field enrollments which are implied by observed course offerings. Under relatively lenient assumptions, these tradeoffs can be interpreted as a measure of the misalignment between student preferences and observed course offerings. In this section, I treat these implied tradeoffs as the university's structural preference parameters in a two-sided model of a university choosing course offerings and students choosing courses from the set of available alternatives. While this requires assuming that the university's problem and student choice model are both correctly specified, it allows me to provide additional intuitive ways to quantify misalignment between student preferences and observed course offerings and to conduct counterfactual policy analyses which incorporate university responses.

6.1 Utility maximizing course offerings and equivalent costs

To further quantify the misalignment between student preferences and observed course offerings, columns (1) - (5) of Table 7 compare average observed course offerings and field enrollments to cost-equivalent offerings and enrollments which would have maximized total student utility. Columns (1) - (3) report averages across semesters of the number of introductory course sections taught by instructors on long term contracts in each field, the number of introductory course sections taught by adjunct instructors on single-semester contracts in each field, and enrollment in introductory courses by field. Columns (4) and (5) then examine how adjunct instructed offerings and enrollments would change if the portion of the budget allocated to pay adjunct instructors were reallocated to maximize total student utility holding contracted offerings in column (1) fixed.[35] Stars indicate where columns (4) and (5) are statistically different from columns (2) and (3) respectively.

Results suggest the utility maximizing allocation of the adjunct instructor budget for introductory courses contains no STEM sections, no business or occupational sections, approximately the same number of humanities and arts sections, and four times as many social science sections. The large increase in social science sections reflects the finding in Table 6 that marginal spending on social science courses produces student utility more efficiently than spending in other fields. Column (5) predicts that offering the utility maximizing adjunct instructed courses would increase overall introductory social science enrollment by 11.65% and decrease overall introductory STEM and business and occupational enrollment by 13.74% and 5.96% respectively.

[35]There are several reasons to reallocate the budget for adjunct instructors only: First, this mechanically restricts counterfactual course offerings to remain relatively close to observed offerings where I am more confident in the predictive power of the estimated student choice model; second, this represents a realistic picture of what could be achieved in the short run since instructors on long term contracts can only be released when those contracts expire; third, the model provides no mechanism for explaining why the university hires instructors of different ranks and thus is not well equipped to predict hiring decisions across ranks.

To provide an additional intuitive way to measure the misalignment between student preferences and observed course offerings, column (6) of Table 7 reports how much costs of adjunct instructors would need to change to induce a utility maximizing university to offer the adjunct instructed sections reported in column (2). I refer to these as the "equivalent costs" of $\hat{\gamma}_f$ since going from observed costs to equivalent costs with a utility maximizing objective would have the same effect on course offerings as going from a utility maximizing objective to an objective characterized by $\hat{\gamma}_f$ holding costs fixed at observed costs. Figure 3 illustrates the idea with one semester and two fields: The observed production possibilities frontier is PPF and the outcomes associated with observed course offerings are given by B. The goal is to solve for counterfactual costs which yield a production possibilities frontier PPF' which makes it so that a utility maximizing university with indifference curves given by Π^{SUM} would offer courses which achieve outcomes B. Intuitively, I infer these equivalent costs by solving for costs which make it so that a utility maximizing university's first order conditions are satisfied at observed course offerings. This means solving for costs which imply that marginal effects per dollar of offering additional course sections on total student utility are equal across fields at observed course offerings. Details are reported in Appendix C.

Results suggest that inducing a utility maximizing university to offer observed courses would require a 45.62% increase in the cost of hiring a social science adjunct instructor, a 24.99% increase in the cost of hiring a humanities or arts adjunct instructor, a 17.01% decrease in the cost of hiring a STEM adjunct instructor, and a 41.99% decrease in the cost of hiring a business and occupational adjunct instructor. This shows that the estimated preference parameters $\hat{\gamma}_f$ have the same effects on course offerings as substantial increases in social science and humanities and arts costs and substantial decreases in business and occupational and STEM costs.

6.2 Counterfactual analyses with university responses

As mentioned previously, one of the primary reasons for moving towards structural models of university behaviors is the capacity to conduct counterfactual policy analyses which incorporate university responses into predictions. In general, universities are not passive parties in the production of human capital but rather active entities which allocate their resources to maximize their objectives subject to constraints. While predicting university responses requires strong assumptions, counterfactual policy analyses which assume university inputs remain fixed are arguably making even stronger assumptions.

To illustrate the value of my two-sided model, and for higher education models which incorporate supply-side responses more generally, this subsection performs several counterfactual analyses which both include university responses and exclude university responses for comparison. To begin, I restate the university's problem with an additional clarification that total student utility V_t and enrollment in each field n_{tf} depend on the set of all observed student characteristics in semester t denoted by $\mathbf{X}_t = \{X_{it}\}_{i=1}^{N}$

$$\mathbf{d}_\mathbf{t}^\star = \text{argmax}_{\mathbf{d_t}} \left\{ V_t\left(\mathbf{d}_t; \mathbf{X}_t\right) + \sum_{f=1}^{F-1} \gamma_f n_{tf}\left(\mathbf{d}_t; \mathbf{X}_t\right) \right\} \quad \text{s.t.} \quad C\left(\mathbf{d_t},\, \psi\right) \leq E_t \tag{37}$$

For counterfactual analyses which incorporate university responses, I proceed in two steps. First, I solve for a counterfactual $\tilde{\mathbf{d}}_t$ which solves (37) given either counterfactual student characteristics $\tilde{\mathbf{X}}_t$ or counterfactual cost parameters $\tilde{\psi}$. These represent the courses the university would offer in a counterfactual scenario in which either student characteristics or course costs are changed. Second, I calculate counterfactual field enrollments $\tilde{n}_{tf}$ given counterfactual student characteristics $\tilde{\mathbf{X}}_t$ and counterfactual course offerings $\tilde{\mathbf{d}}_t$ using Equation (16). For counterfactual analyses which ignore university responses, I calculate field enrollments given counterfactual student characteristics $\tilde{\mathbf{X}}_t$ but observed course offerings $\mathbf{d}_t$. The first order conditions characterizing the solution to Equation (37) are complicated nonlinear functions of course offerings $\mathbf{d}_t$. As such, it is unclear whether a closed form expression for $\mathbf{d}_\mathbf{t}^\star$ exists. Instead of deriving a closed form expression for $\mathbf{d}_\mathbf{t}^\star$, I solve for $\mathbf{d}_\mathbf{t}^\star$ directly using numerical constrained maximization methods.

Tables 8 and 9 predict introductory course offerings and introductory field enrollments in several counterfactual scenarios.[36] To enhance the credibility of these predictions, I make two choices: First, I choose counterfactual scenarios which are relatively close to the observed scenario to increase confidence in the ability of my model to predict university and student choices. Second, as in Table 7, I only allow the university to reallocate the portion of its budget for introductory courses paid to adjunct instructors on single-semester contracts. This also restricts the counterfactual scenarios to be close to the observed scenario and examines a short run scenario in which inputs which are costly to vary are held fixed.

