A.1, where we show the high-level (two-digit) CIP codes and the corresponding category that we have assigned.

We construct a set of outcome variables measuring the percent of students in each of our large categories, by institution. We calculate the outcome variable $DegreePct_{ijt}$ by dividing the number of students obtaining a degree in major category j by the total number of graduates in all seven categories, as shown in the equation below.

$$DegreePct_{ijt} = \frac{Degrees_{ijt}}{\Sigma_{k=1}^{7} Degrees_{ikt}} \times 100 \tag{2}$$

We convert the shares to percentages (multiplying by 100) to scale the regression coefficients for readability.

3.2 Summary Statistics

Table 1 provides summary statistics of the outcome variables and independent variables. All of the statistics in this table are calculated for the academic years 2000-01 through 2019-20, for public universities that have non-missing values of all variables. These statistics are unweighted; they are simple averages across institutions. The first panel in the table shows our outcome variables, as defined above. In the first row, we see that the average annual wage implied by student major choices is $72,626. The average share of students by major category is shown in the next several rows. The "Vocational and Other" category is excluded throughout the presentation of results, but by construction, the shares across all categories sum to one. Social Science and Humanities is the largest category, making up 26.9% of degrees awarded, with Business and Communications a close second at 24.1% of degrees awarded. Arts and Architecture, Education and Health are smaller categories.

Our measure of net tuition is the in-state tuition minus average grants from all sources. During the period 2000-2019, the average of this measure was $2,720. The state-level average appropriations per student is approximately $10,000 during this period, while expenditures per student on salaries and wages for education and general services are around $10,927.

Figure 2 shows the average wages associated with each major category. These statistics are created by merging the occupation-level wages from the 2017 (BLS) National Occupational Employment and Wage Estimates to six-digit CIP codes as described above. We then aggregate from the six-digit CIP codes to our large major categories by taking the weighted average across CIP codes, where weights are the degrees awarded. Business and STEM are associated with the highest annual wages, while Education and Health are at the bottom of the wage distribution.

4 Empirical Strategy

To study the link between net tuition and major choice, we use fixed-effects models with and without an instrument for net tuition. We describe our empirical strategy in more detail in this section.

4.1 Major-Weighted Annual Wage and Net Tuition

The illustrative model in Section 2 suggests that we should see more students majoring in high-wage majors when net tuition increases. In the baseline model, we test this using a fixed-effects panel regression of the following form:

$$Y_{ist} = \beta_0 + \beta_1 NT_{ist-3} + \beta_2 X_{ist-3} + \gamma_{is} + \delta_t + \varepsilon_{ist}, \tag{3}$$

where Y_{ist} is the major-weighted annual wage implied by the degrees awarded at institution i at year t as discussed in Subsection 3.1.1. Although each institution is located in only one state s, we include the state subscripts because they become important in the instrumental variables regression later. NT_{ist-3} is the net tuition for institution i three years before graduation, and X_{ist-3} are controls for state-level economic conditions and university and student characteristics. These controls include the state median income, unemployment rate in the state, college expenditures for salaries and wages related to education and general activities (per student), state and federal grants awarded to the students, and the average admissions test score of the freshman class, measured in ACT score units[1] We lag both the controls and the explanatory variable of interest because the cohort likely makes their major decisions a few years before graduating.

While we do include controls for student- and college-level factors that may be correlated with both net tuition and major choice, it is possible that there are unobserved factors that are correlated with both net tuition and students' choice of major — for example, a trend in the

1. We convert SAT scores to ACT units and average across the student population.

quality or reputation of the college which shifts demand in a specific field. We thus supplement our panel regression with an instrumental variables strategy.

Our instrument captures variation in state budgets for appropriations to public universities. Specifically, the instrument is the appropriations per student at the state-level. We can write this as:

$$A_{st} = \frac{\Sigma_{i \in I_s} appropriations_{it}}{\Sigma_{i \in I_s} enrollment_{it}}, \tag{4}$$

where $enrollment_{it}$ is the full-time undergraduate enrollment at institution i in year t and $appropriations_{it}$ is the total state appropriations given to institution i in year t. I_s is the set of institutions in state s. The relevance of this instrument has been established in previous studies showing that state-level appropriations shocks are related to tuition levels (Webber 2017; Deming and Walters 2017; Chakrabarti, Gorton, and Lovenheim 2020; Cook and Turner 2022).

