Peer Effects and Academic Major: Evidence from USAFA

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Abstract

Academic major is an important choice for college students because it influences the skills with which college graduates enter the job market and their ultimate career path. Despite the importance of academic major, the actual choice of academic major for college students is poorly understood. Although students may consider their perceived strengths and weaknesses as well as potential job opportunities, other factors - such as peer group behavior- may play an important role. Interestingly, we find that all peers do not have equal influence. The overall popularity of academic majors has no influence on the behavior of first year students. However, popularity among high achieving peers appear to increase students' likelihood of declaring similar majors while popularity among low achieving peers seems discourage students from declaring similar majors. We believe this evidence is important to increase our understanding of both the importance of college peer groups, as well as the decision making process regarding choice of academic majors.

Keywords: College, Peer Effects, Academic Major, Student Outcomes, Higher Education

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1 Introduction

The choice of academic major is important because it influences the type of skills developed during college. This choice is important because of its strong effects on career opportunities and earning after graduation. These differences in training, in fact, may be even more important in determining the returns to education than choice of college / university.[1] Students likely consider economic outcomes while choosing what to study, but are also influenced by a myriad of other factors. One possible important factor is the interests and capabilities of other students one is surrounded by during early undergraduate years.

This paper tests the causal effect of students' peers on their academic major decision using random squadron assignments at the United States Air Force Academy. First year students at USAFA are randomly assigned to a squadron of approximately 40 students from each class year, and the vast majority of their social interactions occur within these groups. Moreover, students take a largely uniform set of classes during their first year to complete core-curriculum requirements. This means that early impressions of what different fields are like may be heavily influenced by interactions with upperclassmen in their squad. We show that the overall popularity of the four different academic divisions among upperclassmen does not appear to have any effect on the ultimate major decision of first year students. The experience of juniors in their squadron, however, significantly influences the decisions of first year students. We show that first year students are more likely to select an academic major that is more popular among juniors in the top 25% of their squadron ranked by GPA, but less likely to declare a major popular among students in the bottom quartile. We believe that this is the first evidence of differential peer effects by peer's academic success, and provides important evidence for both the selection of academic major as well as the nature of peer effects for college students.

[1] https://www.economist.com/united-states/2015/03/12/it-depends-what-you-study-not-where

2 Related Literature

"Peer effects" generally refers to the causal effect of the characteristics and behavior of one's close contacts on an individual's decisions and outcomes. Although intuitively we would expect each person to be influenced by the people that surround them, establishing credible estimates of peer effects is difficult. First, people usually choose their peer groups and may choose to surround themselves with people that look and think alike, causing the so-called 'selection effect'. Moreover, as students are influenced by their peers these peers are also influenced by the student themselves causing the 'reflection effect'. Lastly, even in cases where groups are e.g. randomly assigned there may be other correlated factors (such as group leadership) which influences outcomes and cannot be easily separated from actual peer effects (Sacerdote, 2011).

Recent empirical work has used randomly assigned peer groups to identify the peer effects of various outcomes in higher education. Much of this literature has focused on the peer effects of academic achievement (e.g. Sacerdote 2001, Zimmerman 2003, and Carrel 2009). Peer effects, however, expand beyond academic performance. Other papers have looked at the effects of peer's family background (Carrell 2010), attitudes towards cheating (Carrel 2008), and risk-taking behavior (Duncan 2005).

This paper focuses on the peer effects of the academic major decision. The selection of academic major is an important decision for college students because it influences students' later education and career decisions. The choice of college major, however, is complicated and not well understood. The decision is at least partly influenced by economic factors. Students consider, for instance, their own preferences as well as their perceptions of their own relative strengths and weaknesses (Arcidiacono, 2004). In addition, students factor in their own impressions of the job market for people in related fields (Montmarquette, 2002 and Arcidiacono, 2012), and local economic conditions (Liu, 2019 and Ersoy, 2020).

