The Effect of Taking Courses Outside of University of Oregon on Future Performances in Subsequent Courses

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ABSTRACT

In this study, we measure the impact of taking a prerequisite course outside the University of Oregon on the grade received in the subsequent follow up course taken within the university. Many courses within the University of Oregon require completing certain prerequisite courses before students can enroll in them. Some students complete these prerequisites outside the University of Oregon and transfer their credit and grade over. We find that students' grades in follow-up courses are on average 0.17 of a grade point lower if the prerequisite course was taken outside the University of Oregon. However, for currently enrolled students the effect can be up to half a grade point lower.

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INTRODUCTION

It is a common feature of four-year universities to accept credits that students earn at other institutions. Each university has their process for doing this, but it often involves mapping the courses the student earned credit for at other schools to equivalent courses at the home institution. Students at the University of Oregon have the option to use certain transfer credits to satisfy major requirements and prerequisites. Transfer credits can come from dual-enrollment courses (high school courses that counts as college courses), Advanced Placement (AP) courses, other four-year Universities, community colleges, and even overseas high schools or universities. This alone is not an issue, if the courses taken outside the University of Oregon are of the same quality; however, this is not always the case. To that end, the question has been raised as to whether taking classes outside of the University of Oregon has adverse effects on student performance at the University of Oregon.

A key interest of our study revolves around University of Oregon students who are enrolled but choose to take courses outside to fulfill their prerequisites classes. There are several possible explanations for this. One is that rising tuition fees at four year universities is putting financial pressure on students to take certain courses outside where they are cheaper. Another reason could be because of the perception of outside courses being easier. A third reason could be because the student travels home for the summer and is taking courses at another institution over the break. It could be any of these reasons or none of them. While we cannot be certain for why an enrolled UO student would choose to take a course outside, we measure the impact of doing so.

THEORY & HYPOTHESES

Hypothesis I: *Current University of Oregon students who take a prerequisite course outside the University of Oregon will perform worse in the subsequent course than they would have otherwise because the reduced learning outcomes of the outside course.*

This hypothesis is made under several assumptions. That majority of the current University of Oregon students (non-transfer students) who enroll in courses outside the University of Oregon do so either online or at community colleges. A further assumption based on literature review on this topic is that on average both online and community college courses are of lower quality than UO courses. The final assumption made is that we can control in part for the self-selection effect. This effect is found when students choose to take a course outside non-randomly. For example, lower performing students may actively choose to take a course outside at a community college, because community college courses are perceived to be easier. Thus, the effect of taking a course outside may be overstated as these lower performing students do worse in their fallow-up course, not because they took their prerequisite outside, but because they are lower performing students.

Hypothesis II: *While the overall effect of University of Oregon students taking a course outside the University of Oregon will be negative, it will differ by department, being comparatively worse in STEM Courses.*

The second hypothesis is made under the following assumptions. The first assumption is that more technical courses such as Mathematics are more difficult to teach and learn, thus have a wider range of quality at different institutions. The second is that more technical courses rely more heavily on building upon prior course experience.

LITERATURE REVIEW

For our research topic, we are interested in seeing whether there is an impact of taking outside classes to fulfill certain prerequisite courses on future performances of subsequent classes' grades. Previous research has been done similarly to our research question, however, most literature that we have found focuses on the effect of students transferring their credits from community colleges, or using their high school's AP credits, or credits from another four-year university on their subsequent academic performance and/or persistence. However, we are most interested in students who take their prerequisites outside the university after they are enrolled. The study that we are doing seems to be new, as we have not found a study that measures the effect when students who are already enrolled in a university choose to take their prerequisites outside.

A paper by Leonard-Foots (2013) examine the effect of dual-credit enrollment on the Grade Point Average (GPA) of university students by analyzing those who had a prior accumulation of 12 or more dual-credit enrollment hours versus those without any dual-credit enrollment hours at a large four-year university in Texas. Dual enrollment courses are a term that captures all courses that were taken during high school which are transferable and counted towards college credit. The study used the college's transcript data to examine the first-year GPA (contiguous Fall and Spring semester) of 225 randomly selected students who arrived with 12 or more dual credit hours in school year 2008 – 2009, 331 in year 2009 – 2010, and lastly 475 in 2010 – 2011. The same number of randomly selected students without any dual credit hours were selected for each of the school years, in the academic years of the same three-year period. This study was

conducted using a Mann Whitney U-test to determine if differences exist between two groups on one dependent variable with a 0.05 significance level and all calculations were made using the SPSS.

The study by Krieg and Henson (2016) is more closely tied with our research. This study measures the impact of taking an online prerequisite course on follow-up course grades. A large student-level dataset from a medium-sized regional comprehensive university was used to achieve their results. To control for self-selection bias into online courses, the researchers utilized a series of instrumental variables. We do something similar in our model by controlling for student ability. More on this in our methodology section. Krieg and Henson found that students' grades in follow-up courses were predicted to be close to one twelfth of a grade point lower if the prerequisite course was taken online.

Laugerman et al., (2015) estimates the survival rates for students in the College of Engineering in Iowa State University who transferred their calculus and physics credits from a community college before starting school at ISU. Survival rates for students refers to a student making all the way to graduation rather than dropping out. The researcher's definition of transfer students only included those who have credits transferred from a community college. Transferred credits from another four-year university or students who used their AP credits were not considered. To estimate the survival rates, they used the Kaplan-Meier Survival Curves. This measure the retention rate over time. The advantage of using this method was the ability of it considering certain censored data, which occurs whenever a student withdraws or lost from sample. In other

words, for the entire period of an analysis, if students either graduated or dropped out of school, they will not be included and hence, not affect the survival functions.

The last paper we discuss is a study conducted to predict adult learner academic persistence by Wiggam (2004). Adult learners were defined as individuals who enroll in college at ages 21 and 24. The main goal of this study is to determine the relationship between several independent variables (gender, age, ethnicity, transfer credits, and financial aid) with academic persistence. The term academic persistence refers to if the student enrolled in the course work through the entire first three semesters after they are initially enrolled. The study ran a logistic regression model and conclude that among the other independent variables, transfer credits had the strongest relationship with academic persistence. However, according to the r-statistics, the relationship was rather weak, hence, suggesting that these variables might only have small contribution to academic persistence. Though this study is distinct from ours in many respects, because academic persistence is commonly associated doing well academically, this study suggests that students who enroll in the University of Oregon with transfer credits will perform better than those without.

DATA

The data for our analysis comes from the University of Oregon Registrar. The data we received contained student transcript data that are separated into four Comma Separated Values (CSV) files – prerequisite classes, follow-up classes, student demographics, and institution code. Transcript data is paramount to our research as our analysis requires us to compare the grades of a same subsequent class between two group of students – one that has prerequisites taken at the University of Oregon, and the other outside. The variables along with their descriptions for the four CSV files are listed in **Table 10 – 13** of the appendix. An additional CSV file was also obtained that contains instructor specific data (**Table 14**), specifically the grade distribution assigned by instructors for classes taken in the University of Oregon.

Our Prerequisites Course data provides 33 different courses across many of the largest departments at the University of Oregon, namely Business, Journalism, Economics, Science, Psychology, and English. We identify 33 courses using the University of Oregon course catalog as common prerequisites. For Follow-up Course data, we have data on 49 different follow-up courses in the University of Oregon that required one of the 33 prerequisite courses to be taken. Student demographics data contain records of 71,461 students at the University of Oregon from the period of 1991 through 2016. To ensure students' privacy are protected, these records do not display any names or sensitive information, and all student-athletes were dropped from the data. As for the Institutions data set, it contains specific data for 1,639 institutions. We merged all these data set into one to perform our analysis. Further information on the data and how it was cleaned and merged may be found in the appendix.