The two-stage least squares model using this instrumental variable is as follows, where s is the state in which institution i is located:

First Stage:

$$NT_{ist-3} = \alpha_0 + \alpha_1 A_{st-3} + \alpha_2 X_{ist-3} + \tau_{is} + \rho_t + \xi_{ist} \tag{5}$$

Second Stage:

$$Y_{ist} = \beta_0 + \beta_1 \widehat{NT}_{ist-3} + \beta_2 X_{ist-3} + \gamma_{is} + \delta_t + \varepsilon_{ist} \tag{6}$$

The exclusion restriction requires that appropriations are correlated with major choices through net tuition but not through other channels, conditional on controls. This is plausible if the state budget is determined largely by local economic conditions and political priorities rather than the performance of individual institutions. Even so, one concern with the exclusion restriction might be that institutions can react to changes in appropriations by adjusting spending, and that those adjustments might affect major choice, depending on how they are implemented. We include education and general spending (per student) as a control to mitigate this concern.

4.2 Major Categories

An alternative way of quantifying the relationship between chosen major and net tuition is to estimate major-specific regressions with net tuition as the key explanatory variable. This has the advantage that it does not require any mapping of majors to expected wages, but it has the disadvantage that many majors must be classified into a small set of types to facilitate interpretation.

We classify majors into types and construct the outcome variable as the percent of degrees awarded in each field, as discussed in Subsection 3.1.2. Then we estimate regressions of the following form separately for each field:

$$Y_{isjt} = \beta_{0j} + \beta_{1j} NT_{ist-3} + \beta_{2j} X_{ist-3} + \gamma_{ij} + \rho_{jt} + \varepsilon_{isjt} \tag{7}$$

where Y_{isjt} is the percent of degrees awarded in major type j within the institution i (located in state s) in year t. The controls are the same as in Equation 4.

The estimate of β_{1j} will tell us the change in the share of graduates in major type j with a one thousand dollar increase in net tuition. However, because changes in net tuition may be correlated with unobserved institution-level changes that may affect major choice, we also provide estimates from a two-stage least squares model using our instrument based on state appropriations, as discussed in the previous section.

5 Results

5.1 Annual Wages

Table 2 shows the estimates for the OLS and IV Equations 3 and 6, where the outcome variable is the weighted average annual earnings at each institution implied by graduates' degree fields. In the OLS, the relationship between net tuition and the average wage of the chosen major is positive but small ($69) and not statistically different from zero. In the IV regression, we find that a $1,000 increase of the net tuition causes students to choose majors associated with approximately $ 1,723 more in annual earnings.[2] While our focus is on the effect of net tuition, it is interesting to note that the state grant per student is *positively* associated with the annual wage of the chosen major, especially in the IV regression. This could be because the type of student who receives state grant aid (which is often merit-based) is likely to chose a high-earnings majors, in which case we get the positive coefficient because of selection into state aid receipt. In any case, we cannot interpret this coefficient as causal. Other controls are correlated with earnings in ways that are sensible, for example, at schools with high ACT scores, students are more likely to choose high-earnings majors. As we will see below, this is due to the positive association between student ACT scores and the likelihood of majoring in STEM.

5.2 Major Choice

The results of the baseline OLS and IV regression are displayed in Table 3 and Table 4. In the OLS regression, we see that a$1,000 increase in net tuition is associated with a an insignificant but positive increase in the percent of students majoring in Business and Communications, and a 0.117 percentage point increase in students selecting STEM, which is statistically different from zero at the 10% significance level. We also find a positive and highly significant coefficient for the Education major, which implies that a $1,000 increase in net tuition connects with 0.192 percentage point increase of the students choosing Education. The other major categories have a negative relationship with net tuition in this OLS regression.

Table 4 shows the results of the IV regression. Relative to the OLS, the results show a stronger relationship between net tuition and the choice to major in STEM: a $1,000 increase in net tuition leads to a 1.133 percentage point increase in the share of students choosing STEM. Although this coefficient is significant at the 5% level, the standard errors are quite a bit larger than with the OLS regression. The coefficients for Business and Communications and Education majors are both positive, and marginally significant for Education. For Health and Social Science and Humanities majors, we see a negative effect of an increase in net tuition. We find that a $1,000 increase in net tuition leads to a 1.012 percentage point decrease in students choosing Health, and a 1.159 percentage point decrease in students choosing Social Sciences and Humanities. The coefficients for Arts and Architecture is not meaningfully different from zero.

5.3 Robustness: The Great Recession

In this section, we test whether the Great Recession of 2008 has any effect on our empirical findings, as the recession might have changed both student preferences over majors and tuition

2. The first-stage regression corresponding to our IV results is shown in Table A.2. The F-statistic (20.85) in Table shows that we our instrumental variable is relevant. The first stage is the same for the annual wage and the major category regressions.

and appropriations levels. Although our regressions control for the state-level unemployment rate and median household income, one might be concerned that the effect of the recession is not completely captured by our controls, and that unobserved factors during that period might still affect a students' choice of major, tuition choices at the institution-level, and appropriations to public universities.