Given the policy interest in increasing specialization in STEM, one interesting counterfactual scenario to consider is one in which the state subsidizes STEM instructors to increase STEM course offerings and enrollments. To evaluate the effectiveness of such a subsidy, my first counterfactual predicts adjunct instructed introductory course offerings and

[36]Tables 8 and 9 also report predicted introductory course offerings and introductory field enrollments in the observed state in row 1. Stars in rows 2 and beyond indicate whether predictions in counterfactual scenarios are statistically different from predictions in the observed state. Reported figures of averages of predictions across all academic semesters.

introductory field enrollments under a subsidy which reduces the cost of hiring a STEM adjunct instructor by 5%. Row 2 of Table 8 shows that this subsidy would increase the number of adjunct instructed STEM sections by 49.15% and reduce offerings in other fields. Furthermore, row 2 of Table 9 shows that this increase in STEM offerings would lead to a 6.22% increase in overall STEM enrollment with additional students coming mostly from social science and humanities and arts courses. The subsidy would cost $252.87 per adjunct instructed section implying a total cost of $13,498.23 or 4.18% of spending on adjunct instructed introductory courses.

Another interesting scenario to consider is one in which UCA begins attracting higher ability students. From Table 5, we know that higher ability students are generally more interested in STEM suggesting that UCA might respond to a higher ability student body by offering more STEM courses and thus making the STEM field even more attractive. To analyze this scenario, my second counterfactual predicts adjunct instructed introductory course offerings and introductory field enrollments if all student ACT scores and high school GPAs were increased by one-third of a standard deviation holding fixed other student characteristics.[37] Row 3 of Table 8 shows that increasing student abilities would increase the number of adjunct instructed STEM sections by 48.62% and reduce offerings in other fields. To see how field enrollments would change with higher ability students, row 3 of Table 9 first predicts field enrollments in a partial equilibrium where student characteristics are changed but course offerings remain fixed. Results show that attracting higher ability students would increase introductory STEM enrollment by 3.68% without any response in course offerings. Row 4 of Table 9 incorporates the changes in adjunct instructed course offerings and shows that the total effect of attracting higher ability students is a 10.97% increase in introductory STEM enrollment. This illustrates the importance of incorporating university responses into counterfactual policy analyses; ignoring changes in course offerings leads to understating increases in STEM enrollment by approximately a factor of three.

A final scenario to consider is one in which the gender composition of students at UCA changes. Results in Table 5 suggest men and women do not have wildly different field preferences so I choose an extreme counterfactual setting in which all male students are given female field preferences for illustrative purposes. Row 4 of Table 8 shows that if all students had female preferences, UCA would offer 2.4 times as many adjunct instructed social science sections, 54.86% more adjunct instructed humanities and arts sections, 32.69% fewer adjunct instructed STEM sections, and would virtually eliminate adjunct instructed business and

[37]These predictions assume that student field preferences depend on absolute abilities rather than abilities relative to the student body. If field preferences depend on relative abilities then increasing the abilities of all students will have no effect on field preferences and thus no effect on course offerings.

occupational sections. Once again, to separate out the direct effects of changes in students characteristics and the indirect effects of changes in course offerings, row 5 of Table 9 predicts field enrollments in partial equilibrium without changes in course offerings and row 6 of Table 9 predicts field enrollments in general equilibrium with university responses. Results show that stronger female preferences for introductory social science courses imply that giving all students female preferences leads to a 4.71% increase in introductory social science enrollment without any change in course offerings. Incorporating the effects of the increase in adjunct instructed introductory social science sections leads to a total predicted increase in introductory social science enrollment of 8.68%. Once again, ignoring the indirect effects of changes in course offerings leads to significantly understating changes in field enrollments.

7 Suggestive Evidence on Mechanisms

Natural questions arising from the analysis in this paper are: "Why might a university be willing to sacrifice student utility to increase STEM and business and occupational enrollment? Are these tradeoffs beneficial for students and society in the long run or do they reflect selfish interests of the university?" For the most part, I leave these larger questions for future research; however, this section will briefly conclude by discussing literature and presenting suggestive evidence which gives clues as to why UCA might prefer STEM and business and occupational enrollment. To preview, I argue that STEM and business and occupational courses have higher future labor market returns but also higher present psychic costs. As such, a university may favor STEM and business and occupational courses either to paternalistically induce myopic students to make decisions in their best long term interests, or to internalize larger social externalities generated by higher earning graduates.

First, there is ample evidence that STEM and business and occupational degrees have larger labor market returns than degrees in other fields. In a recent review article, Altonji et al. (2012) summarizes the relative returns to different majors: "Engineering consistently commands a high premium, usually followed by business and science. Humanities, social sciences, and education are further behind." Interestingly, this ordering of relative returns closely matches the ordering of UCA's preferences reported in Table 6.

To supplement the findings of Altonji et al. (2012) with suggestive evidence on relative returns at UCA, column 1 of Table 8 reports results from a naïve regression of annual earnings on field of major for workers who earn Bachelor's degrees from UCA. Data on earnings are from Arkansas state unemployment insurance tax filings and include earnings from all employers who pay Arkansas state unemployment insurance taxes (excludes self-employed individuals, federal employees, and all employers outside Arkansas). The sample for this regression is all students who earn Bachelor's degrees between the 1993-94 and 2003-04 academic years and report positive earnings eight years after graduating.[38] The regression controls for ACT scores, high school GPA, gender, and graduation year but should still be considered naïve because there are certainly other omitted factors which are related to both final major and earnings.

Results of this naïve earnings regression suggest earnings are 42.8% higher for STEM graduates relative to observationally equivalent Humanities and Arts graduates, 39.1% higher for Business and Occupational graduates relative to Humanities and Arts graduates, and 10.4% higher for Social Science graduates than Humanities and Arts graduates. These differences in earnings across majors are generally consistent with the summary of relative returns given by Altonji et al. (2012).

A concern with the results in column 1 is that non-random selection into the sub-sample which reports earnings could bias results. In this setting, graduates could be absent from the earnings data either because they are unemployed for the entire year, out of the labor force, working in an excluded sector within Arkansas, or working outside of Arkansas. In this sample, 36.7% of graduates do not report earnings eight years after graduating implying this selection is substantial.

Because there are many possible reasons for absence, it is difficult to even hypothesize how the unobserved characteristics of earners might differ from those of non-earners making it challenging to argue about the signs and magnitudes of biases in column 1. Still, to better understand non-random selection into the earners sub-sample, column 2 of Table 8 reports results from a linear probability model which predicts whether an individual reports earnings eight years after graduating as a function of field of major and controls. Results suggest graduates with Business or Occupational majors and graduates with Social Science majors are more likely to report earnings than observationally equivalent graduates with Humanities or STEM majors. While this selection is non-trivial, it seems unlikely that this selection explains the large differences in column 1. As such, these naïve regressions generally support existing evidence which concludes that STEM and business and occupational degrees have larger labor market returns than degrees in other fields.

There is also existing literature which suggests STEM coursework may involve higher psychic costs to students. Numerous studies find that grading policies in STEM courses are harsher than in other fields (Sabot and Wakeman-Linn, 1991; Thomas, 2019; Johnson, 2003; Stinebrickner and Stinebrickner, 2014b). One reason why harsher grading policies imply higher psychic costs is that fewer students will expect to reach the upper bounding A grade at which point the marginal benefit of effort must diminish. Furthermore, there may be

[38] I exclude degree-earners who complete multiple degrees or majors (4.2% of degree earners).

direct psychic costs associated with receiving lower grades. Relatedly, existing literature also finds that STEM courses are associated with higher study times than courses in other fields (Brint et al., 2012; Stinebrickner and Stinebrickner, 2014b). If one assumes an hour of studying is equally costly across fields, this implies STEM courses involve higher psychic costs than other coursework.