METHODOLOGY

To capture the effect of a prerequisite course on a follow-up course, we organize our data in a matched pair structure. The matched pair structure involves matching before and after effects in one observation. For our data, this means connecting a given student's prerequisite with their follow-up.

Using the UO catalog, and help from the registrar we select 33 lower-division courses across different departments that students were most likely to take outside. These courses were then paired with follow-up courses that required one of the 33 prerequisites. This provided 49 follow-up courses, and a total of 49 matched pairs. The logic behind this is that any given follow-up course only lists a single prerequisite, however that one prerequisite course may be a prerequisite for multiple follow-ups.

As discussed in greater detail in the expanded data section within the appendix, we organize the prerequisite data and follow-up data by using a many-to-many merge. The result of this was every student's prerequisite matched with the appropriate follow-up. Some students in our data took a prerequisite or follow-up multiple times. To account for that, we take each of these instances as individual observations. In other words, we count each attempt as having a different effect on the follow-up course.

In addition, many students take multiple courses in the same term which leads to repeated terms in our data. This creates repeated time values within our panel data, hence we cannot declare the data to be panel in Stata. To work around that, we utilize a random effects model rather than a fixed-effects panel regression and cluster by student ID. This is done to capture the repeated individual-specific effects obtained from a single student over different terms and matched pairs at different occasions.

We use the grade received by a student in their respective follow-up course to measure and quantify their performance in that course. We do this by coding the students' follow-up letter grade earned into its equivalent credit score on a 0 – 4.3 scale. This is depicted in **Table 15** in the appendix.

Our independent variable is whether a student took their prerequisite outside the University of Oregon. This is a dummy variable with 1 = the prerequisite was taken outside, and 0 = the prerequisite was taken at the UO. We are testing whether this variable is significant to explaining a student's follow up grade and measuring the coefficient as the direct impact on the grade points earned.

For our controls, we first consider the consider the effects of the prerequisite course on the grade received in the follow up course. For this we use the grade the student received in their prerequisite course. This control is intended to capture some of the unobserved student factors as well as the relevance of the prerequisite to the follow up.

We then consider the student specific features that would influence their follow-up grades. For this, we consider a given student's past academic performance variables and their demographic features. Of the limited student demographic information that the data provides, we consider the students US residential status (whether they are international students or not) and their gender to be the most important. We make this assumption based on the findings of Krieg and Henson which suggested a student's ethnicity was not significant in influencing their grade.

We further describe students in the data be whether they took an outside course while enrolled after being enrolled to the University of Oregon. For this we consider all students with the term the took and outside course being greater than their enrollment term at the University of Oregon. We include this a dummy variable called *Concurrent* with 1 = meaning that the student has taken and outside course while concurrently being a University of Oregon student, and 0 = meaning the student has not taken an outside after being enrolled.

In addition, we specifically control for the effect of students coming in to the University of Oregon with college credit earned in high school, by creating a dummy variable *High School Transfer* with 1 = having earned college credit in high school and 0 = none. This is an important control because it helps capture the effect of stronger students who opted to take more difficult courses in high school getting higher grades in their outside prerequisite and follow-up simply because they are stronger students.

To control for student's pre-college academic performance, we generated a variable *Ability*. This variable accounts for a student's SAT scores, ACT scores, or their High School GPA, which explains why we normalize these scores as mentioned in our data section. However, we have noticed that international students do not have any of these scores from the records. This is because most international students transfer from their own local institutions, hence, we average out their cumulative GPA through the terms in the University of Oregon and normalize them as well. Then, for each observation, we will input students' pre-university scores in the ranking of normalized SAT scores, ACT scores, High School GPA, and averaged cumulative GPA. In other words, for students with missing normalized SAT scores, ACT scores will be inputted into *ability*. For international students who have missing SAT scores, ACT scores, and High School GPA will have their normalized average cumulative GPA input into the *ability* variable. This variable will be interacted with the *Outside* variable to help control for the self-selection effect. The rationality behind this is that that by considering a student's prior performance will capture a large the features that would cause them to self-select into an outside course, such as individual study habits, and aptitude, and motivation.

We then consider the effect of the follow up courses difficulty on the follow up grade. To control for this, we include an indicator of the course difficulty based on the class average of every specific instance of a follow-up course. It is important to do it this way because it accounts for the unobservable effects that make two instances of the same course unique.

In order to test our second hypothesis, we consider the effect of taking an outside course on a student's follow-up grade of each department independently.

Lastly, we consider some of the institutional specific effects of taking a course outside. More specifically, we consider the effect of taking an outside course at a community college rather than some other kind of institution or not taking an outside course at all. We do this by exchanging the variable *Outside* with a dummy variable that indicates wither or not the outside course was taken at a community college. We name this variable *CC*. Additional we create the variable *Lane_CC* to measure the effect of students who specifically take their outside course at Lane Community College, the closest community college in proximity to the University of Oregon.

EMPIRICAL MODEL

Our general model predicts the performance of a subsequent course through the dependent variable *follow-up grade*. This dependent variable is measured in terms of grade points earned on a 0 – 4.3 scale based on the letter grade earned by the student. The following is our theoretical model for measuring *follow-up grade*.

Follow-up Grade = Student Characteristics + Course Difficulty + Prerequisite Characteristics + Unobserved Factors

We measure student characteristics through the use of two dummy variables based on the most significant demographic features, one being their U.S. residential status and the other being their gender. We measure the follow-up course difficulty as a dummy variable for each course by term and CRN. The course is considered difficult if the class average is below the standard 80%. We measure Prerequisite characteristics by observing if it was taken inside the University of Oregon and the grade the student received for that course. These variables make up our general empirical model hence referred to a model 1 below:

Follow Grade = International + Gender + Course Difficulty + Outside + Prerequisite Grade + u_i (1)

Model 1 is a simple regression with our independent variable *Outside*, *International*, and *Male* as our controls.

Model 2 includes the interaction between *Outside* and *Ability*. *Ability* measures a student's academic ability by normalizing pre-university test scores. This is included in our model to control for the self-selection effect.

$$\textbf{\textit{Follow Grade = Ability + International + Gender + Course Difficulty + Outside + Prerequisite Grade + Ability*Outside + } u_i \quad (2)$$

Our next regression model, model 3 includes the additional control, *Concurrent* and an interaction between *Concurrent* and *Outside*. This is to measure the impact of taking a course outside the University of Oregon after being enrolled as compared to being a permanent transfer student or carrying over high school credit.

$$\textbf{\textit{Follow Grade = Ability + International + Gender + Course Difficulty + Outside + Prerequisite Grade + Concurrent + Ability*Outside + Concurrent*Outside + } u_i \quad (3)$$

Model 4 adds the additional interaction between *Ability* and *Concurrent*. This is to measure the significance between a student's academic ability and taking a course outside.

$$\textit{Follow Grade} = \textit{Ability} + \textit{International} + \textit{Gender} + \textit{Course Difficulty} + \textit{Outside} + \textit{Prerequisite Grade} + \textit{Concurrent} + \textit{Ability*Outside} + \textit{Concurrent*Outside} + \textbf{Ability}\textit{*Concurrent} + u_i \quad (4)$$

Model 5 includes the additional control, *High School Transfer* and an interaction between *High School Transfer* and *Outside*. Thus, the coefficient *Outside* from this model, reflects the effect of taking a prerequisite outside for students without college credit earned in high school.

$$\textit{Follow Grade} = \textit{Ability} + \textit{International} + \textit{Gender} + \textit{Course Difficulty} + \textit{Outside} + \textit{Prerequisite Grade} + \textit{Concurrent} + \textit{Ability*Outside} + \textit{Concurrent*Outside} + \textit{Ability*Concurrent} + u_i \quad (5)$$

Model 6 adds another interaction term, between *Outstate* and *Outside*. This is included to see if out-of-state students influence the *Outside* variable. Thus, the coefficient *Outside* in Model 4 reflects the effect of taking a prerequisite outside for in-state students without college credit earned in high school.