Our strategy is to remove the economic recession years from our regression. The crisis started in very late 2007, with the economy gradually recovering starting in 2010. Hence, we exclude the academic years from 2008-09 through 2011-12 as our robustness check. Table 5 reports the OLS regression results and Table 6 displays the results of IV regression without these years. Both yield very similar patterns to our main regressions in Tables 3 and 4, where we did not exclude the recession years. Excluding the regression years and using the IV specification, we find that a $1,000 increase in net tuition increases the percent of students graduating in STEM fields by 1.11 percentage points, whereas the corresponding number with the recession years included is 1.13 percentage points. Changes for other coefficients are similarly negligible, so we conclude that the economic recession years do not substantively alter the key findings.

6 Conclusion and Discussion

This paper examines the impact of net tuition on students' choice of major. We illustrate two mechanisms that explain how net tuition influences this decision. First, changes in net tuition affect the type of students who attend college. When net tuition rises, students who have high non-pecuniary returns to low-earning majors may decide not to attend college at all rather than switch. Second, students who have a strong preference for attending college but initially prefer low-earning majors alter their major choice in response to rising net tuition. Those who initially prefer lower-paying majors might switch to fields with higher earning potential to offset the reduced consumption due to increased net tuition. While the illustrative model describes labor-market returns in terms of wages alone, job stability might play a role as well. In our empirical results, we find that increases in tuition are associated with increases in the share of students graduating in Education—which features low wages but high job stability—as well as the fields with the highest earnings: Business and Communications and STEM.

Using a fixed-effects regression model, we find that when net tuition increases, students choose majors that are typically higher paying—with the exception of the Education degree as discussed above. But changes in net tuition and major choice may be driven by institutional responses to demand shocks. For example, institutions may increase their price when demand for particular majors is high. To address this endogeneity problem, we use average state appropriations per student at the state-level as an instrumental variable (IV). The IV estimates show a strong positive relationship between net tuition and the average wage of the chosen major.

There are remaining questions that this paper cannot address. For example, it may be the case that students with different family incomes respond differently to changes in net tuition. For example, extremely low-income students may face information barriers or be less prepared for specific subjects, which may make their major choice less responsive to net tuition than the choices of their high-income peers. Alternatively, students from high-income families may be less sensitive to changes in consumption induced by changes in net tuition, because their consumption levels are higher and consumption exhibits diminishing marginal utility. A second remaining question concerns the welfare consequences of the major choices induced by changes in net tuition. The welfare consequences will be affected by potential mismatches between students' abilities and their chosen majors, and general equilibrium effects on the labor market. Our analysis assigns expected wages to a major simply to make the distinction between majors typically considered to be high-wage and those considered to be low-wage, but any changes in selection into majors will have consequences for expected wages through general equilibrium effects and skills mismatch. A third remaining question is the degree to which we can attribute our results to the selection or "switching" mechanisms illustrated in Section 2. We are not able to distinguish between the two with our data and empirical method. These limitations suggest interesting directions for future work on major choice and its association with the price students pay for college.

References

Altonji, J. G., P. Arcidiacono, and A. Maurel. 2016. "The Analysis of Field Choice in College and Graduate School. Determinants and Wage Effects." *Handbook of the Economics of Education* 5:305–396. ISSN: 15740692. https://doi.org/10.1016/B978-0-444-63459-7.00007-5.

Anelli, Massimo, and Giovanni Peri. 2015. "Gender of siblings and choice of college major." *CESifo Economic Studies* 61 (1): 53–71.

Beffy, Magali, Denis Fougere, and Arnaud Maurel. 2012. "Choosing the field of study in post-secondary education: Do expected earnings matter?" *Review of Economics and Statistics* 94 (1): 334–347.

Blom, Erica, Brian C. Cadena, and Benjamin J. Keys. 2021. "Investment over the business cycle: Insights from college major choice." *Journal of Labor Economics* 39 (4): 1043–1082.

Bound, John, Breno Braga, Gaurav Khanna, and Sarah Turner. 2019. "Public universities: The supply side of building a skilled workforce." *RSF: The Russell Sage Foundation Journal of the Social Sciences* 5 (5): 43–66.

———. 2020. "A passage to America: University funding and international students." *American Economic Journal: Economic Policy* 12 (1): 97–126.

Castleman, Benjamin L, Bridget Terry Long, and Zachary Mabel. 2018. "Can financial aid help to address the growing need for STEM education? The effects of need-based grants on the completion of science, technology, engineering, and math courses and degrees." *Journal of Policy Analysis and Management* 37 (1): 136–166.

Chakrabarti, Rajashri, Nicole Gorton, and Michael Lovenheim. 2020. "State Investment in Higher Education: Effects on Human Capital Formation, Student Debt, and Long-term Financial Outcomes of Students." http://www.nber.org/papers/w27885.

Cook, Emily E., and Sarah Turner. 2022. "Progressivity of pricing at US public universities." *Economics of Education Review* 88:102239.

Deming, David J., and Christopher R. Walters. 2017. *The impact of price caps and spending cuts on US postsecondary attainment.* Technical report. National Bureau of Economic Research.