Academic major, however, has also been shown to be influenced by a myriad of behavioral factors. Students are more likely to declare an academic major in a field of a course they have taken more recently (Patterson, 2019), with a intro course not taken early in the morning (Haggag,

2019), and about which they've had to write a research paper (Fricke, 2018). A few papers have tried to establish peer effects related to the selection of college major. De Giorgi (2010) shows that peer behavior influences one's decision between economics and business major. It has been shown that students are more likely to major in engineering if they are placed into a random peer group with upperclassmen that also intend to major in engineering (Lyle, 2007). Students are more likely to major in the Sciences and have higher grades if they have academically stronger peers (Lupino, 2015). Students are also more likely to change major if surrounded by peers that change major, and more likely to change into similar majors (Pu, 2020). Although these papers examine peer effects of academic outcomes, we investigate a more nuanced hypothesis - namely does peer influence in higher education differ by peers' level of academic achievement? We believe we are the first to specifically test this mechanism in the context of undergraduate academic majors.

3 Institutional Background

The student experience at the United States Air Force Academy is similar to many other competitive liberal arts colleges. Students spend the vast majority of their time dedicated to academics (8-9 hours a day). Underclassmen focus primarily on completing a large core curriculum including 29 academic courses in subjects such as Calculus, Chemistry, English, and Engineering Mechanics. Upperclassmen primarily take courses in one of 27 majors in typical fields such as Aerospace Engineering, Management, History, and Biology as well as minors including Spanish, Arabic, Philosophy, etc. Upon graduation these students receive a Bachelor of Science in their chosen field. Admissions are fairly competitive with an average SAT math and verbal scores of 672 and 642, respectively, and an admission rate of 13 percent. There are, however, a few important differences. USAFA students must also engage in both military training exercises and athletics. All students also attend free of charge and will earn a commission into the United States Air Force (or other service branch) upon graduation.

The details of peer group formation at USAFA will be important for identification later in this

paper so we will outline them briefly here. All students upon matriculation are randomly assigned to one of 40 squadrons - these groups of approximately 25 per cohort live, train, and study together and therefore comprise the primary peer group for new students. This has the potential to greatly influence new students in many ways, including which upperclassmen each first year student meets and interacts with - and what these upperclassmen study. Importantly, because squadrons are randomly assigned, some first year students are placed into squadrons with a very high percentage of students studying e.g. Social Sciences while other students are placed into squadrons with relatively very few. This may influence the types of classes students hear upperclassmen talk about and what they say. The experiences of these upperclassmen may influence first year students' opinions of these classes even before beginning any coursework of their own.

It is also important to note that all students begin as "undeclared" and with a randomly assigned academic adviser (Albert, 2021). All students must then declare their academic major during their second year of studies. Moreover, until 2014, these squadrons were randomly reassigned before the start of each student's second academic year. Random squadron assignment before first and second years ensures that: 1) the initial distribution of academic majors first year students are exposed to in their squadrons is random and therefore can be viewed as a natural experiment and 2) these squadrons are reshuffled before each class of first year students become upperclassmen so there will be no autocorrelation within squadrons - e.g. a high percentage of STEM majors in squad 40 in an individual year should not persist superficially through cohorts.

4 Data

Our primary dataset consists of administrative records of all USAFA students graduating from 2004 to 2014. This data contains demographic information for each student as well courses taken and grades earned in each semester, as well as squadron assignment. Using cohort and squadron we link to each first year student's record to information on academic major as well as academic performance of 3rd year students in their squadron. Specifically, we calculate for each squadron

and class-year the percent of 3rd year students with an academic major in each of the four academic divisions (Basic Sciences, Engineering, Humanities, and Social Sciences).[2] We also calculate the percent of third year students in each squadron-by-year group in both the top and bottom quartile by cumulative GPA studying in each of these four academic divisions.

Table (1) presents basic averages of first year students' demographic background and choice of academic major. Note females total only 19% during the years sampled and that students reporting a race other than "White" total 43.6%. Social Sciences is the academic division most popular among students followed by Engineering, Basic Sciences, and Humanities. Estimates below will test the effect of both overall concentration of upperclassmen in each academic division, as well as the concentration of academic high and low performers in each of the four academic divisions. First, examine Figure (1) comparing popularity of each division among 3rd year students in each squadron-by-year group to the eventual majors declared by first year students in these squadrons. These figures do not suggest the overall popularity of different academic majors influences the division of academic major declared by first year students for any of the four divisions; in fact, lines of best fit suggest the relationship may be slightly negative. Next, examine Figure (2) which shows similar relationship, but separately for each squadron's academic high and low performers. Here, note that the lines of best fit are slightly positive for upperclassmen with high GPA but negative for upperclassmen with lower GPA. Although these figures do not represent causal estimates, they do provide graphical evidence that the experience of upperclassmen in each academic division may influence the majors declared by first year students in their squadrons.