Once again, to supplement these findings, columns 1 and 2 of Table 9 contain naïve regressions relating grade outcomes to course field at UCA. The sample for these regressions—which closely mirrors the sample in my main analysis—is all grades earned in introductory courses in Fall and Spring academic semesters between the 2005-06 and 2011-12 academic years.[39] The regressions control for ACT scores, high school GPA, gender, and student level but should once again be considered naïve because there may be omitted factors which are related to both course field and grade outcomes.

Column 1 of Table 9 reports estimates of a linear probability model which predicts whether a student earns the maximum grade of A. In this sample, 25.3% of earned grades are an A implying a substantial number of students reach the upper bounding grade where return on effort must diminish. Results suggest observationally equivalent students are 13.1 percentage points less likely to earn an A in an introductory STEM course relative to an introductory humanities or arts course. Column 2 of Table 9 reports estimates of a censored regression which predicts grade points as a function of course field and controls.[40] The censored feature accounts for the fact that many students receive the maximum grade of A.[41] Results suggest observationally equivalent students should expect to earn 0.600 fewer grade points in STEM courses relative to Humanities or Arts courses, 0.292 fewer points in Social Science courses relative to Humanities or Arts courses, and 0.192 fewer points in Business or Occupational courses relative to Humanities or Arts courses. In this sample, the standard deviation in grade points is 1.224 grade points implying these differences are substantial relative to the overall variation in grades. These results are consistent with existing literature which finds that grading policies are harshest in STEM courses.

A similar selection concern with the results in columns 1 and 2 of Table 9 is that some students withdraw from courses before earning grades. Withdrawals appear on a student's transcript but do not count towards her grade point average; as such, withdrawals probably mean poor expected performance but it is unclear exactly how poor (ADHE, 2011). In this sample, 9.7% of observations are withdrawals implying the confounding effects of this

[39]I exclude 2.1% of observations which have bad grade data.

[40]Letter grades are assigned to numeric grade point values using the Arkansas Department of Higher Education's metric (A=4, B=3, C=2, D=1, F=0) (ADHE, 2011).

[41]Specifications which ignore censoring (available upon request) produce the same ordering of fields but with smaller differences across fields.

selection could be non-trivial. To evaluate this selection, column 3 of Table 9 reports results from a linear probability model which predicts whether an observation is a withdrawal as a function of field of major and other controls. Results suggest observationally equivalent students are most likely to withdraw from STEM courses and least likely to withdraw from Humanities and Arts courses. If students generally withdraw when they expect to earn grades that are lower than their observed covariates imply, this suggests the results in column 2 understate the differences between STEM and Humanities and Arts grades.

To summarize, existing literature shows—and naïve regressions in my data suggest—that STEM and business and occupational courses have higher labor market returns and that STEM courses also have larger present psychic costs. These findings provide some clues as to why UCA might prefer STEM and business and occupational enrollment. First, if students are myopic or lack information about future labor market returns, a paternalistic university may offer additional STEM and business and occupational courses to induce more students to complete courses with high labor market returns. In this setting, the university's offerings may maximize some notion of long term student welfare but not short term choice utility.

Existing literature supports the idea that students may be myopic or lack information about future labor market returns. For myopic behavior, Spear (2000) discusses neurological reasons why adolescents focus more on immediate costs than future gains relative to adults and Oreopoulos (2007) provides evidence that high school students ignore or heavily discount future consequences when deciding to drop out of school. For incomplete information, Wiswall and Zafar (2014) find that providing students with information about average labor market outcomes by major leads students to update their beliefs about their own labor market outcomes and the probabilities that they will complete each major. This supports the idea that paternalism may underlie UCA's preference for STEM and business and occupational enrollment.

Alternatively, if STEM education has larger social externalities than coursework in other fields, UCA may be offering additional STEM courses to maximize social welfare more broadly. One mechanical reason why producing additional STEM graduates may have larger social externalities is that higher earning STEM graduates probably pay more in taxes.[42] Estimates in column 1 of Table 8 imply that a male STEM graduate with average ACT scores and high school GPA who graduates in 2001 earns $46,028 in 2009 while an observationally

[42] The argument that producing additional STEM and business and occupational majors increases total tax take only holds in a human capital framework in which STEM and business and occupational degrees make workers more productive so that producing more of these majors increases total productivity. In an alternative signaling framework where degrees only signal underlying abilities without increasing productivities, effects of additional STEM and business and occupational majors on total productivity are ambiguous.

equivalent humanities or arts graduate earns $28,941 in 2009.[43] If these individuals have no dependents, itemized deductions, or tax credits, the STEM graduate pays $7,106 in federal income tax and $2,349 in Arkansas state income tax while the humanities or arts graduate pays $3,749 in federal income tax and $1,189 in Arkansas state income tax.[44] This likely understates the difference in contributions to state coffers as higher income STEM graduates probably also pay more in state sales taxes and other state and local taxes.[45]

Furthermore, although empirical evidence on heterogeneous social returns to higher education by field is thin, theoretical models of education externalities typically assume externalities arise because individuals learn from one another (Moretti, 2004; Lucas, 1988; Jovanovic and Rob, 1989; Glaeser, 1999). Since STEM degrees have more labor market value for individuals, it seems natural to assume that interactions with STEM graduates yield more valuable learning spillovers than interactions with other graduates. This suggests UCA's preference for STEM enrollment may be an attempt to increase the social externalities produced by their graduates.

Moreover, a preference for STEM enrollment is in line with recent federal and state initiatives to induce more students to complete STEM degrees (PCAST, 2012; Chapman, 2014). The justifications for these initiatives were to "retain [the United States'] historical preeminence in science and technology" (PCAST, 2012) and to "[lay] the foundation for a truly world-class workforce" (Chapman, 2014). Implicit in both justifications is the notion that the high productivity of STEM graduates generates social externalities which justify intervention.

While my analysis does not directly imply that UCA's implicit preferences for STEM and business and occupational enrollment are driven by paternalistic or socially conscious motivations, the evidence in this section does suggest that these preferences would be qualitatively consistent with paternalistic or socially conscious behavior. Future research may delve deeper into the mechanisms underlying university preferences for certain fields.

8 Conclusion

In 1973, Daniel Bell described the university as "the axial institution of post-industrial society" (Bell, 1973). This is more true today than it was over four decades ago. Despite this, there is still a great deal we do not know regarding how universities make decisions and the implications of these decisions for students. These knowledge gaps limit our understanding

[43]Units are nominal dollars in 2009.

[44]See IRS (2009) and ADFA (2009a) for federal and state marginal tax rates in 2009.

[45]In 2009, Arkansas had a 6% general sales tax and a 3% sales tax on food and food ingredients (ADFA, 2009b).

Theoretical model with intensive margin spending decisions

To incorporate intensive margin spending, in this Appendix only, let c_{jt} represent spending on instruction in course section j in semester t, let m_f represent the minimum cost of offering a section in field f, and let e_{jt} represent spending in excess of this minimum which may affect the desirability of section j. For sections taught by instructors on long term contracts, c_{jt} must be paid to honor these contracts. For the share of the budget that remains after all existing contracts are honored, a section in field f is offered if and only if $c_{jt} \geq m_f$.

To allow for the possibility that excess spending affects the desirability of a section, modify student utility in Equation (31) to be:[47]

$$U_{ijt} = X_{it}\beta_f + \theta \log\left(e_{jt} + 1\right) + \epsilon_{ijt} \tag{38}$$

The parameter θ measures the extent to which higher paid instructors make sections more attractive to students.

