Implications of Elective Course Selection by Grade Maximization

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1 Introduction

Elective course selections are a substantial portion of a college student's education decision making. Electives are intended to give students freedom to explore intellectual curiosities and broaden their exposure to various subjects. Yet, previous literature has shown that personal interests are among the least significant determinants of elective course selection (Lee and Ting 2011). Instead, the most significant determinant of course selection is expected grade (Dawson, Gasevic, and Ognjanovic, 2016; Lee and Ting, 2011, Sabot and Wakeman-Linn, 1991). Explanations for this in previous studies have included cultural reasons (Lee and Ting, 2011), theories of self-efficacy (Dawson, Gasevic, and Ognjanovic, 2016), or just maintain that students prefer higher grades to lower grades (Sabot and Wakemann-Linn 1991, Bar, Kadiyali, and Zussman, 2009). However, none of these explanations answer why grades are uniquely the most important determinant in elective course selection. Other decision choices, such as major selection, do not have expected grades as their most significant determinant (Baker, Bettinger, and Jacob 2018; Wiswall and Zafar 2012; Beggs, Bantham, and Taylor 2008). The model in this paper attempts to answer why expected grades are important to electives in particular by offering a signaling explanation. Furthermore, the model considers welfare losses which result from high-grade seeking behaviors for both the student and the labor market, which, to the best of my knowledge, has not been previously modeled.

In the model, students choose electives based on expected grade for signaling purposes. The literature already has welfare concerns about grade maximizing behavior. Students can exploit the high variance of grading distributions across courses (Achen and Courant 2009; Sabot and Wakeman-Linn 1991) by strategically selecting courses to inflate their GPA, which is also functions as a signal of ability. Evidence from a study conducted in Taiwan by Keng (2016) concluded that students who had lower academic achievement in previous semesters were more likely to strategically enroll in leniently graded courses, while evidence from Bar, Kadiyali, and Zussman (2009), found that students of higher ability did not have as strong of a preference for leniently graded courses. Discussions on welfare losses from this behavior has focused on the resulting difficulties of separating high and low ability students in post-graduate markets. The model in this paper extends this welfare loss by showing additional welfare losses to the students who only elect courses where they expect to receive a high grade, and to the labor market which is eventually composed of these students. Most education choice models focus on how students arrive at their decision, while this model will focus on what students decide not to choose in the interest of grade maximization. It is the choices students do not make that additional welfare losses stem from.

In any education decision, students may face tensions between maximizing their learning desires maximizing their grades. However, these tensions seem to be more prominent in elective course decision making, given that when students select their major, personal interests and future career opportunities are more significant determinants than expected grades (Baker, Bettinger, and Jacob 2018; Wiswall and Zafar 2012; Beggs, Bantham, and Taylor 2008). This may be because electives, unlike majors, are typically unknown to firms. However, electives still affect cumulative GPA, which is seen by firms. This will be a critical assumption of the labor market in the model.

The model will also assume that students have access to public grading distributions, which seems to further grade-maximizing behavior. Brown and Kosovich (2015) found that students use public information about professor "easiness" when enrolling in courses, and that courses taught by the easier professors filled up more quickly. Bar, Kadiyali, and Zussman (2009), using course enrollment data from Cornell, showed that once grading distributions became public, enrollment increased in courses which had more lenient grading.

The rest of paper will begin by presenting the model. The presentation of the model will begin with the one-period model where a student selects their optimal elective, followed by a presentation of the two-period model where students must also consider their labor market outcome at time of course selection. Following the model will be a discussion of the model's predictions, and ideas for future research.

2 The Model

In this model, students have a choice between two courses, $C = \{T, N\}$, where T is an elective technical course and N is an elective non-technical course. A student in this model has some interest in T such that if they enroll, they gain additional utility of $\alpha > 0$ for taking the course. α is the additional utility the student gets for enrolling in the technical course, net of costs, although exact interpretation varies upon student and can include factors such as intellectual curiosity or potential for labor market rewards.

