

Too Few Women? -Or Too Many Men?

The Gender Imbalance in Undergraduate Economics*

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Abstract

There is a gender imbalance in undergraduate economics departments with most departments educating a strong majority of young men. This imbalance has led many economists to ponder the question of why relatively few women choose to take courses and major in economics. Our hypothesis is that the gender imbalance in undergraduate economics, particularly at institutions with traditional liberal arts curriculums, is as much the result of too many men choosing economics as it is too few women. Students choose their majors based on both their interests and their abilities. The literature indicates that the grade a student receives in an introductory class relative to grades received in other departments is one of the strongest predictors of whether or not the student chooses to enroll in more courses in the discipline. However, our hypothesis is that men who take economics courses are less responsive to this signal than are women. As a result, men who do poorly in economics are more likely to continue in the major. Women who do poorly, in contrast, are more likely to abandon economics and pursue a different major. Our results, generated from 16 years of data from a liberal arts college where economics is one of the most popular majors, support this hypothesis. The overall economics GPA for female majors is significantly higher than that for males. In addition, histograms show that male students dominate the bottom of the grade distribution. Finally, results from estimation of a series of selection models of the decision to take more economics courses indicate that, holding other characteristics constant, women are more responsive to the relative grade received in the second semester of economics than are men.

JEL Codes: I20, I21

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I. Introduction

There is a gender imbalance in undergraduate economics with most departments educating a strong majority of young men. National data from 2000 shows that only 32% and 35% of undergraduate economics majors at public and private institutions, respectively, were women¹. This imbalance has led many economists to ponder the question of why relatively few women choose to take courses and major in economics. Scholars have suggested the gender composition of the economics faculty, women's poorer math preparation, women's lower relative performance in introductory economics courses, the topics that are included in the typical economics curriculum, and the teaching techniques used in introductory economics classes as possible explanations for the shunning of economics by female undergraduates.

The persistent under-representation of female undergraduates in economics may be partially explained by the persistent under-representation of female faculty in economics departments. According to the Committee on the Status of Women in the Economics Profession's Annual Report, in 2002, only 27% of those who completed a PhD in economics were women. However, the literature is mixed on the notion that a "role model" effect exists in higher education. Neumark and Gardecki (1998) find weak evidence that female dissertation chairs lower the time to complete a Ph.D. and raise the completion rate of female Ph.D. candidates in economics. Dynan and Rouse (1997) find that faculty gender does not help explain the gender gap in economics majors at Harvard University. Robb and Robb (1999) find no female role model effect in the decision to pursue more economics courses after taking introductory microeconomics (or on student performance) at Brock University. Similarly,

¹ The CASPAR database of the Department of Education and the National Science Foundation (<http://caspar.nsf.gov>) provides national time series data on the gender composition of undergraduate majors as part of the IPEDS Completion Survey.

focusing only on the economics major, Jensen and Owen (2001) find that faculty gender is not systematically related to the student's decision to pursue more than a first economics course.

Canes and Rosen (1995) use aggregate data on the proportion of female faculty and the proportion of female students in departments across three academic institutions to examine the role model effect and find that, across all the empirical specifications, there is no correlation between the proportion of female faculty and the proportion of female students. However, Rask and Bailey [2002] find that role model effects are significant for both gender and race. They find that all types of students are more likely to continue in a major if they have a "contact" with a faculty member of the same race and gender. In fact, their results indicate that white male faculty members have the biggest role model influence on white male students.