$$\textit{Follow Grade} = \textit{Student Ability} + \textit{International} + \textit{Gender} + \textit{Course Difficulty} + \textit{Outside} + \textit{Prerequisite Grade} + \textit{Concurrent} + \textit{Ability*Outside} + \textit{Concurrent*Outside} + \textit{Ability*Concurrent} + \textit{High School Transfer} + \textit{High School Transfer*Outside} + \textit{Outstate} + \textit{Outstate*Outside} + u_i \quad (6)$$

RESULTS & ANALYSIS

We have eight different groups (**Tables 2 – 9**) that each include six regression models from the Empirical Model section. The first group looks at the effect of all students across different departments. The second group is the same as the first only excluding students who receive withdrawal for their prerequisite class and/or their follow-up class. The next four groups look at the effect by department and will also exclude students who receive withdrawal for their prerequisite class and/or their follow-up class. The reason for excluding students who withdraw from their course before completion is because we believe that it might overestimate our results. This is because in the given data set, it did not state the reason behind a student's withdrawal. There can be other reasons behind why a student decides to withdraw from a class besides failing it. Hence, by running one with withdrawals and compare to one that does not, we can get a lower-bound estimate. As for our last two groups, we look at the effect of taking prerequisite classes outside, specifically at a community college, on follow-up grades.

General Model including Students with Withdrawals

In the first group, we set students with grades of W as 0 in the 0 - 4.3 scale because we assume that the effect is the same as receiving an F or No Pass. Referencing to (**Table 2)** in the appendix, our first regression suggests that by taking a prerequisite class outside the University of Oregon, the student's follow-up grades will decrease by 0.0504 grade points on average, holding others constant. This result is significant at the 99% level.

Looking at our controls, *prerequisite grade, difficult, ability, international, and male*, they too are all significant at the 99% level. If a student's prerequisite grades increase by 1 grade point, on average, we should expect the student's follow-up grades to increase 0.436 grade point. As for our *difficult* control variable as mentioned earlier, we incorporate this control to ensure that our results are not overestimated because of a difficult follow-up class where on average, majority is not doing well. The result has a negative effect on follow-up grades if the class is difficult should not come as a surprise.

For our next model, we add an interaction between *outside* and *ability*. This allow us to look at the effect of students' academic performance and having taken a prerequisite class outside of the university has on follow-up grades. From the results, the student's follow-up class grades increase by 0.0584 grade points at a 99% significance level.

Moving on to the next model, we include an interaction between *concurrent* and *outside* because we believe that if a student took prerequisite outside after he or she has enrolled with the University of Oregon, there will be an effect on the *outside* dummy variable. The result suggests that if an enrolled student takes prerequisite class outside, the student's follow-up grades will decrease by 0.455 grade points at a 99% significance level. This very large negative effect makes intuitive sense as it largely considers some of the 'wrong' reasons a student may choose to take an outside course, such as outside courses being easier, and excludes permanent transfer students or students who took college level courses in high school credit.

Next, we decide to interact *concurrent* and *ability* to measure the significance of a currently enrolled students with their academic performance. The result suggests that it is at a 99% significance level.

For our fifth model, we look at the interaction between high school transfer students and students who takes prerequisite outside. We believe students transferred their high school credits will be academically strong, hence, even if they take classes outside, it should not affect their follow-up grades negatively. Our results do suggest that if students who have high school transfer credits take prerequisite classes outside, their follow-up grade increase by 0.176 grade point on average at a 99% significance level.

For our final model in the first group, we add another interaction term *outstate* with *outside*. This is to consider whether being an out-of-state student has an effect on taking prerequisites outside the university. Our regression output suggests that by being an out-of-state student and taking a prerequisite class outside, it will increase their follow-up grade by 0.345 grade point on average. This is significant at the 99% level. An explanation for this is that these students are taking courses over the summer back in their home state.

With all the added controls in the sixth model for this group we find the coefficient on taking a prerequisite outside to be -0.189, meaning that students' grades in follow-up courses are in general 0.189 of a grade point lower if the prerequisite course was taken outside the University of Oregon compared to students who took the course within the university. In addition, students who took a prerequisite outside after he or she has enrolled with the University of Oregon would be expected to receive half a grade point lower than students who took the course in the University of Oregon.

General Model Excluding Students with Withdrawals

For our second group (**Table 3**), we drop observations with grades that are W. As mentioned

earlier, this is done to see the differences in the effect of not including W will have on our results. Comparing our first regression model with previous group, we find that by taking prerequisites outside increase the follow-up grades by 0.0311 grade points on average. This is significant at the 95% level. This suggests that by the excluding students with grades W from our observations does have an effect on our results. In other words, excluding students who withdraw from their courses, we find the effect of taking a course outside on a student's follow-up performance is not negative or as significant.

Aside from that, the remaining interactions term for regression model 2 – 6 in the second group are all significant at the 99% level. Now with the exclusion of the grade W, if the student takes prerequisite class outside and taking into account of their ability, their follow-up class grades will increase by 0.0418 grade point. Then, when we look at a student who takes a prerequisite outside while being enrolled as a University of Oregon student, he or she will expect to see the follow-up grade decrease by 0.428 grade points on average. This is an interesting result and suggests that even with excluding students who withdrew from their course before completion students who took a prerequisite outside after he or she has enrolled with the University of Oregon would be expected to receive nearly half a grade point lower than students who took the course in the University of Oregon.

As for students who have high school transfer credits and taking prerequisites outside the university, the student's follow-up grade will increase by 0.153 grade points on average. For out-

of-state students taking prerequisites outside of the university will have their grades in subsequent classes increase by 0.284 grade points on average.

By Mathematics Department:

Since the two groups above are just looking at all departments in general, we decide to narrow down our focus to capture the specific departmental effect and see which department in the University of Oregon has the biggest effect if prerequisite classes are not taken within the university. For the third group, we look at the Mathematics department and run the similar six regression models. In other words, we assume taking a prerequisite Mathematics course outside will have a different effect on a student's follow-up math grade than taking a writing course outside would have on a student's follow-up writing grade.

Looking at our results in **Table 4** in the appendix, our first regression suggests that if a student takes a Mathematics prerequisite class outside of the university, this student's follow-up Mathematics grade will decrease by 0.171 grade points on average. This is significant at the 99% level. By interacting *outside* and ability, taking a prerequisite class outside will increase student's grade for follow-up class by 0.0318 grade point. As for our interaction terms with outside, it appears to be statistically significant for both high school transfers and out-of-state students but not for students who are currently enrolled but choose to take their prerequisites outside. For students with high school transfer credits and choose to take Mathematics prerequisite classes outside will see an increase of 0.166 grade points on average to their follow-up Mathematics grade. This still supports our assumption that since these students enroll to the university with high school

credits, they tend to be academically stronger, hence, by taking prerequisites outside should not affect their grades at least in a negative way. Looking at out-of-state students who have Mathematics prerequisites taken outside will have their follow-up Mathematics grades increase by 0.243 grade points on average. This is significant at the 99% level. Looking the last model, holding everything constant, if a student takes a prerequisite class outside of the university, he or she can expect the grade of their follow-up class to decrease by 0.375 grade point at a 99% significant level.

By Science Department:

Moving to the next group, we now narrow our focus to students who take classes of the science department instead. These classes will include subject such as Chemistry, Biology, Physics, and some Mathematics only for prerequisites. From the result of the first regression (**Table 5**), we can conclude that if a student take their science prerequisite classes outside of the university, that student can expect to see a decrease in 0.202 grade points on average. This is statistically significant at the 99% level. Looking at our interaction terms, they are all statistically significant which differs from the Mathematics results which did not have a significant coefficient for the *concurrent* and *outside* interaction.