Each student facing this course selection decision are either of high or average self-assessed ability in their elective courses, $\theta = \{\theta_H, \theta_A\}$. Additionally, students use public grading information at the time of course selection, so they are aware of the different grading distributions in the courses, $D = \{D_L,\ D_H\}$, where T has the grading distribution with a low mean, D_L, and N has the grading distribution with a high mean, D_H. This assumption that the technical course has a lower average grade is consistent with empirical evidence from Achen and Courant (2009) and Sabot and Wakeman-Linn (1991) which find that technical courses tend to have lower grades, on average, than non-technical courses. θ and D are both determinants of expected grade, which can be high or low $G = \{G_H,\ G_L\}$. Expected grade given C is defined by the equation

$$E(G|C) = p\,(G_H) + (1-p)G_L$$

where p is some function of θ and D such that

$$p = \begin{cases} 1 & if\ \theta = \theta_H\ or\ D = D_H \\ 0 & if\ \theta = \theta_A\ and\ D = D_L \end{cases}$$

and the interpretation of p is the confidence a student has in their expectation of receiving a high grade. Therefore, it follows that if a student is θ_H,

$$E(G|N) = E(G|T)$$

and if a student is θ_A,

$$E(G|N) > E(G|T)$$

A student of θ_H will expect to receive G_H regardless of D, while a student of θ_A only expects to receive G_H if D_H, and will otherwise expect to receive G_L if D_L.

A student's utility function is thus

$$u(G, C, \alpha) = E(G|C) + E(\alpha|C)$$

where

$$E(\alpha\,|\,C = N) = 0$$

$$E(\alpha\,|\,C = T) = \alpha$$

The student chooses the course which maximizes their utility. A student of ability θ_H is maximizing between the following two payoffs

$$u = \begin{cases} G_H + \alpha & if\ C = T \\ G_H & if\ C = N \end{cases}$$

and because $\alpha > 0$, the θ_H student will always choose T because it will yield α more utility than choosing N.

A student of ability θ_A is maximizing between the following two payoffs

$$u = \begin{cases} G_L + \alpha & if\ C = T \\ G_H & if\ C = N \end{cases}$$

where they will choose T if $\mathrm{G}_L + \alpha > G_H$, N if $\mathrm{G}_L + \alpha < G_H$, and is indifferent in the case that $\mathrm{G}_L + \alpha = G_H$.

The intuition behind this is that if a student's interest in the technical course, α, is high enough, then the student is willing to enroll in T despite expecting to receive a lower grade.

3 GPA in Labor Market Screening

In the simple labor market I lay out, there is an initial screening process where firms first filter candidates by desired major and cumulative GPA. GPA serves as a proxy for ability, θ. To the firm, *P(θ = High | GPA = High) > P(θ = High | GPA = Low)*. A firm will not progress candidates who have a low GPA. Firms also value a student's technical skills, ω, which are independent from θ, but are not initially observable. I assume that only students who have taken T have obtained additional technical skill, ω.

Consider the three type of students, S, who each represent the three different outcomes of the model. The firm only sees cumulative GPA and major, so elective course selection is unknown to the firm. Each student chose C so that their utility was maximized. Student 1 (S_1) has high ability in elective courses and faced no difference in expected grade. Therefore, they chose T, received G_H, and gained ω. Student 2 (S_2) has average ability and maximized their utility from choosing T. They enrolled despite expecting to receive G_L, because their utility from α was large enough to compensate for this. S_2 also gained ω from enrolling in T. Student 3 (S_3), also of average ability, maximized their utility from choosing N and did not receive ω, but did receive G_H in N.

In the labor market, only S_1 and S_3 pass the initial GPA screening. S_2 fails to pass because they look comparatively worse due to their lower GPA from election of T. However, S_2 would have been a more competitive candidate than S_3. In terms of elective course ability, S_2 is identical to S_3, and has additional ω from enrollment in T. However, because the labor market only looks at GPA, it wrongfully assumes that S_2 is less qualified.

4 Course Selection Modifications: Two Period Optimization Model

In this model, students face a two-period optimization problem where they must maximize both their expected utility from courses selection and their expected labor market outcomes. In the first time period, students face the course selection optimization described earlier

$$u_{t=1}(G_1, C_1, \alpha_1) = E(G_1|C_1) + E(\alpha_1|C_1)$$

In the second time period, students are maximizing the success of their labor market outcomes, L = *success, failure*

$$u_{t=2}(L_2) = E(L_2)$$

where

$$u_{t=2} = \begin{cases} (0, \infty) & if\ success \\ -u_{t=1} & if\ failure \end{cases}$$