Another possible explanation for the under-representation of women in undergraduate economics is simply that women do not perform as well in introductory economics courses and, therefore, are less likely to continue. There is significant evidence that relative performance in introductory courses is an important determinant of undergraduate major choice (Sabot and Wakeman-Linn (1991), Horvath et al. (1992), Dynan and Rouse (1997), Jensen and Owen (2001), and Rask and Bailey (2002)) and some additional evidence that women receive lower grades than men in introductory economics courses (Anderson et al. (1994), Tay (1994), Dynan and Rouse (1997), and Robb and Robb (1999)). Horvath et al. (1992) and Robb and Robb (1999) find that even after controlling for the relative grade in the economics introductory course, female students are still significantly less likely to continue taking economics than are men. This result suggests that other factors are also important. However, Chizmar (2000) finds that, after controlling for relative grades in economics and economics credit hours, female students who have declared an economics majors are just as likely to continue in the major as

male students. In addition, Dynan and Rouse (1997) find that the female dummy variable becomes insignificant when a variable indicating whether or not the student believes that he/she did better in introductory economics than in other courses is included as a determinant of the decision to major in economics.

What other factors might explain why women are less likely to continue in economics than men? Using survey data from students taking their first introductory economics course at 34 co-ed liberal arts colleges, Jensen and Owen (2001) find that students' confidence in their ability to understand economics, predisposition to major in economics, perception that economics is relevant, and perception that economics is important to their career, as well as relative grade, are all determinants of student interest in continuing to study economics. However, gender was not a significant predictor of relevance or confidence.

Our hypothesis is that the gender imbalance in undergraduate economics at some institutions is as much the result of too many men choosing economics as it is too few women. At institutions that do not offer a concentration in business at the undergraduate level, economics is often one of the most popular majors. While nationally the number of economics majors has declined in the past decade, the strong number of economics majors at colleges with traditional liberal arts undergraduate curriculums has persisted. For example, at the top 25 liberal arts colleges, among which the undergraduate business major is a rarity, the number of economics majors increased by 8.2% between 1990 and 2000².

Students choose their majors based on both their interests and their abilities. As outlined above, there is significant evidence in the literature that the grade a student receives in an

² National data from CASPAR indicates that the number of undergraduate economics degrees awarded annually at public institutions declined 28% between 1990 and 2000. This decline was more modest at private institutions at only 8% over this time period.

introductory class relative to grades received in other courses is one of the strongest predictors of whether or not the student chooses to enroll in more courses in a discipline. That is, undergraduates see the relative grade in an introductory course as an important signal of their likely success in a major. However, our hypothesis is that because of interests and/or social pressure to succeed financially, men who take economics courses are less responsive to this signal than are women. As a result, men who do poorly in economics are more likely to continue in the major. Women who do poorly, in contrast, are more likely to drop out of the economics sequence and pursue a different major. The outcome is a skewed distribution with most of the poorest economics students being men.

In order to test this hypothesis, we examine the determinants of men and women's decisions to continue in economics at a liberal arts college where economics is one of the most popular majors. The data, discussed further in Section 2, are a 16 year panel following students through their college careers. The descriptive results, presented in Section 3, show that although men are more likely to continue with economics, the overall economics GPA for female majors is significantly higher than that for males. In addition, histograms show that male students dominate the bottom of the grade distribution. The results from the estimation of a series of selection probit models, presented in Section 4, indicate that in making the decision to take more economics courses women are significantly more responsive to the relative grade received than are men. The conclusions and suggestions for further work are outlined in Section 5.