[2]We use academic division rather than individual academic major throughout, although estimating similarly using academic major is theoretically possible. We use division instead for two reasons. First, the sheer number of academic majors (over 20) that some of them are very small (as low as 0-6 students per yer) would cause our estimates to be imprecise. More importantly, we believe that the majors likely interact with one another - a squadron with many Aeronautical Engineering majors may also produce a great number of Astronautical Engineering majors. Economics and Management majors also share many classes and may appear interchangeable to first year students. Academic divisions allow us to combine fields that students likely view as similar without creating arbitrary bins based on the authors' discretion.

5 Methods

Our first task is to estimate the effect the number upperclassmen majoring in each academic division on the academic division of major declared by first year students in randomly assigned squadrons. This can be accomplished via differences-in-difference regression of the form:

$$Declared_{i,j,t} = \alpha_{j,t} + \beta_j GPA^{OWN} * I(Division_j) + \gamma Peers_{i,j,t} + \varepsilon_{i,j,t} \quad (1)$$

Here, $\alpha_{j,t}$ represents fixed effects for each interaction of year t and division j, β_j estimates the effect of own 1st semester GPA on likelihood of declaring in division j, and γ is the coefficient of interest - the causal effect of popularity of division j among an individual squadron's junior-year students on the likelihood of first years students majoring in division j. The desired causal effect is identified as long as popularity of major-division among a squadrons juniors is not somehow correlated with other unobserved factors that effect the eventual major of first year students. Since initial squadron is randomly assigned this assumption should hold. Moreover, as mentioned above, first-year students are then randomly reassigned before their 2nd year (before they themselves become juniors in another cohort) so there is no risk of e.g. autocorrelation in major popularity within individual squadrons.

To determine whether the popularity of academic divisions among a squadron's high and low academic achievers influences the major delcared by first year students, we estimate similarly:

$$Declared_{i,j,t} = \alpha_{j,t} + \beta_j GPA^{OWN} * I(Division_j) + \gamma_H GPAhigh^{PEER}_{i,j,t} + \gamma_L GPAlow^{PEER}_{i,j,t} + \varepsilon_{i,j,t} \quad (2)$$

Here $\alpha_{j,t}$ and β_j are defined as above. The treatment of interest, however, now focuses on the popularity of each academic division for the squadrons high and low achieving students. That is, γ_L estimates the causal effect of an increase in the portion of juniors in an individual squadron that are in the bottom 25% of that squadron by cumulative GPA in each academic division. Coefficient γ_H estimates the effect of a 1% increase for students in a squadron's top 25% by GPA. As be-

fore, we believe the desired causal effect is properly identified since initial squadron assignment is random and therefore the distribution of juniors' academic divisions in each GPA quartile should necessarily be uncorrelated with other factors influencing first year students' major selection.

6 Results

Table (2) shows results from estimating as in Equation (1). Here results seem to match what was suggested by Figure (1). The coefficient for the effect of the popularity of each academic division on the eventual major declared by first year students is slightly negative. Importantly, the coefficient is not statistically significant at even 10%. Results subsetting by academic division are also statistically insignificant throughout. Table (3) shows results subsetting by demographics rather than academic division. Here again results are all statistically insignificant for all estimates. These results in total provide fairly consistent evidence that overall popularity of an academic major among upperclassmen does not influence the choice of academic major for first year students.

Next we estimate whether the popularity of academic majors among high performing and low performing classmates has an effect on choice of academic major for first year students. First, see Table (4) which shows estimates of the effect of the popularity of different academic divisions within each squadron's high and low GPA upperclassmen, as in Equation (2). Estimates in Column (1) show that, overall, a 1% increase in high achieving upperclassmen increases the probability of declaring a major in their academic division by about 0.03%, significant at 5%. Similarly, a 1% increase in low achieving upperclassmen decreases the probability of declaring a major in their academic division by about 0.03%, also significant at the 5% level.. These effects appear to be driven by students in the Engineering and Social Sciences divisions, with smaller magnitude and low statistical precision for both Basic Sciences and Humanities. Table (5) shows similar estimates, subsetting instead by demographic subgroups. Interestingly - the positive effect of high achieving squad-mates is particularly pronounced for females, while the discouraging effect of low achieving squad-mates has higher magnitude and statistical significance for male students.