If a student is currently enrolled with the University of Oregon and decides to take any of their science prerequisite classes outside of the university, the student's follow-up science classes' grade will decrease by 0.182 grade points on average. Whereas a student with high school transfer credits and have their science prerequisites taken outside of the university, that student's follow-up

science grades will increase by 0.116 grade points on average. Out-of-state students who take science prerequisite classes outside of the university still fare better as their follow-up science classes' grades will increase by 0.355 grade points on average.

Overall, this supports our assumption that the effect of taking a prerequisite outside the University of Oregon has on the grade received in the follow-up course differs by subjects. In the case of Mathematics, we find that taking a Mathematics prerequisite class outside the University of Oregon has a larger negative effect on your follow-up grade than taking a science prerequisite outside the university.

By Economics Department:

Looking at our fifth group (**Table 6**) that looks solely at the Economics department, if a student takes Economics prerequisite class outside of the university, he or she can expect the follow-up grade for Economics class to decrease by 0.144 grade points on average and this is statistically significant at the 99% level. Looking at the interaction terms, they are all statistically significant except for the interactions between *high school transfer* and *outside.* For students who are already enrolled in the University of Oregon but took their Economics prerequisite classes outside of the university, their grades for follow-up Economics classes will decrease by 0.138 grade points on average. This is statistically significant at the 95% level. Out-of-state students that have their Economics prerequisite classes taken outside of the university will increase their grades for follow-up Economics classes by 0.175 grade points on average. By looking at the last regression model, holding others constant, by taking an Economics prerequisite class outside of the University of

Oregon will decrease Economics follow-up grades by 0.276 grade point at a 99% significance level. Comparing the Economics department with the Mathematics department, it appears that having Mathematics prerequisite classes taken outside of the University of Oregon has a greater negative impact on students' subsequent classes' grades.

By English Department:

For our final group, we analyze the English department to give a comparison with a less technical class in a sense that prior knowledge is not much of an importance. Based on the results as shown in **Table 7** down at the appendix, if a student takes writing prerequisite class outside of the University of Oregon will expect an increase in 0.0925 grade points on average for their follow-up grades in writing classes. This is statistically significant at the 99% level. Looking at the interaction terms, the only statistically significant interaction is between *Outside* and *Ability*, *Concurrent* and *Ability, and Outside* and *Outstate*. By looking at ability with outside, we see an increase of 0.053 grade point on average. An out-of-state student who takes writing prerequisite outside the university can expect to see an increase of 0.101 grade points on average to their follow-up writing classes.

Community College:

If student takes prerequisite class outside specifically at a community college our model predicts the student's follow-up class grade will decrease by 0.405 on average. This is statistically significant at the 99% level. This result may be seen in **Table 8**. Looking at our interaction terms,

only *concurrent* and *ability*, *community college* and *high school transfer*, and *community college* and *outstate* are statistically significant. By interacting current enrolled University of Oregon students with their academic performance, the result shows that follow-up class grades will decrease by 0.0132 grade points on average. If students with high school transfer credits goes to community college, their follow-up grades will increase 0.0813 grade points on average. This is significant at the 95% level. Lastly, for out-of-state students who take prerequisite classes outside at community college will have their follow-up class grade increase by 0.148 grade point at the 99% level.

Lane Community College:

For our last group regression depicted in **Table 9**, we specifically look at students who take a prerequisite course outside at Lane Community College. This is because we expect if students who are currently enrolled in the University of Oregon want to fulfill their prerequisite classes outside of the university will take it at the Lane Community College instead due to the close proximity of the two school. Our first regression model suggests that if student takes prerequisite classes outside of the university at Lane Community College, he or she can expect a 0.447 grade point decrease on average to their follow-up classes at the 99% significant level. With our interaction terms, we find that only students with high school transfer credits and taking at the Lane Community College is statistically significant at the 90% level. Our final regression model concludes that holding everything constant, if student take a prerequisite class outside of the university at Lane Community College, the student's follow-up grade will decrease by 0.510 grade point on average.

CONCLUSION

From our analysis, we find that students' grades in follow-up courses are in general 0.17 of a grade point lower if the prerequisite course was taken outside the University of Oregon compared to students who took the course within the university. To give a little context, this is a little more than half the difference between and A- and an A. Without incorporating for students who withdrew from their course before completion, the result changes to a 0.08 increase in the follow-up grade. This is likely because of the effect of permanent transfer students who are typically stronger because of their past experience. Interestingly, the interaction between outside prerequisites and students who take outside courses after enrollment stays roughly consistent with and without the W students included in the model. For these students who take an outside course after enrollment to the University of Oregon, we find that on average their follow-up grade will be around half a grade point lower which typically means a full drop of a letter grade. We further find that the effects seem to be worse if the outside prerequisite is taken at a community college rather than inside or at a different type of outside institution.

This finding supports our first hypothesis which states, *Current University of Oregon students who take a course outside the University of Oregon will perform worse in the subsequent course than they would have otherwise because the reduced learning outcomes of the outside course.*

By running our model on different departments, we find that the taking prerequisite classes outside of the university have the most negative effect on student's follow-up Mathematics grades. Indeed, the effect of taking a prerequisite math course outside is 0.437 of a grade point lower without

withdrawals included in the observations. This supports our second hypothesis which states, *while the overall effect of current University of Oregon students who take a course outside the University of Oregon will be negative, it will differ by department, being comparatively worse in more technical courses.* This makes sense considering how Mathematics courses are often build upon the knowledge acquired in the previous course, so without a solid foundation, the new material will be much more challenging to learn.

The findings in this study imply that there is an overall negative effect to taking a prerequisite course outside the University of Oregon on subsequent student performance. However, this effect greatly differs depending on the situation. For example, it is far more detrimental for a student to take an outside course after they have already enrolled in the University of Oregon than it is to simply transfer over course credit. Additionally, departmental differences must be considered as taking a Mathematics course outside the University of Oregon has far greater ramifications than it does for writing course.

Further analysis, on this effect could be done by adding additional control variables, such as more controls for the outside institution. One that comes to mind is the institution's status, such as private non-profit, private for-profit, and public. Another possible area for expansion is including the grade distribution for the outside prerequisite course. This would help the model to further account for the self-selection bias.

APPENDIX

Summary Statistics

Table 1

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
id	445,581	35,046	20,584	1	71,461
term	445,581	201,102	291.8	200,601	201,603
outside	445,581	0.232	0.422	0	1
outstate	445,581	0.419	0.493	0	1
ability	445,581	0.207	1.262	-6.417	4.300
pre_grade	445,581	2.593	1.167	0	4.300
follow_term	198,006	201,157	282.7	200,601	201,602
follow_grade	198,006	2.601	1.211	0	4.300
male	445,581	0.501	0.500	0	1
cum_gpa	190,552	3.008	0.555	0	4.300
hs_transfer	445,581	0.155	0.362	0	1
follow_subjnum	198,006	223.9	81.81	102	462
stype	445,581	2.382	2.158	0	8
subjnum	445,581	190.4	52.20	101	361
stud_age	445,581	19.23	2.692	8	73
min_term	445,581	201,062	315.6	199,102	201,603
term_adm	445,581	201,070	311.9	199,401	201,603
term_grad	249,052	201,239	222.1	200,601	201,602
intl	445,581	0.102	0.303	0	1
ethn	445,581	5.666	1.813	1	9
hsgpa_norm	399,382	0.0573	0.982	-6.417	3.776
sat_norm	299,207	0.0439	0.974	-4.565	3.217
act_norm	133,399	0.0502	0.978	-3.477	2.822
birth_yr	445,581	1,991	4.066	1,940	1,999
hsgpa	399,382	3.522	0.382	1	4.970
satm	299,230	566.2	82.86	200	800
satv	299,247	552.6	86.53	200	800
actm	133,410	24.49	4.249	11	36
acte	133,428	24.19	5.032	7	36
avg_cumgpa	399,788	3.002	0.565	0	4.300
concurrent	445,581	0.649	0.477	0	1
class_avg	90,381	2.692	0.998	0	4.300
difficult	90,381	0.389	0.488	0	1
total_non_w	90,381	135.0	126.9	3	479
rmax	90,381	31.46	29.12	0	153
degree_type	77,272	2.191	0.508	0	4
school_type	77,272	1.053	0.229	1	3