For simplicity, assume ϵ_{ijt} are iid draws from a type 1 extreme value distribution. Similar to Section 3.2, total expected student utility in semester t, the expected number of students choosing courses in field f in semester t, and the effects of both extensive margin spending and intensive margin spending on both of these outcomes can be defined as a function of model parameters and observed data. The effects of intensive margin spending on total expected student utility in semester t and on the expected number of students choosing courses in field f in semester t are given by:[48]

$$\frac{\partial V_t\left(\mathbf{d_t}, \mathbf{e_t}\right)}{\partial e_{jt}} = \sum_{i=1}^{N} P_{itj} \left(\frac{\theta}{e_{jt}+1}\right) \tag{39}$$

$$\frac{\partial n_{tf}\left(\mathbf{d_t}, \mathbf{e_t}\right)}{\partial e_{jt}} = \begin{cases} \sum_{i=1}^{N} \left\{ \left(\frac{\theta}{e_{jt}+1}\right) P_{itj}\left(1 - P_{itj}\right) - \sum_{j' \in f \setminus j} \left(\frac{\theta}{e_{jt}+1}\right) P_{itj} P_{itj'} \right\} & j \in f \\ - \sum_{i=1}^{N} \sum_{j' \in f} \left(\frac{\theta}{e_{jt}+1}\right) P_{itj} P_{itj'} & j \notin f \end{cases} \tag{40}$$

where $\mathbf{e_t}$ is a vector containing all excess spending decisions, $\mathbf{d_t}$ is a vector containing all offered courses, and P_{itj} is the probability that student i chooses course j in semester t. As one might expect, these equations illustrate the crucial role of the parameter θ in determining the effects of intensive margin spending on student outcomes.

With these marginal effects, one can construct the set of intensive margin university

[47] The log function is used to ensure diminishing marginal returns to avoid a corner solution in which the university spends its entire discretionary instruction budget on a single course. I add 1 to ensure marginal effects of excess spending are finite over the entire support of excess spending.

[48] Other equations are straightforward to derive and are omitted for brevity.

first order conditions analogous to the extensive margin conditions given by Equation (7):

$$\frac{\partial V_t(\mathbf{d_t}, \mathbf{e_t})}{\partial e_{j_1 t}} + \sum_{f'=1}^{F-1} \gamma_{f'} \left(\frac{\partial n_{tf'}(\mathbf{d_t}, \mathbf{e_t})}{\partial e_{j_1 t}} \right) = \frac{\partial V_t(\mathbf{d_t}, \mathbf{e_t})}{\partial e_{j_2 t}} + \sum_{f'=1}^{F-1} \gamma_{f'} \left(\frac{\partial n_{tf'}(\mathbf{d_t}, \mathbf{e_t})}{\partial e_{j_2 t}} \right) \quad \forall j_1, j_2 \tag{41}$$

As in Section 2.3, this system can be rearranged to solve for the university preference parameters which best explain why observed intensive margin spending decisions were preferred to all feasible alternative decisions.

The intuition underlying this method is analogous to the intuition behind the extensive margin methods discussed in the body: If the university were purely trying to maximize total student utility, it would choose excess spending levels so that the marginal effect of increasing excess spending on total student utility is the same across all course sections. If the university is consistently overpaying instructors in a certain field relative to the allocation which maximizes student utility, it must be that the university is trying to draw more students into this field thus revealing an institutional preference to increase the number of students in this field.

Effects of intensive and extensive margin spending

I chose to abstract from intensive margin spending decisions in my analysis because empirical evidence suggests intensive margin spending has much smaller effects on student choices than extensive margin spending. Panel A of Table A1 reports estimates of the elasticity of enrollment with respect to spending on instructors estimated with several specifications of the regression:

$$\log(S_{jt}) = \tilde{\theta} \log(c_{jt}) + \xi_k + \eta_{jt} \tag{42}$$

where S_{jt} is the number of students enrolled in section j in semester t and ξ_k is a course number fixed effect (e.g. ECON 101). Specification 2 suggests the elasticity of enrollment with respect to instructor salary could be as large as 0.162 for sections taught by adjunct instructors on single-semester contracts. This would imply that doubling spending on instruction for all adjunct instructed field f sections but keeping other course characteristics fixed would increase adjunct instructed field f enrollment by 16.2%. However, specification 4 suggests this moderately large estimate is driven by a small number of very small course sections. When I exclude 45 course observations with five or fewer students, the elasticity drops to 0.0534. This suggests doubling spending on field f adjunct instructors but keeping other course characteristics fixed only increases adjunct instructed field f enrollment by 5.34%. Elasticities for all instructor contract types (columns 1 and 3) suggest similarly small effects.

While it is not the focus of this paper, I should note that this finding is in line with existing literature which finds that higher paid instructors have small or zero effects on student outcomes at universities (Bettinger and Long, 2010; Figlio et al., 2015).

Comparatively, Panel B of Table A1 reports estimates of elasticities of enrollment with respect to spending on course offerings computed using estimates of the nested logit course choice model, observed adjunct instructed course offerings, and estimates of costs of hiring adjunct instructors.[49] Estimates of these elasticities range from 0.3229 in social science to 0.4999 in humanities and arts. This suggests that doubling the number of adjunct instructed field f course sections offered to students increases adjunct instructed field f enrollment by 32.29 - 49.99%.

The large differences between intensive margin elasticities and extensive margin elasticities suggest UCA can increase total student utility more and attract more students into desirable fields by spending marginal dollars offering additional course sections rather than increasing spending on instruction. This implies that no values for γ_f can rationalize both observed intensive and observed extensive margin spending decisions at UCA. Furthermore, the small effects of intensive margin spending suggest variation in spending on instruction at UCA exists for some reason other than influencing student choices and utility. For this reason, I focus on extensive margin decisions which have significant effects on student choices and utility at UCA. Future research may seek to better explain variation in spending on instruction.

Appendix C: Solving for equivalent costs

In this appendix, I describe my method for estimating the equivalent costs reported in Column 6 of Table 7. The goal of this exercise is to solve for counterfactual costs of hiring adjunct instructors which come closest to inducing a utility maximizing university to offer observed adjunct instructed courses.

[49]Specifically, the formula is:

$$\epsilon_{tf} = \frac{\partial n_{tf}(\mathbf{d}_t)}{\partial d_{tf}} \times \frac{d_{tf}^N}{n_{tf}^N(\mathbf{d}_t)} \tag{43}$$

where d_{tf}^N is the number of field f course sections taught by adjunct instructors in semester t and $n_{tf}^N(\mathbf{d}_t)$ is observed enrollment in adjunct instructed field f course sections in semester t. Figures in Panel B of Table A1 are field specific averages of elasticities across academic semesters.

A utility maximizing university's problem is given by:

$$\mathbf{d_t^{SUM}} = \text{argmax}_{\mathbf{d_t}} \left\{ V_t \left(\mathbf{d}_t \right) \right\} \quad \text{s.t.} \quad \sum_{f=1}^{F} d_{tf}^N c_f \leq E_t^N \tag{44}$$

where c_f is the cost of hiring an adjunct instructor to teach a field f course section, d_{tf}^N is the number of adjunct instructed field f course sections offered in semester t, and E_t^N is the residual share of the semester t instruction budget which is paid to adjunct instructors on single-semester contracts. This equation is similar to Equation 3 except that it excludes the implied preference terms $\gamma_f n_{tf}$, it uses the empirical linear budget constraint, and it imposes the counterfactual restriction that the university can only reallocate the portion of its budget paid to adjunct instructors on single-semester contracts. The goal of the equivalent cost exercise is then to solve for equivalent costs $\tilde{c}_f$ which imply that the solutions to Equation (44) are as close as possible to observed course offerings.