The discouragement effect is also very strong for non-white students, but insignificant and near zero as estimated for white students.

At USAFA, athletic performance is measured and scrutinized in a manner parallel to academic performance and each semester students receive a Physical Education Average (PEA) which is calculated as an index of their grades in physical education classes and their fitness test scores. Table (6) estimates similarly to Equation (2), but using athletic performance (PEA) instead of grades. No group shows negative effect of low PEA peers on propensity to declare similar majors. This is as expected - the presence or absence of peers performing poorly in athletics may not be informative about the academic experiences in different academic divisions. Interestingly, female students show a positive influence from high PEA peers while male students show a negative influence. This is likely due to the overall high academic performance of high PEA females and the relatively low academic performance of high PEA males.

7 Conclusions

Previous studies have not consistently found convincing evidence that peer effects influence the choice of academic major by first year college students. Peer effects are, in general, hard to identify for a variety of reasons - but the random assignment and reassignment of USAFA squadrons provide a convenient natural experiment. We show that the overall popularity of different academic divisions by randomly assigned upperclassmen peers does not effect the major choice of first year students consistent with previous literature. We instead consider the relative popularity of academic divisions among squadrons high and low performing students, as measured by GPA quartile. Consistent with expectation we find that first year students are more likely to declare an academic major in a division more popular among high achieving peers and less likely to declare in divisions popular among low achieving peers. In magnitude, an increase in popularity by 1% among high performing students causes an increase in likelihood to declare similar major by 0.03% with similar effect in opposite direction for low achieving peers.

We believe this is important evidence on the nature of peer effects for college students. This evidence suggests that popularity of academic majors is not sufficient to influence freshmen behavior. Students do not care about a major's overall popularity - perhaps instead they care about either the types of students in that major or their academic experiences. This suggests two potentially complimentary hypothesis for the phenomenon observed. First year students may want to emulate their successful peers and avoid association with under-performers. Or, first year students observe the experiences of their upperclassmen peers and adjust their own expectations regarding their experience in similar fields.

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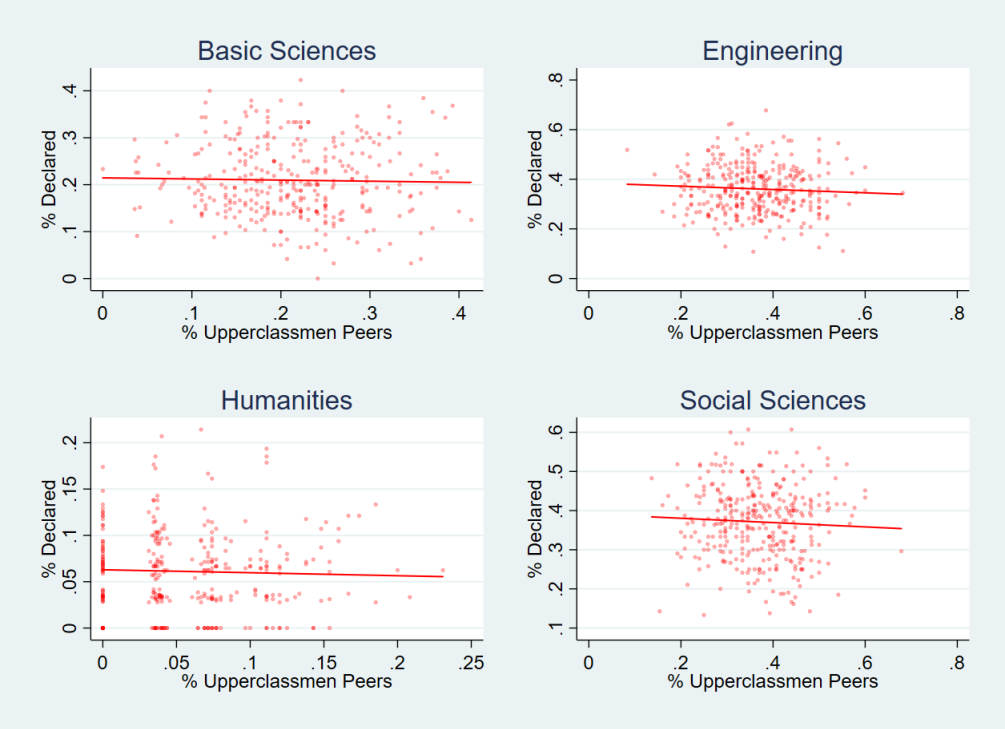
9 Figures and Tables