Regression Tables

Table 2: General Including W

VARIABLES	(1) Follow-Up Grade	(2) Follow-Up Grade	(3) Follow-Up Grade	(4) Follow-Up Grade	(5) Follow-Up Grade	(6) Follow-Up Grade
Outside	-0.0504***	-0.0766***	-0.0350**	-0.0389**	0.0709***	-0.189***
	(0.0138)	(0.0141)	(0.0168)	(0.0169)	(0.0181)	(0.0208)
Prerequisite Grade	0.436***	0.438***	0.439***	0.439***	0.438***	0.442***
	(0.00473)	(0.00475)	(0.00475)	(0.00475)	(0.00474)	(0.00476)
Difficult	-0.538***	-0.537***	-0.535***	-0.535***	-0.535***	-0.531***
	(0.00815)	(0.00816)	(0.00816)	(0.00816)	(0.00816)	(0.00815)
Ability	0.0898***	0.0767***	0.0762***	0.0533***	0.0536***	0.0530***
	(0.00414)	(0.00427)	(0.00427)	(0.00736)	(0.00735)	(0.00734)
International	-0.0549***	-0.0588***	-0.0535***	-0.0529***	-0.0407**	0.0648***
	(0.0160)	(0.0160)	(0.0160)	(0.0160)	(0.0162)	(0.0171)
Male	-0.159***	-0.158***	-0.157***	-0.158***	-0.154***	-0.151***
	(0.00943)	(0.00943)	(0.00942)	(0.00941)	(0.00943)	(0.00940)
Outside X Ability		0.0584***	0.0491***	0.0698***	0.0726***	0.0588***
		(0.00975)	(0.00982)	(0.0111)	(0.0110)	(0.0110)
Concurrent			-0.0121	-0.0186*	-0.0188*	-0.0178*
			(0.00983)	(0.00991)	(0.00991)	(0.00991)
Outside X Concurrent			-0.455***	-0.451***	-0.444***	-0.479***
			(0.0406)	(0.0408)	(0.0408)	(0.0408)
Concurrent X Ability				0.0298***	0.0293***	0.0297***
				(0.00826)	(0.00824)	(0.00822)
High School Transfer					0.0674***	0.0648***
					(0.0132)	(0.0133)
Outside X High School Transfer					0.176***	0.215***
					(0.0355)	(0.0355)
Outstate						0.00688
						(0.0101)
Outside X Outstate						0.345***
						(0.0286)
Constant	1.619***	1.615***	1.620***	1.625***	1.616***	1.601***
	(0.0164)	(0.0164)	(0.0181)	(0.0181)	(0.0182)	(0.0188)
Observations	90,381	90,381	90,381	90,381	90,381	90,381
R-squared	0.215	0.215	0.217	0.217	0.218	0.221

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3: General Excluding Withdrawals

VARIABLES	(1) Follow-Up Grade	(2) Follow-Up Grade	(3) Follow-Up Grade	(4) Follow-Up Grade	(5) Follow-Up Grade	(6) Follow-Up Grade
Outside	0.0311**	0.0114	0.0397***	0.0367**	0.00833	-0.0924***
	(0.0126)	(0.0130)	(0.0153)	(0.0154)	(0.0166)	(0.0191)
Prerequisite Grade	0.411***	0.413***	0.414***	0.414***	0.413***	0.416***
	(0.00453)	(0.00455)	(0.00455)	(0.00455)	(0.00455)	(0.00457)
Difficult	-0.495***	-0.494***	-0.494***	-0.494***	-0.494***	-0.491***
	(0.00758)	(0.00758)	(0.00759)	(0.00759)	(0.00759)	(0.00758)
Ability	0.0887***	0.0797***	0.0792***	0.0609***	0.0610***	0.0609***
	(0.00376)	(0.00388)	(0.00388)	(0.00651)	(0.00650)	(0.00649)
International	-0.102***	-0.105***	-0.0992***	-0.0987***	-0.0904***	-0.0999***
	(0.0151)	(0.0151)	(0.0151)	(0.0151)	(0.0153)	(0.0161)
Male	-0.124***	-0.123***	-0.122***	-0.122***	-0.120***	-0.118***
	(0.00863)	(0.00863)	(0.00862)	(0.00861)	(0.00863)	(0.00861)
Outside X Ability		0.0418***	0.0323***	0.0489***	0.0515***	0.0389***
		(0.00905)	(0.00908)	(0.0101)	(0.0100)	(0.0100)
Concurrent			-0.0267***	-0.0319***	-0.0320***	-0.0311***
			(0.00881)	(0.00894)	(0.00894)	(0.00894)
Outside X Concurrent			-0.428***	-0.426***	-0.420***	-0.449***
			(0.0379)	(0.0379)	(0.0380)	(0.0380)
Concurrent X Ability				0.0239***	0.0235***	0.0238***
				(0.00730)	(0.00729)	(0.00727)
High School Transfer					0.0423***	0.0382***
					(0.0123)	(0.0123)
Outside X High School Transfer					0.153***	0.188***
					(0.0316)	(0.0315)
Outstate						-0.0119
						(0.00921)
Outside X Outstate						0.284***
						(0.0258)
Constant	1.765***	1.763***	1.779***	1.783***	1.777***	1.774***
	(0.0157)	(0.0157)	(0.0170)	(0.0171)	(0.0172)	(0.0177)
Observations	86,047	86,047	86,047	86,047	86,047	86,047
R-squared	0.230	0.230	0.233	0.233	0.233	0.235

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Math Department

VARIABLES	(1) Follow-Up Grade	(2) Follow-Up Grade	(3) Follow-Up Grade	(4) Follow-Up Grade	(5) Follow-Up Grade	(6) Follow-Up Grade
Outside	-0.171***	-0.184***	-0.285***	-0.282***	-0.318***	-0.375***
	(0.0240)	(0.0243)	(0.0289)	(0.0291)	(0.0315)	(0.0356)
Prerequisite Grade	0.337***	0.338***	0.336***	0.336***	0.333***	0.336***
	(0.00825)	(0.00830)	(0.00824)	(0.00824)	(0.00825)	(0.00826)
Difficult	-0.393***	-0.393***	-0.410***	-0.410***	-0.409***	-0.409***
	(0.0196)	(0.0196)	(0.0197)	(0.0197)	(0.0197)	(0.0197)
Ability	0.148***	0.137***	0.130***	0.142***	0.143***	0.141***
	(0.00841)	(0.0100)	(0.0101)	(0.0146)	(0.0146)	(0.0146)
International	0.160***	0.158***	0.164***	0.165***	0.173***	0.137***
	(0.0293)	(0.0293)	(0.0292)	(0.0292)	(0.0295)	(0.0313)
Male	-0.0227	-0.0215	-0.0182	-0.0178	-0.0151	-0.0140
	(0.0195)	(0.0195)	(0.0195)	(0.0195)	(0.0195)	(0.0195)
Outside X Ability		0.0318*	0.0329*	0.0221	0.0254	0.0135
		(0.0172)	(0.0172)	(0.0195)	(0.0194)	(0.0195)
Concurrent			-0.189***	-0.185***	-0.185***	-0.183***
			(0.0200)	(0.0203)	(0.0204)	(0.0204)
Outside X Concurrent			-0.0652	-0.0694	-0.0569	-0.102
			(0.0721)	(0.0722)	(0.0727)	(0.0722)
Concurrent X Ability				-0.0172	-0.0173	-0.0163
				(0.0169)	(0.0170)	(0.0169)
High School Transfer					0.0343	0.0333
					(0.0316)	(0.0316)
Outside X High School Transfer					0.166***	0.205***
					(0.0609)	(0.0610)
Outstate						0.0295
						(0.0219)
Outside X Outstate						0.243***
						(0.0540)
Constant	1.570***	1.568***	1.712***	1.709***	1.706***	1.689***
	(0.0310)	(0.0311)	(0.0340)	(0.0341)	(0.0344)	(0.0360)
Observations	18,768	18,768	18,768	18,768	18,768	18,768
R-squared	0.160	0.160	0.165	0.165	0.166	0.168