To solve for equivalent costs $\tilde{c}_f$, note that the system of first order conditions characterizing a solution to (44) if adjunct instructor costs are given by $\tilde{c}_f$ is:

$$\left(\frac{1}{\tilde{c}_{f_1}} \right) \left[\frac{\partial V_t \left(\mathbf{d}_t^\star \right)}{\partial d_{tf_1}} \right] = \left(\frac{1}{\tilde{c}_{f_2}} \right) \left[\frac{\partial V_t \left(\mathbf{d}_t^\star \right)}{\partial d_{tf_2}} \right] \quad \forall f_1, f_2 \tag{45}$$

$$\sum_{f=1}^{F} d_{tf}^N \tilde{c}_f = E_t^N \tag{46}$$

Because this university's objective is to maximize total student utility, optimal course offerings simply equate marginal utility per dollar of additional course offerings across all academic fields.

Rearranging and stacking fields and semesters yields:

$$\left(\mathbf{M}^1 + \mathbf{M}^2 \right) \tilde{\mathbf{c}} = \mathbf{ME} \tag{47}$$

where

$$\underset{(F-1,\,F-1)}{\mathbf{M}_t^1} \left(f_1,\, f_2 \right) = \left(\frac{\partial V_t \left(\mathbf{d_t} \right)}{\partial d_{tf_1}} \right) \left(\frac{d_{tf_2}}{d_{tF}} \right)$$

$$\underset{((F-1) \times T,\, F-1)}{\mathbf{M}^1} = \begin{bmatrix} \mathbf{M}_1^1 \\ \vdots \\ \mathbf{M}_T^1 \end{bmatrix}$$

$$\underset{(F-1,F-1)}{\mathbf{M}_t^2}(f_1,\ f_2) = \begin{cases} \frac{\partial V_t(\mathbf{d_t})}{\partial d_{tF}} & f_1 = f_2 \\ 0 & f_1 \neq f_2 \end{cases}$$

$$\underset{((F-1)\times T,\, F-1)}{\mathbf{M}^2} = \begin{bmatrix} \mathbf{M}_1^2 \\ \vdots \\ \mathbf{M}_T^2 \end{bmatrix}$$

$$\underset{(F-1,1)}{\tilde{\mathbf{c}}(f)} = \tilde{c}_f$$

$$\underset{(F-1,1)}{\mathbf{ME}_t(f)} = \left(\frac{\partial V_t(\mathbf{d_t})}{\partial d_{tf}}\right)\left(\frac{E_t^N}{d_{tF}}\right)$$

$$\underset{((F-1)\times T,\,1)}{\mathbf{ME}} = \begin{bmatrix} \mathbf{ME}_1 \\ \vdots \\ \mathbf{ME}_T \end{bmatrix}$$

This system of equations can then be inverted to derive the following expression for equivalent costs:

$$\tilde{\mathbf{c}} = \left(\mathbf{M}^1 + \mathbf{M}^2\right)^+ \mathbf{ME} \tag{48}$$

where M^+ denotes the pseudo-inverse of M.

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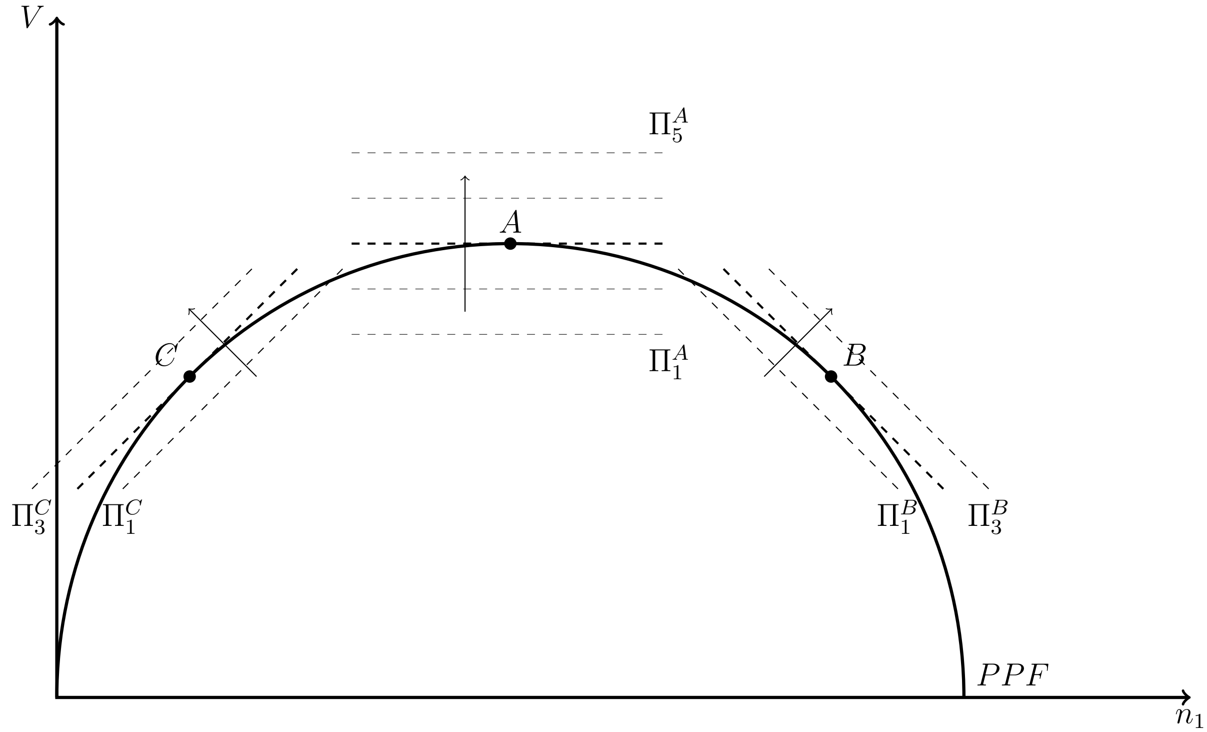
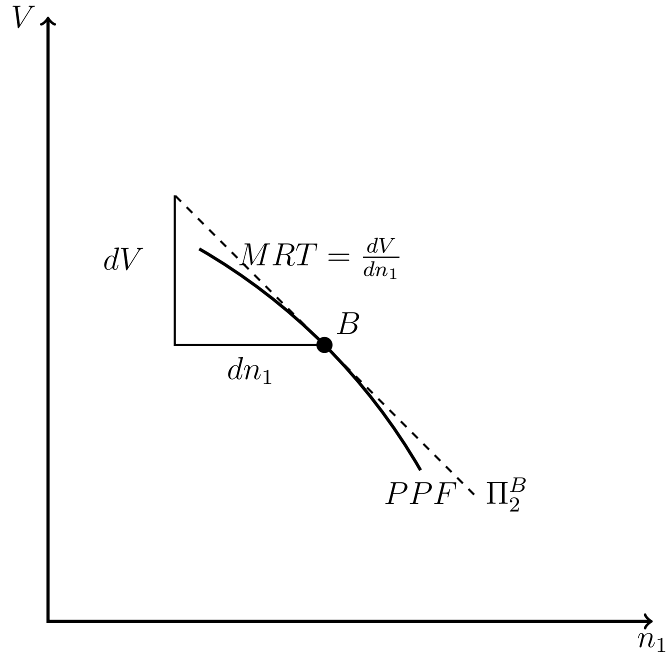
Figure 1: Optimal Course Offerings