Students gain some positive value for success in the labor market, and lose utility equal to utility gained from the first time period if they fail. Therefore, students now face the following objective function

$$\max_{G_1, C_1, \alpha, L_2} U(G_1, C_1, \alpha_1) + U(L_2)$$

Students are aware that to pass the first round of labor market screening, their GPA must be high. That is, they realize

$$E(L|GPA = Low) = failure$$

$$E(L|GPA = High) = success$$

and therefore,

$$u(G_1 = G_L, C_1, \alpha_1, L_2) = 0$$

$$u(G_1 = G_H, C_1, \alpha_1, L_2) > 0$$

Intuitively, a student will not feel the course elected was worthwhile and will "lose" the utility gained from a course if they believe it prevented them from achieving labor market success. Therefore, the only way for a student to maximize their utility in this model is to ensure they receive G_H, which may result in course selection modifications.

S_1 and S_3 are aware of their expected success in the labor market, and so continue with the same course selection behavior. S_2, however, knows that if they maximize their utility in t=1 and elect T, that they will look less qualified compared to S_1 and S_3, and will not pass the first labor market screening. In the one-period model, where S_2 is not concerned about their grade as a signal, they prefer to select T. However, in the two-period model, S_2 must think about their grade as a signal in the labor market and determinant of their expected success. To maximize their chances of earning a desirable job, they impose restrictions on their first period decision making such that they will only enroll in a course if $E(G|C) = G_H$. Now, course T is eliminated as an option. They will now select N and sacrifice α, or personal taste, in the first period. The resulting welfare loss is that S_2 has selected a course they are less interested in taking. Additionally, the labor market has lost ω it would have otherwise gained had S_2 optimized under the one-period model. The student has made themselves and the labor market worse off by pursuing grade maximizing behavior.

For reference, I provide the scenarios where the firm observes θ and ω instead of the GPA signal. Then, their applicant pool looks like this under the two-period model

$$S_1 : \theta_H + \omega$$

$$S_2 : \theta_A$$

$$S_3 : \theta_A$$

whereas when students optimize according to the one-period model, the firm would see a slightly different applicant pool of

$$S_1 : \theta_H + \omega$$

$$S_2 : \theta_A + \omega$$

$$S_3 : \theta_A$$

Here, the decline in applicant quality is clear. In the one-period model, S_2 takes the technical course and obtains additional ω, which is lost in the two-period model. Whether the firm is still willing to proceed with a student of average ability depends on the firm, but at the very least, they have a more qualified applicant pool when students optimize according to the one-period time frame.

5 Discussion of Model Predictions

In this model, students of high ability do not face trade-offs between maximizing expected grades and maximizing learning interests. Instead, it is students of average ability who face these tensions, and instead are likely to sacrifice personal interests for the sake of maximizing GPA. This is consistent with empirical evidence from Keng (2016), which found that lower ability students were more likely to select courses with lenient grading distributions, and Bar, Kadiyali, and Zussman (2009), which found that high ability students were less likely to change their course selection decisions even after grading information became public. The model predicts that if grading distributions are consistent across courses, then average ability students will maximize utility by choosing the course they are more interested in because expected grades are the same. For reference, expected grade is given by

$$E(G|C) = p\,(G_H) + (1-p)G_L$$

where p is some function of θ and D such that

$$p = \begin{cases} 1 & if\ \theta = \theta_H\ or\ D = D_H \\ 0 & if\ \theta = \theta_A\ and\ D = D_L \end{cases}$$

The average ability student faced trade-offs before because of the different grading distributions, but if the distribution changes to have a high average in both courses, then the average ability student no longer faces any trade-offs between expected grade and learning. They now face the same maximization problem as the high ability student

$$u = \begin{cases} G_H + \alpha & if\ C = T \\ G_H & if\ C = N \end{cases}$$

where because G is equal between the courses, the student will then pick T because it offers α more utility than N. In other words, holding the mean constant across courses will increase enrollment in courses which otherwise had lower enrollment. Sabot and Wakeman-Linn (1991) conducted a simulation using enrollment data from Williams college and found that if the Math department, which had the lowest mean grade and harshest distributions, had the same mean grade and distribution as the English department, which had a significantly higher mean grade and more generous distribution, then there would conservatively be an 80.2 percent increase in students taking at least one additional math course. This could mean there is a substantial amount of potential untapped quantitative talent that exists only because students are fearful of earning a low grade.