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Science Courses (Biology, Physics, and Chemistry)

VARIABLES	(1) Follow-Up Grade	(2) Follow-Up Grade	(3) Follow-Up Grade	(4) Follow-Up Grade	(5) Follow-Up Grade	(6) Follow-Up Grade
Outside	-0.202***	-0.244***	-0.221***	-0.222***	-0.245***	-0.358***
	(0.0197)	(0.0205)	(0.0243)	(0.0245)	(0.0264)	(0.0291)
Prerequisite Grade	0.445***	0.449***	0.449***	0.449***	0.447***	0.448***
	(0.00628)	(0.00631)	(0.00630)	(0.00630)	(0.00631)	(0.00631)
Difficult	-0.399***	-0.400***	-0.401***	-0.401***	-0.401***	-0.400***
	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0103)
Ability	0.126***	0.109***	0.109***	0.104***	0.104***	0.104***
	(0.00570)	(0.00594)	(0.00595)	(0.0103)	(0.0102)	(0.0102)
International	-0.0142	-0.0217	-0.0211	-0.0209	-0.01000	-0.000262
	(0.0232)	(0.0231)	(0.0231)	(0.0232)	(0.0234)	(0.0247)
Male	-0.0327**	-0.0309**	-0.0313**	-0.0314**	-0.0284**	-0.0281**
	(0.0128)	(0.0127)	(0.0127)	(0.0127)	(0.0128)	(0.0127)
Outside X Ability		0.0784***	0.0736***	0.0784***	0.0802***	0.0672***
		(0.0135)	(0.0136)	(0.0154)	(0.0153)	(0.0152)
Concurrent			-0.00232	-0.00482	-0.00441	-0.00693
			(0.0128)	(0.0136)	(0.0136)	(0.0136)
Outside X Concurrent			-0.182***	-0.181***	-0.177***	-0.203***
			(0.0540)	(0.0542)	(0.0542)	(0.0537)
Concurrent X Ability				0.00684	0.00659	0.00732
				(0.0112)	(0.0112)	(0.0111)
High School Transfer					0.0587***	0.0488***
					(0.0176)	(0.0177)
Outside X High School Transfer					0.116**	0.170***
					(0.0505)	(0.0505)
Outstate						-0.0534***
						(0.0137)
Outside X Outstate						0.355***
						(0.0441)
Constant	1.444***	1.440***	1.442***	1.445***	1.438***	1.461***
	(0.0209)	(0.0209)	(0.0233)	(0.0236)	(0.0238)	(0.0246)
Observations	43,334	43,334	43,334	43,334	43,334	43,334
R-squared	0.245	0.246	0.247	0.247	0.247	0.250

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6: Economics Department

VARIABLES	(1) Follow-Up Grade	(2) Follow-Up Grade	(3) Follow-Up Grade	(4) Follow-Up Grade	(5) Follow-Up Grade	(6) Follow-Up Grade
Outside	-0.144***	-0.158***	-0.215***	-0.211***	-0.225***	-0.276***
	(0.0206)	(0.0214)	(0.0261)	(0.0263)	(0.0281)	(0.0318)
Prerequisite Grade	0.348***	0.349***	0.349***	0.349***	0.347***	0.349***
	(0.00736)	(0.00741)	(0.00738)	(0.00738)	(0.00739)	(0.00740)
Difficult	-0.360***	-0.360***	-0.373***	-0.373***	-0.374***	-0.373***
	(0.0149)	(0.0149)	(0.0151)	(0.0151)	(0.0151)	(0.0151)
Ability	0.132***	0.123***	0.119***	0.133***	0.133***	0.133***
	(0.00698)	(0.00823)	(0.00828)	(0.0129)	(0.0129)	(0.0129)
International	0.0995***	0.0971***	0.102***	0.102***	0.110***	0.0858***
	(0.0222)	(0.0222)	(0.0222)	(0.0222)	(0.0225)	(0.0244)
Male	-0.0225	-0.0215	-0.0191	-0.0188	-0.0167	-0.0167
	(0.0170)	(0.0169)	(0.0169)	(0.0169)	(0.0170)	(0.0169)
Outside X Ability		0.0265*	0.0238*	0.0110	0.0126	0.00135
		(0.0137)	(0.0137)	(0.0163)	(0.0163)	(0.0163)
Concurrent			-0.114***	-0.109***	-0.109***	-0.107***
			(0.0178)	(0.0183)	(0.0183)	(0.0183)
Outside X Concurrent			-0.138**	-0.142**	-0.139**	-0.171***
			(0.0612)	(0.0613)	(0.0615)	(0.0614)
Concurrent X Ability				-0.0187	-0.0191	-0.0183
				(0.0145)	(0.0145)	(0.0145)
High School Transfer					0.0461*	0.0435
					(0.0273)	(0.0273)
Outside X High School Transfer					0.0751	0.110**
					(0.0555)	(0.0557)
Outstate						0.0152
						(0.0191)
Outside X Outstate						0.175***
						(0.0443)
Constant	1.579***	1.578***	1.669***	1.664***	1.659***	1.651***
	(0.0273)	(0.0274)	(0.0301)	(0.0304)	(0.0307)	(0.0321)
Observations	27,051	27,051	27,051	27,051	27,051	27,051
R-squared	0.164	0.165	0.167	0.167	0.167	0.168

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7: English Department

VARIABLES	(1) Follow-Up Grade	(2) Follow-Up Grade	(3) Follow-Up Grade	(4) Follow-Up Grade	(5) Follow-Up Grade	(6) Follow-Up Grade
Outside	0.0925***	0.0868***	0.103***	0.0912***	0.0882***	0.0500*
	(0.0189)	(0.0189)	(0.0235)	(0.0242)	(0.0256)	(0.0304)
Prerequisite Grade	0.171***	0.175***	0.174***	0.174***	0.174***	0.181***
	(0.00993)	(0.00999)	(0.0101)	(0.0101)	(0.0101)	(0.0104)
Difficult	-0.276***	-0.275***	-0.275***	-0.275***	-0.275***	-0.273***
	(0.0261)	(0.0261)	(0.0261)	(0.0261)	(0.0261)	(0.0261)
Ability	0.0914***	0.0728***	0.0716***	0.101***	0.101***	0.0985***
	(0.00795)	(0.00943)	(0.00955)	(0.0152)	(0.0152)	(0.0154)
International	-0.372***	-0.360***	-0.366***	-0.363***	-0.360***	-0.369***
	(0.0288)	(0.0291)	(0.0293)	(0.0294)	(0.0296)	(0.0306)
Male	-0.211***	-0.210***	-0.211***	-0.211***	-0.211***	-0.207***
	(0.0156)	(0.0156)	(0.0156)	(0.0156)	(0.0156)	(0.0156)
Outside X Ability		0.0530***	0.0544***	0.0255	0.0257	0.0237
		(0.0170)	(0.0171)	(0.0204)	(0.0204)	(0.0206)
Concurrent			0.0252	0.0135	0.0130	0.0128
			(0.0201)	(0.0209)	(0.0209)	(0.0208)
Outside X Concurrent			0.0266	0.0454	0.0456	0.0498
			(0.0873)	(0.0892)	(0.0893)	(0.0889)
Concurrent X Ability				-0.0399**	-0.0401**	-0.0386**
				(0.0183)	(0.0183)	(0.0184)
High School Transfer					0.0208	0.0218
					(0.0265)	(0.0265)
Outside X High School Transfer					0.00445	0.0114
					(0.0414)	(0.0416)
Outstate						0.0160
						(0.0191)
Outside X Outstate						0.101***
						(0.0343)
Constant	2.836***	2.822***	2.806***	2.819***	2.816***	2.785***
	(0.0357)	(0.0360)	(0.0377)	(0.0382)	(0.0383)	(0.0413)
Observations	11,934	11,934	11,934	11,934	11,934	11,934
R-squared	0.098	0.099	0.099	0.099	0.100	0.101