The vertical axis is total expected student utility. The horizontal axis is expected number of students choosing courses in field 1 (the expected number of students choosing courses in field 2 is the complement). The solid semi-circle is a production possibilities frontier representing the frontier of outcomes which can be achieved given the university's constraints. Dashed line segments represent potential university indifference curves with payoffs increasing in the direction of the arrows. University A only values total expected student utility $\left(\gamma_1^A = 0\right)$ and offers courses to achieve outcome A. University B has institutional preferences to increase the expected number of students choosing courses in field 1 $\left(\gamma_1^B > 0\right)$ and offers courses to achieve outcome B. University C has institutional preferences to decrease the expected number of students choosing courses in field 1 $\left(\gamma_1^C < 0\right)$ and offers courses to achieve outcome C.

Figure 2: Revealed Institutional Preferences



This is Figure 1 zoomed in to focus on the tangency condition of university B. The derivative of the PPF at point B, or marginal rate of transformation (MRT), is given by the instantaneous change in total expected student utility relative to the instantaneous change in the expected number of students choosing courses in field 1 as the university marginally reallocates funds from field 1 to field 2. The instantaneous change in total expected student utility is given by the marginal effect per dollar of offering an addition field 2 section on total expected student utility minus the marginal effect per dollar of offering an addition field 1 section:

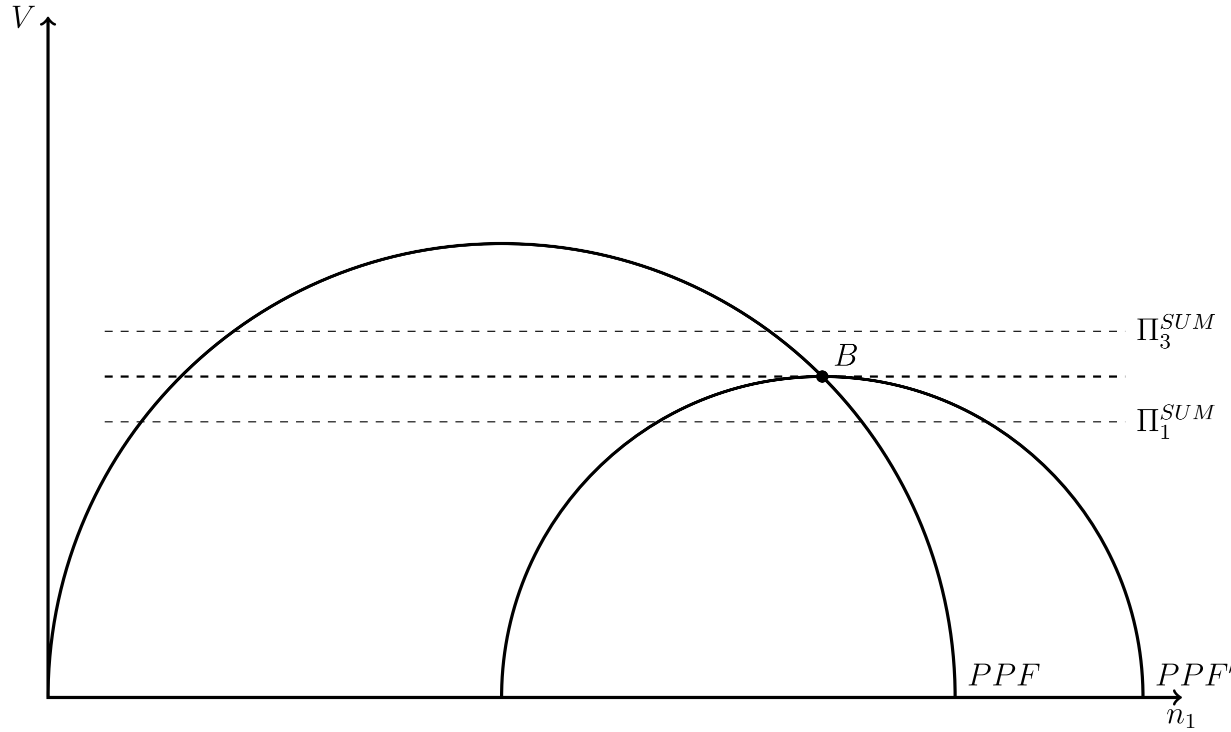
$$dV = \left(\frac{1}{c_2^N}\right)\left(\frac{\partial V}{\partial d_2}\right) - \left(\frac{1}{c_1^N}\right)\left(\frac{\partial V}{\partial d_1}\right)$$

The instantaneous change in the expected number of students choosing courses in field 1 is given by the marginal effect per dollar of offering an addition field 2 section on the expected number of students choosing courses in field 1 minus the marginal effect per dollar of offering an addition field 1 section on the expected number of students choosing courses in field 1.

$$dn_1 = \left(\frac{1}{c_2^N}\right)\left(\frac{\partial n_1}{\partial d_2}\right) - \left(\frac{1}{c_1^N}\right)\left(\frac{\partial n_1}{\partial d_1}\right)$$

This graphically demonstrates how marginal effects of spending can be used to solve for the slope of the indifference curves which rationalize why point B was optimal for this university.

Figure 3: Equivalent Costs to Make a Utility Maximizing University Offer Observed Courses



PPF' is the production possibilities frontier under "equivalent costs" which would induce a student utility maximizing university to offer courses producing observed allocation B. They are equivalent in the sense that going from preferences characterized by Π^A to preferences characterized by Π^B while holding PPF fixed in Figure 1 has the same effect on course offerings as going from PPF to PPF' while maintaining utility maximizing preferences characterized by Π^{SUM} in this figure.

Table 1: University of Central Arkansas

Institutional Characteristics	
Undergraduates	9,887
Full-time faculty	547
Admission Rate	92%
Yield	44%
ACT 25th pctile	20
ACT 75th pctile	26
6 year graduation rate	45%
Student characteristics	
Full-time	84%
24 and under	90%
In-state	89%
Female	59%
White	66%
Black	18%
Hispanic	5%
Other race	11%

Source: National Center for Education Statistics. Fall, 2015. Yield is the percent of students who choose to enroll conditional on being offered admission. ACT scores are composite scores. Graduation rate is for students pursuing a Bachelor's degree.