As shown in discussion of the two-period model, neglecting to enroll in electives due to expected lower grades makes sense if students want to have success in the labor market. Because elective course selections are not seen by firms, it is easy for students to use electives as a way to maximize their grades to come across as stronger candidates. This could explain the findings of Lee and Ting (2011) which finds that personal taste and potential for career skills rank as less important determinants of elective selection, and that difficulty is the most significant determinant of elective selection. It is difficult for employers to see skills gained from elective selection. Therefore, it is difficulty, which implies something of a concern for expected grade, that becomes the main determinant of elective courses because it is what has the most direct impact on labor market success. Because students have so many choices when it comes to electives, they can use electives as a way to maintain or even boost cumulative GPA. This improves their probability of labor market success. However, choosing to enroll in difficult electives can lower probability of labor market success by lowering cumulative GPA, and this effect is only exacerbated as more students select electives only to maximize grades.

While discussion in this paper has focused on decisions between a technical and non-technical course, there is still a welfare loss to students regardless of course type if students are not choosing courses they would enjoy most due to fear of labor market punishment. Additionally, the educational goals of institutions in implementing electives as a way for students to explore their learning interests are compromised when students behave in this way.

6 Future Research

The model presents several opportunities for future empirical research. A next step could be an empirical test to study the extent to which students choose grade maximization over their personal interests when it comes to elective course selection. Such a study would need to survey students as they undergo course selection asking them not only why they selected the electives they did, but if their selection would change if there were no difference in expected grades between elective course options. This survey would also present an opportunity to study how well students evaluate their own ability. The model assumed that students were able to correctly assess their ability, and thus, their expected grade. Surveying students' expected grade and comparing it to the realized grade after the course could help us better understand how accurate students are at forming expectations for elective courses. This would add to existing course selection literature by attempting to better understand not only what courses students do select and why, but also which courses are decided against, and why.

Because the model predicts that courses with lower averages are more likely to be decided against, the courses opted out of could disproportionately be technical courses. If so, there is opportunity to understand labor market welfare losses which occur as a result of this untapped technical talent. There may be instances of natural experiments where technical courses began to reward higher average grades. These instances should be studied to see how enrollment changed as a result of the grade change. Additionally, studies could compare student elective course selection at schools which have substantial grade inflation in non-technical courses, to schools which have grade deflation across all departments to see if there is more enrollment in technical courses when their grades are not as relatively low compared to other departments.

It would also be useful to better understand how firms use GPA as a signaling mechanism. If firms have a more nuanced understanding of variations in grading, then the GPA screening may not be as strict as the GPA screening in the model, and welfare losses may not be as large. This study would require data on how firms evaluate resumes, and what factors determine whether a student advances to first round interviews. The extent to which students are aware of how GPA functions in the labor market may also be interesting to study, as if students know that GPA is less important in the labor market, they may not be as restrictive in only selecting courses which maximize GPA. However, there may still be incentive for students to maximize GPA to appear more talented than their competition. This model does not go in depth in understanding how students may strategically respond to the course selection behaviors of their peers. In order to understand this, surveying students' beliefs about GPA importance in the labor market, and whether they think about their peers' elective enrollment when enrolling in their own courses would be necessary.

Additionally, the model suggests that average ability students who exhibit grade maximizing behavior may be less qualified candidates, yet advance further in the labor market hiring process than average ability candidates who have tastes for difficult courses and receive low grades in them. It may be worthwhile to investigate any differences in how these two different types of students fare in the actual labor market, if at all. This would require following a cohort of different types of students of varying ability and tastes and seeing if the students who only elect electives on the basis of grade maximization differ in labor market outcomes than students who elect elective courses despite expecting to receive lower grades.

7 Conclusion

The goal of this model was to understand why students may prioritize grade maximization over their personal interests when it comes to elective course selection and to evaluate the welfare losses associated with this behavior. The model finds that when students also consider their labor market outcome at the time of course selection that they will defer to choosing the course which maximizes their expected labor market success. However, this can come at the cost of of opting not to choose a course the student may have been more interested in, potentially compromising educational goals of institutions. It may also result in lower enrollment in low grading technical courses, meaning there could be an untapped pool of technical skill with high value to the labor market. The findings of the model provide clarity on why expected grade appears to be the most significant determinant of elective course selection. Knowledge of this may inform grading policy and firm candidate selection policy in a way which can mitigate these welfare losses.

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