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8: Community College

VARIABLES	(1) Follow-Up Grade	(2) Follow-Up Grade	(3) Follow-Up Grade	(4) Follow-Up Grade	(5) Follow-Up Grade	(6) Follow-Up Grade
Community College	-0.405***	-0.402***	-0.482***	-0.480***	-0.498***	-0.527***
	(0.0172)	(0.0178)	(0.0205)	(0.0204)	(0.0227)	(0.0241)
Prerequisite Grade	0.420***	0.420***	0.422***	0.422***	0.421***	0.421***
	(0.00453)	(0.00454)	(0.00453)	(0.00454)	(0.00454)	(0.00454)
Difficult	-0.489***	-0.489***	-0.491***	-0.491***	-0.492***	-0.491***
	(0.00753)	(0.00753)	(0.00752)	(0.00752)	(0.00752)	(0.00752)
Ability	0.0920***	0.0932***	0.0891***	0.0982***	0.0981***	0.0985***
	(0.00369)	(0.00385)	(0.00383)	(0.00629)	(0.00628)	(0.00628)
International	-0.119***	-0.119***	-0.108***	-0.109***	-0.0989***	-0.0969***
	(0.0150)	(0.0150)	(0.0151)	(0.0151)	(0.0152)	(0.0160)
Male	-0.120***	-0.120***	-0.116***	-0.116***	-0.113***	-0.114***
	(0.00853)	(0.00853)	(0.00852)	(0.00852)	(0.00853)	(0.00853)
Community College X Ability		-0.00966	-0.00897	-0.0168	-0.0136	-0.0177
		(0.0108)	(0.0109)	(0.0116)	(0.0117)	(0.0116)
Concurrent			-0.139***	-0.135***	-0.135***	-0.135***
			(0.00843)	(0.00851)	(0.00850)	(0.00850)
Community College X Concurrent			-0.0104	-0.0131	-0.00646	-0.0401
			(0.0449)	(0.0450)	(0.0453)	(0.0463)
Concurrent X Ability				-0.0132*	-0.0132*	-0.0133*
				(0.00707)	(0.00706)	(0.00706)
High School Transfer					0.0643***	0.0625***
					(0.0120)	(0.0121)
Community College X High School Transfer					0.0813*	0.0930**
					(0.0420)	(0.0420)
Outstate						-0.0109
						(0.00902)
Community College X Outstate						0.148***
						(0.0420)
Constant	1.768***	1.768***	1.863***	1.859***	1.851***	1.856***
	(0.0155)	(0.0155)	(0.0161)	(0.0162)	(0.0163)	(0.0169)
Observations	86,047	86,047	86,047	86,047	86,047	86,047
R-squared	0.238	0.238	0.241	0.242	0.242	0.242

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 9: Lane Community College

VARIABLES	(1) Follow-Up Grade	(2) Follow-Up Grade	(3) Follow-Up Grade	(4) Follow-Up Grade	(5) Follow-Up Grade	(6) Follow-Up Grade
Lane Community College	-0.447***	-0.437***	-0.496***	-0.495***	-0.513***	-0.510***
	(0.0270)	(0.0278)	(0.0324)	(0.0324)	(0.0344)	(0.0352)
Prerequisite Grade	0.414***	0.413***	0.414***	0.414***	0.413***	0.413***
	(0.00452)	(0.00452)	(0.00451)	(0.00452)	(0.00452)	(0.00453)
Difficult	-0.493***	-0.493***	-0.494***	-0.494***	-0.495***	-0.495***
	(0.00756)	(0.00756)	(0.00756)	(0.00756)	(0.00755)	(0.00755)
Ability	0.0909***	0.0920***	0.0894***	0.0943***	0.0945***	0.0943***
	(0.00373)	(0.00380)	(0.00380)	(0.00599)	(0.00598)	(0.00598)
International	-0.108***	-0.108***	-0.101***	-0.101***	-0.0922***	-0.0985***
	(0.0151)	(0.0151)	(0.0151)	(0.0151)	(0.0152)	(0.0161)
Male	-0.122***	-0.122***	-0.120***	-0.120***	-0.117***	-0.117***
	(0.00860)	(0.00860)	(0.00860)	(0.00860)	(0.00861)	(0.00862)
Lane Community College X Ability		-0.0226	-0.0202	-0.0241	-0.0215	-0.0213
		(0.0165)	(0.0165)	(0.0169)	(0.0169)	(0.0169)
Concurrent			-0.0844***	-0.0821***	-0.0814***	-0.0816***
			(0.00827)	(0.00839)	(0.00839)	(0.00839)
Lane Community College X Concurrent			0.0787	0.0780	0.0781	0.0698
			(0.0627)	(0.0628)	(0.0630)	(0.0715)
Concurrent X Ability				-0.00761	-0.00782	-0.00787
				(0.00685)	(0.00684)	(0.00684)
High School Transfer					0.0605***	0.0617***
					(0.0121)	(0.0121)
Lane Community College X High School Transfer					0.154*	0.154*
					(0.0788)	(0.0792)
Outstate						0.0109
						(0.00906)
Lane Community College X Outstate						0.0105
						(0.0786)
Constant	1.771***	1.771***	1.829***	1.827***	1.818***	1.813***
	(0.0155)	(0.0155)	(0.0162)	(0.0163)	(0.0164)	(0.0170)
Observations	86,047	86,047	86,047	86,047	86,047	86,047
R-squared	0.234	0.234	0.235	0.235	0.235	0.235

Robust standard errors in parentheses
*** p<0.01, ** p<0.05,
* p<0.1

Expanded Data Specification, Merging, and Cleaning

Matching Courses

To merge these files, a unique identifying variable needs to be generated so that it can correctly match a given student's prerequisite course with their corresponding follow-up course. Using the Economics Department as an example, a student needs to take Introduction to Econometrics I (EC 320) before he or she is authorized to take Introduction to Econometrics II (EC 421). Hence, if a student in our data has taken EC 320, the follow-up class should be EC 421. To successfully pair the right classes together, we first build an *IF* statement in Microsoft Excel that would yield the prerequisite for the given follow-up. The logic behind this is that one follow-up course only has a single unique prerequisite, though a prerequisite can have many potential follow-ups. Next, we use the *Concatenate* function in Microsoft Excel to combine the unique student identifier (ID) with the appropriate prerequisite course in both data sets that will be our *merge ID*, which will be used to merge both prerequisite and follow-up course data.

Prerequisite & Follow-Up Course Merge

Starting with our Prerequisite Course data, we drop 4,642 observations out of 451,235, that comprise of students who are not admitted degree-seeking undergraduates, because these students are beyond the scope of our question. From there, we generate two new dummy variables, *outside* and *high school transfer*, which we will describe in detail at our methodology section. We then convert all grades received into 0 – 4.3 grade scale for both prerequisite and follow-up course data. We proceed to merge both data sets using many-to-many merge function in Stata with *merge ID* as our common variable.