Leppel, Karen, Mary L. Williams, and Charles Waldauer. 2001. "The impact of parental occupation and socioeconomic status on choice of college major." *Journal of Family and Economic issues* 22:373–394.

Long, Mark C., Dan Goldhaber, and Nick Huntington-Klein. 2015. "Do completed college majors respond to changes in wages?" *Economics of Education Review* 49:1–14.

Minicozzi, Alexandra. 2005. "The short term effect of educational debt on job decisions." *Economics of Education Review* 24 (4): 417–430.

New York State Higher Education Services Corporation. 2024. *New York State STEM Incentive Program.* Accessed: August 25, 2024. https://www.hesc.ny.gov/find-aid/nys-grants-scholarships/nys-science-technology-engineering-and-mathematics-stem-incentive/.

Rothstein, Jesse, and Cecilia Elena Rouse. 2011. "Constrained after college: Student loans and early-career occupational choices." *Journal of Public Economics* 95 (1-2): 149–163.

Shin, Jung Cheol, and Sande Milton. 2008. "Student response to tuition increase by academic majors: Empirical grounds for a cost-related tuition policy." *Higher Education* 55:719–734.

Sjoquist, David L, and John V Winters. 2015a. "The effect of Georgia's HOPE scholarship on college major: a focus on STEM." *IZA Journal of Labor Economics* 4:1–29.

———. 2015b. "State merit aid programs and college major: A focus on STEM." *Journal of Labor Economics* 33 (4): 973–1006. ISSN: 0734306X. https://doi.org/10.1086/681108.

Stater, Mark. 2011. "Financial aid, student background, and the choice of first-year college major." *Eastern Economic Journal* 37:321–343.

U.S. Bureau of Labor Statistics. 2024. *Occupational Outlook Handbook.* Accessed: August 25, 2024. U.S. Department of Labor. https://www.bls.gov/ooh/home.htm.

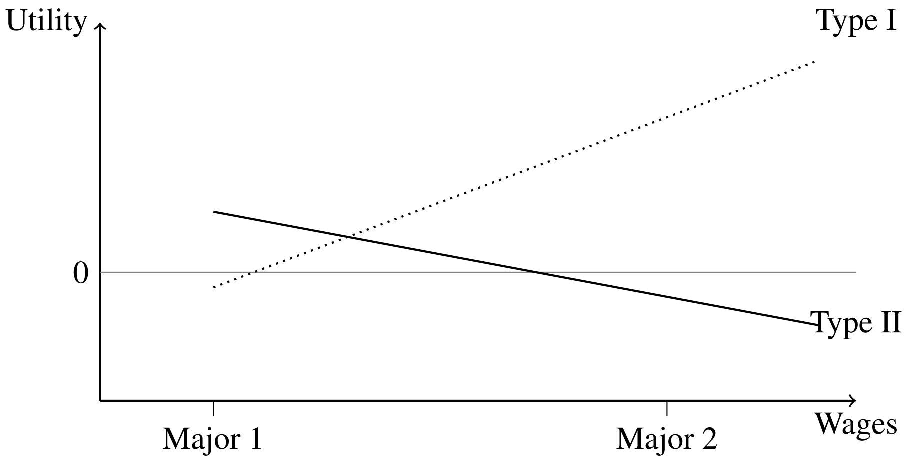
U.S. National Science Foundation. 2024. *Education and Human Resources (EHR).* Accessed: August 25, 2024. https://new.nsf.gov/edu.

Webber, Douglas A. 2017. "State divestment and tuition at public institutions." *Economics of Education Review* 60:1–4.

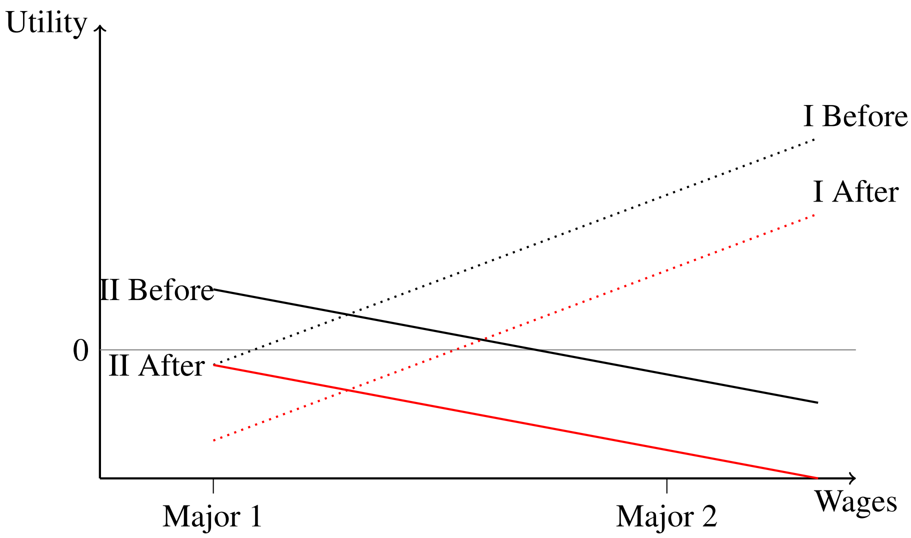
Wiswall, Matthew, and Basit Zafar. 2015. "Determinants of college major choice: Identification using an information experiment." *The Review of Economic Studies* 82 (2): 791–824.