Table 2: Field Characteristics at UCA

	STEM	Social Science	Humanities and Arts	Business and Occupational
Avg. intro courses per semester	33.1	64.7	52.6	25.2
Avg. intro sections per semester	210	259	165	88
Avg. intro enrollment per semester	5590	8833	4802	2330
Avg. intro enrollment per section	26.6	34.1	29.2	26.6
Intro section cost (25th pctile)	\$5,766	\$4,566	\$5,184	\$5,168
Intro section cost (Median)	\$8,684	\$6,088	\$6,801	\$7,012
Intro section cost (75th pctile)	\$10,927	\$8,781	\$9,382	\$11,407
Avg. ACT score	24.2	23.7	23.9	23.9
Avg. HS GPA	3.42	3.37	3.36	3.41
Share Female	58.0%	59.8%	57.9%	48.2%
Share Freshmen	43.9%	40.5%	40.2%	11.4%
Share Sophomores	27.9%	31.8%	34.7%	40.6%
Share Juniors	16.9%	18.1%	16.1%	35.5%
Share Seniors	11.2%	9.6%	9.0%	12.5%

Notes: Statistics are for introductory courses at the University of Central Arkansas. "Courses" are defined by a course number (e.g. Econ 101). "Sections" are defined by a course number, instructor and meeting time (e.g. Econ 101 taught by Prof. Jane Doe meeting MWF from 9 - 10:30AM). Section cost is the amount an instructor is implicitly paid to teach a course section. This depends on an instructor's salary, teaching load, and other responsibilities. Average student scores and demographic proportions treat every instance of a student choosing an introductory course as an observation and compute statistics conditional on the field of the introductory course.

Table 3: Course Offerings and Enrollment Shares

STEM	Semester											
	F04	S05	F05	S06	F06	S07	F07	S08	F08	S09	F09	S10
Courses	34	30	33	33	34	32	33	33	33	34	33	35
Sections	194	175	221	179	235	208	248	211	222	207	219	201
Sections (%)	30%	28%	31%	28%	30%	29%	30%	28%	29%	29%	28%	29%
Enrollment (%)	27%	24%	28%	24%	26%	25%	27%	25%	26%	26%	26%	26%

Social Science	Semester											
	F04	S05	F05	S06	F06	S07	F07	S08	F08	S09	F09	S10
Courses	59	64	65	61	65	64	65	66	66	67	69	65
Sections	227	220	250	231	284	269	297	271	272	270	279	240
Sections (%)	35%	35%	36%	36%	36%	37%	36%	37%	35%	37%	36%	34%
Enrollment (%)	42%	43%	41%	42%	41%	41%	40%	41%	40%	41%	41%	40%

Humanities and Arts	Semester											
	F04	S05	F05	S06	F06	S07	F07	S08	F08	S09	F09	S10
Courses	47	48	49	52	51	50	55	53	56	54	56	60
Sections	146	146	148	148	169	158	182	172	182	160	187	176
Sections (%)	22%	23%	21%	23%	22%	22%	22%	23%	24%	22%	24%	25%
Enrollment (%)	21%	23%	21%	23%	22%	22%	22%	23%	22%	21%	23%	23%

Business and Occupational	Semester											
	F04	S05	F05	S06	F06	S07	F07	S08	F08	S09	F09	S10
Courses	26	26	26	24	26	24	25	25	26	24	25	25
Sections	90	81	85	77	95	86	98	87	96	85	91	82
Sections (%)	14%	13%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
Enrollment (%)	10%	11%	10%	11%	10%	11%	11%	11%	11%	12%	10%	11%

Notes: Statistics are for the University of Central Arkansas. FXX/SXX indicate fall/spring semester of 20XX. “Courses” are defined by a course number (e.g. Econ 101). “Sections” are defined by a course number, instructor and meeting time (e.g. Econ 101 taught by Prof. Jane Doe meeting MWF from 9 - 10:30AM).

Table 4: Course Section Cost Regression

	Course Section Cost
STEM	5057.4
	124.9
Social Science	2816.9
	127.1
Humanities and Arts	3191.3
	152.2
Business and Occupational	4650.9
	198.1
Tenured	5595.1
	143.4
Tenure-track	5433.6
	161.2
Contracted non-tenure	3132.5
	135.0
Single-semester adjunct	*omitted*
Course Section Observations	8857

Notes: Block bootstrapped standard errors (1000 iterations, sampling course sections) are in italics. Dependent variable is the amount an instructor is implicitly paid to teach a course section. This depends on an instructor's salary, teaching load, and other responsibilities. All course sections are categorized into either STEM, social science, humanities and arts, or business and occupational (the regression does not include a constant). As such, coefficient on STEM indicates that the predicted cost of offering a STEM course section with an adjunct instructor on a single-semester contract is $5,057.40. Adjunct instructors on single-semester contracts are hired to teach for one semester and have no explicit guarantee that their contracts will be renewed.

Table 5: Student Course Choice Parameters

	STEM	Social Science	Humanities and Arts	Business and Occupational
Intercept	0.473***	1.344***	0.543***	*omitted*
	0.032	*0.045*	*0.023*	
ACT Z-Score	0.155***	0.073***	0.127***	*omitted*
	0.013	*0.012*	*0.014*	
Missing ACT	-0.203***	-0.161***	-0.233***	*omitted*
	0.029	*0.026*	*0.030*	
GPA Z-score	0.003	-0.093***	-0.126***	*omitted*
	0.013	*0.013*	*0.015*	
Missing GPA	0.089***	0.162***	0.180***	*omitted*
	0.031	*0.029*	*0.032*	
Female	0.416***	0.525***	0.457***	*omitted*
	0.024	*0.021*	*0.025*	
Sophomore	-1.737***	-1.495***	-1.395***	*omitted*
	0.028	*0.026*	*0.029*	
Junior	-2.086***	-1.923***	-2.016***	*omitted*
	0.031	*0.030*	*0.034*	
Senior	-1.449***	-1.522***	-1.561***	*omitted*
	0.040	*0.037*	*0.042*	
Nesting Parameter ρ_f	0.680	0.547	0.642	0.461
	0.007	*0.011*	*0.008*	*0.008*

Notes: Block bootstrapped standard errors (1000 iterations, sampling student panels) are in italics. *** indicates significantly different from omitted category (normalized to zero) at 1% significance. ACT/GPA Z-scores are scores that have been rescaled to have mean 0 and standard deviation 1 in my observed sample of students.

Table 6: Relative Marginal Effects and Implied Preferences

	Relative Average Marginal Effect on Total Utility (1)	Relative Average Marginal Effect on Total Utility per Dollar (2)	Implied Preferences (3)
STEM	1.484***	1.365***	0.611***
	0.033	*0.059*	*0.041*
Social Science	1.533***	2.533***	0
	0.035	*0.117*	
Humanities and Arts	1.541***	2.249***	0.086***
	0.031	*0.109*	*0.029*
Business and Occupational	1	1	1.114***
			0.068

Notes: Block bootstrapped standard errors (1000 iterations, sampling student panels for student parameters and course sections for costs) are in italics. Column 1 contains marginal effects of offering an additional course section in the specified field on total expected student utility. These are averaged across academic semesters and reported relative to the effect for a business or occupational course section. Column 2 divides marginal effects by the cost of hiring an adjunct instructor to teach a course section in the specified field. Once again, these are averaged across semesters and reported relative to the effect per dollar for a business or occupational course section. Column 3 reports estimates of implied preference parameters γ_j with social science as the omitted field. Estimates quantify how much student utility the university is implicitly willing to sacrifice to move one student from a social science course to a course in the specified field.