Table 1: Student Averages, Demographic and Academic Major

Variable	Mean
Female	0.190
Nonwhite	0.436
Basic Sciences Major	0.212
Engineering Major	0.352
Humanities Major	0.061
Social Sciences Major	0.375

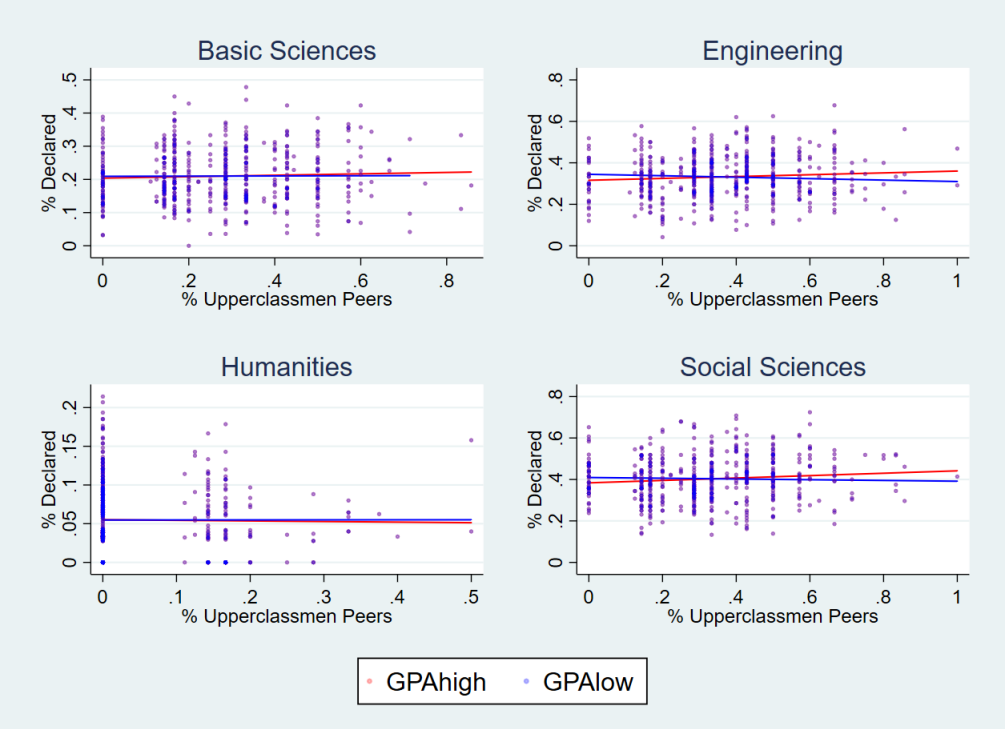
The columns above shows the group averages for all first year students across demographic and academic major subsets.

Figure 1: Major Division Declared vs Upperclassmen



*The four figures above show scatter plot as well as line of best for division fo major declared by first year student compared to popularity (in terms of student percentage) by junior year students in individual squad. Each dot reflects observations for squad*year cell.*

Figure 2: Major Division Declared vs Upperclassmen GPA



*The four figures above show scatter plot as well as line of best for division for major declared by first year student compared to popularity (in terms of student percentage) by junior year students in individual squad by GPA-quartile. Specifically, the red line (and dots) shows percent of top 25% GPA in each squad*year while the blue line (and dots) show similar for bottom 25%. Each dot reflects observations for squad*year cell.*

Table 2: Estimates: Major Division Declared vs Upperclassmen, by Division

	(1)	(2)	(3)	(4)	(5)
VARIABLES	All	Basic Sciences	Engineering	Humanities	Social Sciences
PercentJuniors	-0.033	-0.032	-0.047	0.038	-0.040
	(0.036)	(0.059)	(0.050)	(0.056)	(0.054)
Observations	41,052	10,263	10,263	10,263	10,263
R-squared	0.133	0.025	0.046	0.016	0.080
Dep Var Mean	0.250	0.210	0.335	0.055	0.399