Figure 1: Model Illustrations

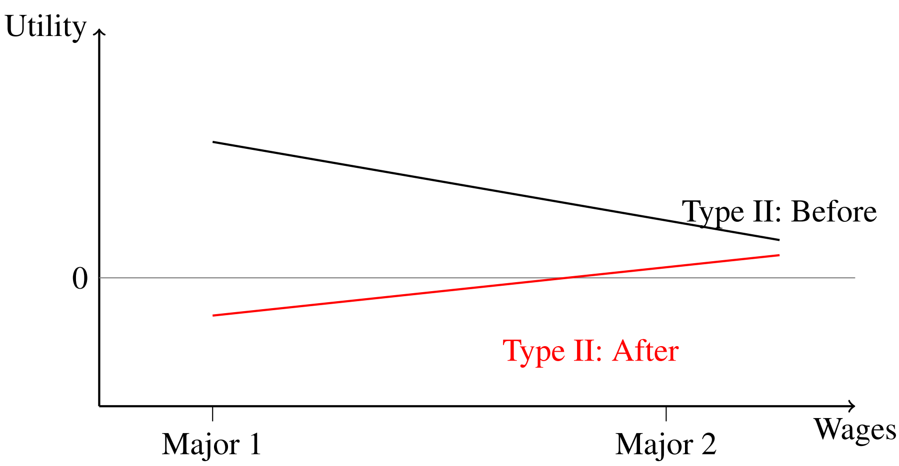
(a) Utility Across Majors and Student Types



(b) Selection Effect

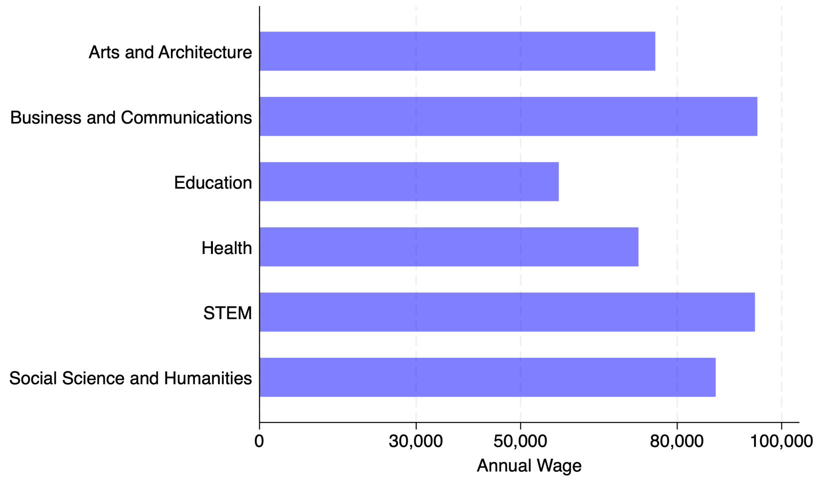


(c) Switching Effect



Note:The figure in panel a illustrates potential preferences by two different types of students over a set of majors. For Type I, the non-pecuniary and pecuniary benefits of majors are correlated and the student has a strong preference for Major 2. For Type II, the student's non-pecuniary and pecuniary benefits are negatively correlated and the student's current choice is Major 1. In panel b, after the net tuition increases, Type II students no longer find it optimal to attend college because the utility across any available major drops to below zero, which is the value of the outside option of not attending college.

Figure 2: Annual Wage by Major Category



Notes: The figure is based on 2017 BLS OEWS data. We first merge the BLS data to IPEDS degrees data using a crosswalk between CIP codes at the six-digit (detailed) level that are used in the IPEDS data and SOC codes that are used in the BLS wage data. For six-digit CIP codes with multiple matches in the BLS data, we take a weighted average of the BLS wage data where the weights are employment by SOC code. We display the weighted average wages across detailed CIP codes by our six major groups, where the weights are the total degrees awarded.