Table 7: Utility Maximizing Course Offerings and Equivalent Costs

	Observed			**Utility Maximizing**		
	(1)	(2)	(3)	(4)	(5)	(6)
	Average Contracted Sections	Average Adjunct Instructed Sections	Average Field Enrollment	Average Adjunct Instructed Sections	Average Field Enrollment	Equivalent Cost Differences
STEM	175.08	34.92	5589.75	0.00***	4821.49***	-17.01%***
				0.00	33.45	1.13
Soc Sci	234.58	24.58	8833.33	98.35***	9862.71***	45.62%***
				10.52	178.39	3.57
Hum and Arts	150.17	14.33	4801.83	14.69	4681.97	24.99%***
				8.72	169.01	3.18
Bus and Occ	81.00	6.75	2330.25	0.00***	2191.49***	-41.99%***
				0.00	24.52	2.08

Notes: Block bootstrapped standard errors (1000 iterations, sampling student panels for student parameters and course sections for costs) are in italics. Columns 1-3 are the observed number of course sections taught by instructors on long term contracts, the observed number of course sections taught by adjunct instructors on single semester contracts, and observed field enrollments averaged across semesters. Column 4 reallocates the residual budget spent on adjunct instructors to maximize total student utility and column 5 reports estimated field enrollments under these utility maximizing offerings. In columns 4 and 5, *** indicates significantly different from observed values at 1% significance. Column 6 reports how much the cost of hiring an adjunct instructor would need to change to induce a utility maximizing university to offer the observed adjunct instructed course sections reported in column 2. In other words, the implied preferences reported in Table 6 have the same effect on course offerings as changing costs by the percentages reported in column 6. In column 6, *** indicates significantly different from zero at 1% significance.

Table 8: Adjunct Instructed Course Offerings in Counterfactual Scenarios

		STEM	Social Science	Humanities and Arts	Business and Occupational
(1)	Observed state	35.79	20.55	12.15	9.73
	(predicted)	*0.15*	*0.36*	*0.24*	*0.29*
(2)	Reduce cost of STEM	53.38***	6.31***	5.00***	7.03***
	instructors by 5%	*0.30*	*0.53*	*0.28*	*0.24*
(3)	Increase all SAT scores and	53.19***	2.71***	4.25***	7.04***
	GPA by 1/3 of a std dev	*0.60*	*0.57*	*0.54*	*0.42*
(4)	Make all students	24.09***	49.91***	18.82***	0.14***
	female	*1.95*	*2.39*	*2.04*	*0.12*

Notes: Block bootstrapped standard errors (1000 iterations, sampling student panels for student parameters and courses for costs) are in italics. Row 1 is the average number of course sections taught by adjunct instructors on single-semester contracts predicted by the estimated model in the observed state. Rows 2-4 are the average number of course sections taught by adjunct instructors on single-semester contracts in counterfactual states. In rows 2-4, *** indicates significantly different from row 1 at 1% significance.

Table 9: Field Enrollments in Counterfactual Scenarios

		STEM	Social Science	Humanities and Arts	Business and Occupational
(1)	Observed state	5619.26	8787.54	4779.57	2371.28
	(predicted)	*36.11*	*43.37*	*29.19*	*26.78*
(2)	Reduce cost of STEM	5968.65***	8566.8***	4667.73***	2354.48
	adjunct by 5%	*37.93*	*42.52*	*28.86*	*26.23*
(3)	Increase all SAT scores and	5825.93***	8676*	4749.75	2305.98*
	GPA by 1/3 of a std dev (PE)	*39.48*	*44.91*	*30.54*	*26.27*
(4)	Increase all SAT scores and	6235.6***	8369.65***	4615.37***	2337.03
	GPA by 1/3 of a std dev (GE)	*46.08*	*45.5*	*33*	*28.64*
(5)	Make all students	5563.19	9201.64***	4865.66*	1927.17***
	female (PE)	*40.9*	*49.31*	*36.2*	*26.5*
(6)	Make all students	5288.73***	9550.23***	4884.21	1834.49***
	female (GE)	*70.75*	*69.65*	*61.13*	*26.46*

Notes: Block bootstrapped standard errors (1000 iterations, sampling student panels for student parameters and courses for costs) are in italics. Row 1 are average field enrollments predicted by the estimated model in the observed state. Rows 2-6 are average field enrollments in counterfactual states. In rows 2-6, ***/**/* indicates significantly different from row 1 at 1%/5%/10% significance. (PE) indicates that student characteristics are changed but course offerings are held fixed. (GE) indicates that course offerings change in response to counterfactual student characteristics as reported in Table 8.

Table 10: Naive Earnings Regressions

Field of major	(1) Log annual earnings conditional on reporting 8 years after graduating	(2) Reporting earnings 8 years after graduating
STEM	0.428***	0.00223
	(0.0625)	(0.0233)
Social Science	0.104**	0.0498**
	(0.0513)	(0.0195)
Humanities	*Omitted*	*Omitted*
Business and Occupational	0.391***	0.0909***
	(0.0443)	(0.0168)
General / Missing Field	0.283***	0.125***
	(0.0466)	(0.0179)
Observations	7,375	11,645
R-squared	0.060	0.013

Notes: Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Additional controls include ACT scores, high school GPA, gender, and graduation year. Columns 2 is a linear probability models. Data are for students who earn Bachelor's degrees between the 1993-1994 and 2003-2004 academic years. 27.5% of degrees cannot be matched to a field and thus are included in the General / Missing Field category. Graduates who complete multiple degrees or majors are excluded (4.2% of degree earners).

Table 11: Naive Grade Regressions

Field of course	(1) Earning an A grade conditional on completing	(2) Grade points conditional on completing (Censored Regression)	(3) Withdraw / Incomplete Grade
STEM	-0.131***	-0.600***	0.0392***
	(0.00235)	(0.00833)	(0.00157)
Social Science	-0.0671***	-0.292***	0.0103***
	(0.00213)	(0.00758)	(0.00143)
Humanities	*Omitted*	*Omitted*	*Omitted*
Business and Occupational	-0.0434***	-0.192***	0.0225***
	(0.00306)	(0.0109)	(0.00205)
Observations	258,924	258,924	286,682
R-squared	0.157	N/A	0.025

Notes: Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Controls include ACT scores, high school GPA, gender, and student level. Columns 1 and 3 are linear probability models. A withdrawal or incomplete is recorded on a student's transcript but does not impact the student's GPA (9.7% of observations). Letter grades are assigned to numeric grade point values using the Arkansas Department of Higher Education's metric (A=4, B=3, C=2, D=1, F=0). 25.3% of grades are an A. Data are for introductory courses in Fall and Spring academic semesters between the 2005-06 and 2011-2012 academic years.

Table A1: Elasticities of enrollment

Panel A: Elasticity with respect to instructor salaries (log-log regression)

	log(Enroll)	log(Enroll)	log(Enroll)	log(Enroll)
log(Instructor Salary)	0.0888***	0.162***	0.0220***	0.0534***
	0.0112	*0.0388*	*0.0064*	*0.0191*
Course fixed effects	Yes	Yes	Yes	Yes
Adjunct instructed only	No	Yes	No	Yes
Enrollment>5	No	No	Yes	Yes
Observations	8,556	873	8,280	819
R-squared	0.499	0.564	0.609	0.589

Panel B: Elasticity with respect to spending on course offerings (model based)

	STEM	Soc Sci	Hum and Arts	Bus and Occ
Elasticity	0.4963***	0.3229***	0.4999***	0.3844***
	0.0055	*0.0064*	*0.0064*	*0.0067*

Notes: Standard errors in italics. *** denotes p-value for test that coefficient is not equal to zero is $p<.01$. Panel A contains estimates of the elasticities of enrollment with respect to spending on instructor salaries which are estimated using the log-log regression specification given in Equation 41. Panel B contains estimates of the elasticities of enrollment with respect to spending on course offerings which are derived from estimates of the nested logit student choice model.