After merging these two sets we have 198,485 matching observations and 309,574 unmatched observations. Of these 309,574 observations, 32,745 are from the master data (Follow-up Course data) and the remaining 276,829 are from the using data (Prerequisite Course data). The explanation as to why we have not matched observations from the using data, that is because a student takes a specific prerequisite class but did not take a follow-up class in our match course list. Contrarily, there are cases where our data have students who have follow-up classes but did not show any record of their prerequisite classes. Our assumption is that these students could have transferred college credits from another four-year university but their prerequisite classes and associated grades are not reflected in the records which possibly explains the not matched 32,745 observations. Seeing that we are interested in explaining how by taking a prerequisite class outside of the University of Oregon influences their follow-up classes, we drop these 32,745 observations that have missing prerequisite grades.

Student Demographics Merge

Before we begin merging the student data with our newly merged course data, we must manipulate the raw data set as the given SAT scores, ACT scores, and High School GPA are not of the same unit. Therefore, we normalize all three scores. In addition, we believe that by being an international student has an effect to explaining our research question so we generate a dummy variable *intl*. Out of the 71,461 students, 6,602 are international students in the data set. We then proceed to perform a many-to-one merge using *ID* as our common variable with our previously merged Follow-up & Prerequisite Course data as the master and the Student Demographics data as the

using. We use the many-to-one relationship because Follow-up & Prerequisite Course data are in panel. Thus, they consist multiple observations of the same student who took different courses across their time at the university. Whereas, the Student Demographics data comprise a record of unique students. From this merger, we create a dummy variable *male* that will be used as a control later. In addition, we also create another dummy variable *outstate* that will tell us if a student is an out-of-state student at the time of their undergraduate admission. On top of that, we generate *ability* variable that will be used to control for students' pre-university academic performance. Finally, we generated *concurrent* which is another dummy variable to distinguish if student took the outside class after enrolling into the University of Oregon. Like before, these new generated variables will be discussed in further detail later in our methodology section.

Instructor Specific Merge:

To make the instructor specific data useful, we want to compare a given students grade for a given follow-up class with the average grade for that class. We ignore prerequisite grade distribution because it will cause collinearity problems with the *outside* variable, since we do not have the grade distributions for prerequisite classes that are transferred. This would have been ideal data to have because it would have allowed us to observe the difficulty level of prerequisite courses compared to those taken at the University of Oregon. We use a variety of different measures of how other students do in the follow-up courses. The grade distribution is a set of letter grade variables that tell us how many students got for a letter grade in a follow-up class taught by a specific instructor in a given term. We generate variable *rmax* to identify which letter grade has the most number of students for a specific follow-up class. After that, we generate another variable

class_avg that will display the average grades in a 0 - 4.3 scale that student got for a follow-up class. Furthermore, we create a dummy variable *difficult* that will be another control for our regressions.

Again, these new variables will be discussed in the methodology section. Having the instructor specific data, we now merge using a many-to-many relationship and ensuring that the instructor specific data set (using data) merge only when there is a matching term, course name, and instructor name for follow-up classes. This merge has 90,372 observations matched and of the remaining 475,622 observations that are not matched, we drop 120,413 observations that did not match from the using data set.

Institutional Data merge:

Finally, we arrive at our last merger, the institutional data from the non-UO schools. We obtained this data from the US Department of Education. To merge it with our other sets, we rename our *Institution* variable within our latest merger to *inst_code*. We then use many-to-one relationship with *inst_code* as the common variable to merge the latest merger mention above as the master data while the institutional data as the using. Through this merger, we have 79,432 observations matched and the remaining 360,891 observations are not matched – meaning they were taken at UO. We then drop all the using data that are not matched, a total of 331 observations. This high number of mismatched observations does not come as a surprise because it would be illogical to see majority of the students transferring their prerequisite classes from another institution.

After merging all five data sets, our clean data set contains 445,581 observations that will be used for our regression analysis to answer our research question. Next, we will cover our methodology.

Variable Specification Tables

Table 10: Prerequisite Course Data

Variable Name	Description
ID	Unique student identifier
Trans_Flag	I = UO, T = transfer
Term	Transcript term
Subj	Subject Code
Course	Course Number
CRN	Course Reference Number
Instructor	Name of the instructor
Grade	Grade student gets for prerequisite
Stype	Student Type - if student transfer credits to UO
Slevel	Student Level: NU - Non-Admit Undergraduate; UG - Admitted Degree-Seeking Undergraduate
Institution	Transfer Institution Code

Table 11: Follow-up Course Data

Variable Name	Description
ID	Unique student identifier
Term	Transcript term
Subj	Subject code
Course	Course number
Crn	Course Reference Number
Instructor	Name of instructor
Grade	Grade student received for follow up classes
Cum_GPA	Cumulative GPA through term prior to course

Table 12: Student Demographics Data

Variable Name	Description
ID	Unique student identifier
Min_Term	Earliest term of enrollment as non-admit (NU) or admitted undergrad (UG)
Term_Adm	Term the student was admitted to the University of Oregon
Ethn	Federal ethnicity code
Birth_Yr	Year of Birth

Hsgpa	High School GPA
Satm	SAT Math
Satv	SAT Verbal
Actm	ACT Math
Acte	ACT English
Stype	Student type (see lookup tab) at time of UG admission
Res	Residency (N/R) at time of UG admission
Intl	International Flag (Y/blank) at time of UG admission
Term_Grad	Graduation (UG) term

Table 13: Institution Code Data

Variable Name	Description
Inst_Code	Unique code for institution
Inst_Desc	Name of the institution
Inst_City	City the institution is located
Inst_State	State the institution is located
Inst_Zip	Zip code of the institution
Inst_Natn	Country the institution is located

Table 14: Instruction Specific Data

Variable Name	Description
Term	Transcript Term
Course	Course Subject and Number
CRN	Course Reference Number
Instructor	Instructor Name
AP	Grade A+
A	Grade A
AM	Grade A-
BP	Grade B+
B	Grade B
BM	Grade B-
CP	Grade C+
C	Grade C
CM	Grade C-
DP	Grade D+
D	Grade D
DM	Grade D-

F	Fail
P	Pass
W	Withdraw
Total_Non_W	Total number of non-withdrawal
Rank	Rank of instructor

Table 15: 0 - 4.3 Scale Grade Conversion

Grade Conversion			
A+	4.3	**D**	1
A	4	**D-**	0.7
A-	3.7	**F**	0
B+	3.3	**I**	0
B	3	**N**	0
B-	2.7	**P**	1.7
C+	2.3	**W**	0 OR Dropped
C	2	**X**	Dropped
C-	1.7	**Y**	Dropped
D+	1.3	**AU**	Dropped

Table 16: Additional Variable Created

Variable Name	Description
Outside	1 = Prerequisite taken outside of UO; 0 = Prerequisite taken in UO
Pre_Grade	Prerequisite grades based on 0 - 4.3 scale
Pre_Course	Prerequisite subject and course number

Pre_Term	Term in which student took prerequisite class
Follow_Grade	Follow up grades based on 0 -4 scale
Follow_Term	Term in which student took follow up class
Follow_Course	Follow up subject and course number
Sat_norm	Normalized SAT Math & Verbal
Act_norm	Normalized ACT Math & English
Hs_transfer	High school transfer: 1 = Students who transfer HS credits; 0 = Students who did not
Intl	Change it to a dummy variable: 1 = International student; 0 = Domestic Student
Male	1 = Male Student; 0 = Female Student
Outstate	1 = Outstate student; 0 = Instate student at time of UG admission
Ability	A control using pre-college grades. Consists of either SAT scores, ACT scores, High School GPA, or Average Cumulative GPA of a unique student because some students might not have SAT & ACT scores and even High School GPA. This on a percent basis: (Score received / Max possible score)
Concurrent	Concurrent is a dummy variable: 1 = term_adm < term, i.e. student who took a prerequisite class after admission.
Degree_Type	0 = Not Classified 1 = Predominantly certificate-degree granting 2 = Predominantly associate's-degree granting 3 = Predominantly bachelor's-degree granting

Controls	1 = Public 2 = Private nonprofit 3 = Private for-profit

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