Table 1: Summary Statistics

Variable	mean (sd)
Outcome Variables	
Annual Wages	88.188
	(7.113)
% Arts and Architecture	4.513
	(3.386)
% Business and Communication	23.143
	(8.331)
% Education	8.222
	(7.796)
% STEM	17.323
	(12.704)
% Health	8.262
	(7.921)
% Social Science and Humanities	26.284
	(12.374)
Other College-Level Variables	
Net Tuition	2.587
	(2.892)
Ed and General Spending: Salaries	11.371
	(6.726)
Average ACT score	22.175
	(2.840)
Average State Grant	1.498
	(1.241)
Average Federal Grant	1.822
	(0.941)
State-level Variables	
State appropriations per student	9.621
	(3.330)
Unemployment Rate	5.858
	(2.066)
State Median Income	59.726
	(9.136)
Observations	7,543

Notes: Standard deviations are in parentheses. Statistics in this table are for public four-year colleges for the years 2000-2019. All monetary values are measured in thousands of 2019 dollars.

Table 2: Relationship between annual wage and net tuition

VARIABLES	OLS Regression Mean of Annual Wage	IV Regression Mean of Annual Wage
Net Tuition	0.069	1.723***
	(0.078)	(0.528)
Ed and General Spending: Salaries	0.033	-0.046
	(0.043)	(0.075)
Average ACT Score	0.246**	0.205
	(0.097)	(0.138)
State Median Income	-0.046**	-0.004
	(0.021)	(0.031)
Unemployment Rate	0.337***	0.115
	(0.104)	(0.101)
Average State Grant	0.070	1.073***
	(0.165)	(0.345)
Average Federal Grant	-1.444***	0.703
	(0.272)	(0.763)
Observations	5,968	5,968
Number of Unitid	465	465
Year Fixed Effects	YES	YES
Mean of Dependent Variable	88.19	88.19

Notes: Standard errors in parentheses. All of the independent variables are lagged by 3 years. All monetary values are measured in thousands of 2019 dollars. $*: p \leq 0.1, **: p \leq 0.05, ***: p \leq 0.01$.

Table 3: OLS regression for public universities

VARIABLES	(1) Arts and Architecture	(2) Business and Communications	(3) Education	(4) STEM	(5) Health	(6) Social Science and Humanities
Net Tuition	-0.037	0.100	0.192***	0.117*	-0.140*	-0.158
	(0.023)	(0.082)	(0.064)	(0.067)	(0.073)	(0.099)
Education and General Spending	0.028	-0.043	0.080**	0.083	-0.033	-0.047
	(0.022)	(0.065)	(0.037)	(0.053)	(0.054)	(0.073)
Average ACT score	-0.077**	-0.004	0.148	0.614***	-0.200	-0.255*
	(0.031)	(0.101)	(0.092)	(0.102)	(0.132)	(0.135)
State Median Income	-0.002	-0.062**	0.067***	0.028	-0.045	0.012
	(0.008)	(0.025)	(0.019)	(0.022)	(0.043)	(0.032)
State Unemployment rate	0.040	-0.087	-0.154***	0.180**	-0.075	0.183*
	(0.025)	(0.096)	(0.046)	(0.076)	(0.130)	(0.110)
Average State Grant	-0.116**	0.020	0.717***	0.176	-0.158	-0.582***
	(0.045)	(0.195)	(0.128)	(0.159)	(0.186)	(0.219)
Average Federal Grant	0.247**	-0.825***	-0.583**	-1.084***	0.555	1.120***
	(0.100)	(0.294)	(0.239)	(0.237)	(0.354)	(0.429)
Constant	6.112***	29.189***	-2.591	1.641	16.087***	32.096***
	(0.925)	(3.457)	(2.479)	(2.872)	(5.777)	(4.344)
Observations	5,968	5,968	5,968	5,968	5,968	5,968
Number of Unitid	465	465	465	465	465	465
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Institution Fixed Effects	YES	YES	YES	YES	YES	YES
Mean of Dependent Variable	4.513	23.14	8.222	17.32	8.262	26.28

Notes: Standard errors in parentheses. All of the independent variables are lagged by 3 years. All monetary values are measured in thousands of 2019 dollars. $*: p \leq 0.1, **: p \leq 0.05, ***: p \leq 0.01$.