The columns above shows the coefficient for estimating 5 separate regressions, each estimating the effect of the proportion of juniors in a first semester student's squadron majoring in an individual academic division on the likelihood of a declaring a major in that division. Robust standard errors clustered by student. Model includes fixed effects for student as well as each major's department.
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Estimates: Major Division Declared vs Upperclassmen, by Demographics

	(1)	(2)	(3)	(4)	(5)
VARIABLES	All	Females	Males	Nonwhite	White
PercentJuniors	-0.033	0.051	-0.055	-0.055	-0.022
	(0.036)	(0.072)	(0.039)	(0.062)	(0.037)
Observations	41,052	7,992	33,060	14,476	26,576
R-squared	0.133	0.131	0.150	0.145	0.129
Dep Var Mean	0.250	0.250	0.250	0.250	0.250

The columns above shows the coefficient for estimating 5 separate regressions, each estimating the effect of the proportion of juniors in a first semester student's squadron majoring in an individual academic division on the likelihood of a declaring a major in that division. Robust standard errors clustered by student. Model includes fixed effects for student as well as each major's department.
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Estimates: Major Division Declared vs Upperclassmen GPA

	(1)	(2)	(3)	(4)	(5)
VARIABLES	All	Basic Sciences	Engineering	Humanities	Social Sciences
GPAhigh	0.033**	0.017	0.036*	-0.015	0.055***
	(0.014)	(0.022)	(0.020)	(0.022)	(0.020)
GPAlow	-0.027**	0.004	-0.046**	0.000	-0.033*
	(0.011)	(0.023)	(0.018)	(0.023)	(0.017)
Observations	57,428	14,357	14,357	14,357	14,357
R-squared	0.149	0.025	0.061	0.012	0.100
Dep Var Mean	0.250	0.210	0.335	0.055	0.399

The columns above shows the coefficient for five separate regressions (OLS), each estimating the effect of the proportion of high and low GPA juniors in a first semester student's squadron majoring in an individual academic division on the likelihood of a declaring a major in that division. Robust standard errors clustered by student. Model includes fixed effects for student as well as each major's department.
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Estimates: Major Division Declared vs Upperclassmen GPA, by Demographics

	(1)	(2)	(3)	(4)	(5)
VARIABLES	All	Female	Male	NonWhite	White
GPAhigh	0.033**	0.068**	0.022	0.040	0.029
	(0.014)	(0.028)	(0.016)	(0.024)	(0.018)
GPAlow	-0.027**	0.008	-0.036***	-0.065***	-0.006
	(0.011)	(0.023)	(0.013)	(0.018)	(0.014)
Observations	57,428	11,628	45,800	20,780	36,648
R-squared	0.149	0.147	0.164	0.174	0.137
Dep Var Mean	0.250	0.250	0.250	0.250	0.250

The columns above shows the coefficient for five separate regressions (OLS), each estimating the effect of the proportion of high and low GPA juniors in a first semester student's squadron majoring in an individual academic division on the likelihood of a declaring a major in that division. Robust standard errors clustered by student. Model includes fixed effects for student as well as each major's department.
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Estimates: Major Division Declared vs Upperclassmen PEA

	(1)	(2)	(3)	(4)	(5)
VARIABLES	All	Female	Male	NonWhite	White
PEAhigh	-0.011	0.073**	-0.035**	-0.009	-0.012
	(0.014)	(0.033)	(0.014)	(0.023)	(0.018)
PEAlow	-0.014	-0.003	-0.016	-0.035	-0.003
	(0.014)	(0.024)	(0.015)	(0.022)	(0.019)
Observations	50,784	10,112	40,672	18,076	32,708
R-squared	0.096	0.111	0.110	0.113	0.093
Dep Var Mean	0.250	0.250	0.250	0.250	0.250

The columns above shows the coefficient for five separate regressions (OLS), each estimating the effect of the proportion of high and low GPA juniors in a first semester student's squadron majoring in an individual academic division on the likelihood of a declaring a major in that division. Robust standard errors clustered by student. Model includes fixed effects for student as well as each major's department.

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