Table 4: IV regression for public universities

VARIABLES	(1) Arts and Architecture	(2) Business and Communications	(3) Education	(4) STEM	(5) Health	(6) Social Science and Humanities
Net Tuition	0.006	0.629	0.673*	1.133**	-1.012*	-1.159**
	(0.154)	(0.433)	(0.343)	(0.563)	(0.539)	(0.585)
Education and General Spending	0.026	-0.068	0.056	0.034	0.009	0.000
	(0.025)	(0.068)	(0.040)	(0.063)	(0.062)	(0.084)
Average ACT Score	-0.078**	-0.017	0.136	0.588***	-0.179	-0.230
	(0.032)	(0.100)	(0.097)	(0.124)	(0.131)	(0.153)
State Median Income	-0.001	-0.049*	0.080***	0.054**	-0.067	-0.014
	(0.009)	(0.029)	(0.022)	(0.026)	(0.044)	(0.038)
State Unemployment Rate	0.034	-0.158*	-0.219***	0.043	0.042	0.318**
	(0.030)	(0.093)	(0.061)	(0.081)	(0.125)	(0.131)
Average State Grant	-0.090	0.341	1.009***	0.794**	-0.687**	-1.189***
	(0.106)	(0.334)	(0.224)	(0.385)	(0.324)	(0.412)
Average Federal Grant	0.303	-0.138	0.042	0.236	-0.577	-0.179
	(0.219)	(0.623)	(0.533)	(0.761)	(0.733)	(0.869)
Observations	5,968	5,968	5,968	5,968	5,968	5,968
Number of Unitid	465	465	465	465	465	465
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Institution Fixed Effects	YES	YES	YES	YES	YES	YES
Mean of Dependent Variable	4.513	23.14	8.222	17.32	8.262	26.28

Notes: Standard errors in parentheses. All of the independent variables are lagged by 3 years. All monetary values are measured in thousands of 2019 dollars. $*: p \leq 0.1, **: p \leq 0.05, ***: p \leq 0.01$.

Table 5: OLS regression without 2008-2011

VARIABLES	(1) Arts and Architecture	(2) Business and Communications	(3) Education	(4) STEM	(5) Health	(6) Social Science and Humanities
Net Tuition	-0.054*	0.179*	0.239***	0.107	-0.134	-0.280**
	(0.028)	(0.096)	(0.077)	(0.086)	(0.102)	(0.113)
Education and General Spending	0.026	-0.045	0.101**	0.083	-0.040	-0.075
	(0.025)	(0.074)	(0.041)	(0.057)	(0.059)	(0.081)
Average ACT Score	-0.090**	-0.001	0.198**	0.700***	-0.177	-0.403**
	(0.035)	(0.112)	(0.100)	(0.107)	(0.167)	(0.162)
State Median Income	-0.008	-0.057**	0.071***	0.033	-0.059	0.024
	(0.010)	(0.027)	(0.019)	(0.024)	(0.039)	(0.034)
State Unemployment Rate	0.030	-0.098	-0.219***	0.188**	-0.031	0.152
	(0.024)	(0.111)	(0.058)	(0.080)	(0.127)	(0.122)
Average State Grant	-0.118**	0.093	0.822***	0.146	-0.239	-0.697***
	(0.053)	(0.212)	(0.155)	(0.172)	(0.195)	(0.220)
Average Federal Grant	0.230**	-0.842**	-0.700**	-0.982***	0.606	1.209**
	(0.111)	(0.338)	(0.304)	(0.258)	(0.425)	(0.493)
Constant	6.790***	28.517***	-4.121	-0.057	16.534**	34.953***
	(1.031)	(3.955)	(2.520)	(3.025)	(6.594)	(5.015)
Observations	4,416	4,416	4,416	4,416	4,416	4,416
Number of Unitid	463	463	463	463	463	463
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Institution Fixed Effects	YES	YES	YES	YES	YES	YES
Mean of Dependent Variable	4.513	23.14	8.222	17.32	8.262	26.28

Notes: Standard errors in parentheses. All of the independent variables are lagged by 3 years. All monetary values are measured in thousands of 2019 dollars. $* : p \leq 0.1, ** : p \leq 0.05, *** : p \leq 0.01$

Table 6: IV regression without 2008-2011

VARIABLES	(1) Arts and Architecture	(2) Business and Communications	(3) Education	(4) STEM	(5) Health	(6) Social Science and Humanities
Net Tuition	-0.076	0.691	0.595*	1.105**	-0.750	-1.585***
	(0.143)	(0.437)	(0.346)	(0.529)	(0.460)	(0.523)
Education and General Spending	0.027	-0.061	0.090**	0.051	-0.021	-0.034
	(0.027)	(0.077)	(0.041)	(0.072)	(0.065)	(0.095)
Average ACT Score	-0.090**	0.010	0.206**	0.721***	-0.191	-0.431**
	(0.035)	(0.114)	(0.103)	(0.133)	(0.165)	(0.195)
State Median Income	-0.009	-0.048	0.078***	0.051*	-0.070*	0.000
	(0.010)	(0.030)	(0.020)	(0.026)	(0.039)	(0.040)
State Unemployment Rate	0.032	-0.149	-0.255***	0.087	0.031	0.284**
	(0.026)	(0.105)	(0.067)	(0.082)	(0.123)	(0.131)
Average State Grant	-0.134	0.450	1.071***	0.843**	-0.668**	-1.608***
	(0.117)	(0.376)	(0.244)	(0.418)	(0.317)	(0.405)
Average Federal Grant	0.204	-0.233	-0.277	0.205	-0.126	-0.344
	(0.201)	(0.584)	(0.545)	(0.668)	(0.612)	(0.749)
Observations	4,416	4,416	4,416	4,416	4,416	4,416
Number of Unitid	463	463	463	463	463	463
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Institution Fixed Effects	YES	YES	YES	YES	YES	YES
First Stage F-statistic	23.41	23.41	23.41	23.41	23.41	23.41
Mean of Dependent Variable	4.513	23.14	8.222	17.32	8.262	26.28

Notes: Standard errors in parentheses. All of the independent variables are lagged by 3 years. All monetary values are measured in thousands of 2019 dollars. $*: p \leq 0.1, **: p \leq 0.05, ***: p \leq 0.01$.

Online Appendix

A Additional Figures & Tables

Table A.1: Major Categories

Classification	CIP code	CIP description
Arts and Architecture	4	ARCHITECTURE AND RELATED SERVICES
	50	VISUAL AND PERFORMING ARTS
Business and Communications	9	COMMUNICATION, JOURNALISM, AND RELATED PROGRAMS
	10	COMMUNICATIONS TECHNOLOGIES/TECHNICIANS AND SUPPORT SERVICES
	52	BUSINESS, MANAGEMENT, MARKETING, AND RELATED SUPPORT SERVICES
Education	13	EDUCATION
STEM	11	COMPUTER AND INFORMATION SCIENCES AND SUPPORT SERVICES
	14	ENGINEERING
	15	ENGINEERING TECHNOLOGIES AND ENGINEERING-RELATED FIELDS
	26	BIOLOGICAL AND BIOMEDICAL SCIENCES
	27	MATHEMATICS AND STATISTICS
	40	PHYSICAL SCIENCES
	41	SCIENCE TECHNOLOGIES/TECHNICIANS
Health	34	HEALTH-RELATED KNOWLEDGE AND SKILLS
	51	HEALTH PROFESSIONS AND RELATED PROGRAMS
Social Science and Humanities	5	AREA, ETHNIC, CULTURAL, GENDER, AND GROUP STUDIES
	16	FOREIGN LANGUAGES, LITERATURES, AND LINGUISTICS
	22	LEGAL PROFESSIONS AND STUDIES
	23	ENGLISH LANGUAGE AND LITERATURE/LETTERS
	24	LIBERAL ARTS AND SCIENCES, GENERAL STUDIES AND HUMANITIES
	30	MULTI/INTERDISCIPLINARY STUDIES
	38	PHILOSOPHY AND RELIGIOUS STUDIES
	39	THEOLOGY AND RELIGIOUS VOCATIONS
	42	PSYCHOLOGY
	45	SOCIAL SCIENCES
	54	HISTORY
Vocational, Other	1	AGRICULTURE, AGRICULTURE OPERATIONS, AND RELATED SCIENCES
	3	NATURAL RESOURCES AND CONSERVATION
	12	PERSONAL AND CULINARY SERVICES
	19	FAMILY AND CONSUMER SCIENCES/HUMAN SCIENCES
	21	TECHNOLOGY EDUCATION/INDUSTRIAL ARTS
	25	LIBRARY SCIENCE
	28	MILITARY SCIENCE, LEADERSHIP AND OPERATIONAL ART
	29	MILITARY TECHNOLOGIES AND APPLIED SCIENCES
	31	PARKS, RECREATION, LEISURE, AND FITNESS STUDIES
	33	CITIZENSHIP ACTIVITIES
	36	LEISURE AND RECREATIONAL ACTIVITIES
	43	HOMELAND SECURITY, LAW ENFORCEMENT, FIREFIGHTING AND RELATED PROTECTIVE SERVICES
	44	PUBLIC ADMINISTRATION AND SOCIAL SERVICE PROFESSIONS
	46	CONSTRUCTION TRADES
	47	MECHANIC AND REPAIR TECHNOLOGIES/TECHNICIANS
	48	PRECISION PRODUCTION
	49	TRANSPORTATION AND MATERIALS MOVING

Notes: The table shows high-level (two-digit) Classification of Instructional Programs Codes and the assigned category used in our analysis.

Table A.2: First-Stage Regression

VARIABLES	(1) Net Tuition
State appropriation per student	-0.147***
	(0.032)
Education and general spending	0.060*
	(0.032)
Average ACT score	0.012
	(0.051)
State median income	-0.024**
	(0.011)
State unemployment rate	0.082**
	(0.036)
Average state grant	-0.621***
	(0.061)
Average federal grant	-1.344***
	(0.116)
Constant	7.286***
	(1.400)
Observations	5,968
Number of unitid	465
Year fixed effects	YES
Institution fixed effects	YES
Mean of dependent variable	2.542
First Stage F-statistic	20.85

Notes: Standard errors in parentheses. All of the independent variables are lagged by 3 years. All monetary values are measures in thousands of 2019 dollars. $*: p \leq 0.1, **: p \leq 0.05, ***: p \leq 0.01$.