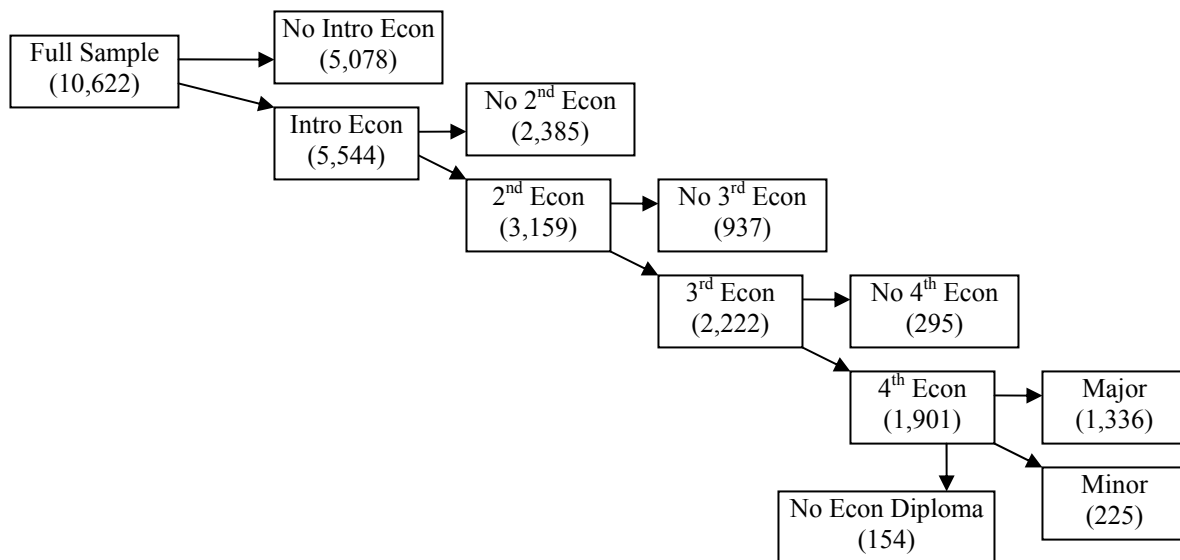
II. Data & Empirical Model

The data are derived from the Colgate University graduating classes of 1989-2004. Only students who have graduated from Colgate are included in the sample. We eliminate students who transferred to Colgate and those who received Advanced Placement credit in economics

because they do not have a recorded grade for Introduction to Economics. The final sample includes 10,622 students.

Information from the admissions files (information reported from their pre-Colgate years) and college transcript records provide the base of information. The admissions files provide measures of pre-collegiate academic achievement (SATs and high school grades), and pertinent demographic information. From the transcripts, specific courses taken, when they were taken, and the grades received are identified. The progression in the economics major is modeled as a series of dichotomous choices allowing for a selected sample at each stage. For example, the first choice is whether or not to take a second semester of economics, conditional upon the fact that you have taken introductory economics. The second choice modeled is whether one takes a third semester of economics, conditional upon the fact that they took a second. After the fourth semester we model the decision as a multinomial choice of whether to major, minor, or pursue no emphasis in economics. Figure 1 illustrates the progression in economics of our initial sample of 10,622 students.

Figure 1



The decision to progress in economics is modeled as a function of a student's human capital, absolute and relative grades, demographic characteristics (gender and race), student's seniority (cumulative semesters at Colgate at the time of each decision), time (graduating class) and the gender and race of the instructor. The relative grade is calculated as the grade in the economics course divided by the average grade in the non-economics courses taken in the same term³. Our hypothesis is that women are more responsive to the relative grade received in making the decision to continue in economics and, therefore, the relative grade is interacted with gender. Finally, to allow for the possibility of role model effects, race and gender of women and minority faculty are interacted with women and minority students.

A student's human capital or ability is proxied by his or her high school academic success (in the first selection equation) and SAT scores throughout. Both the SAT math and SAT verbal scores (students who took them under the old scoring have been re-centered) are included. The most consistent measure of the undergraduate's academic success in high school contained in the admissions files is a record of the student's high school rank reported as an exact rank, and sometimes as a decile or quintile. Roughly 80% of the students' high schools report rank while a high school GPA is reported for the remaining 20%. Rather than excluding the 20% who report GPAs, we construct an index that allows the comparison of students who report a rank with those that report a GPA. The *Converted Rank Score* (CRS) is a score that ranges from 20-80 (80 is the maximum). The conversion accounts for the student's rank in relation to their class size, or their GPA depending upon their grading scale (4.00, 11.0, or 100). For example, a student with a 90% average on a 100 point scale has a CRS=69. Someone with a GPA between 3.50-3.60 on a 4.00 scale also receives a 69. When an exact rank is reported, the CRS is based

³ If a student has taken the same economics more than once, the first grade received is retained in their records and subsequent retakes are eliminated.

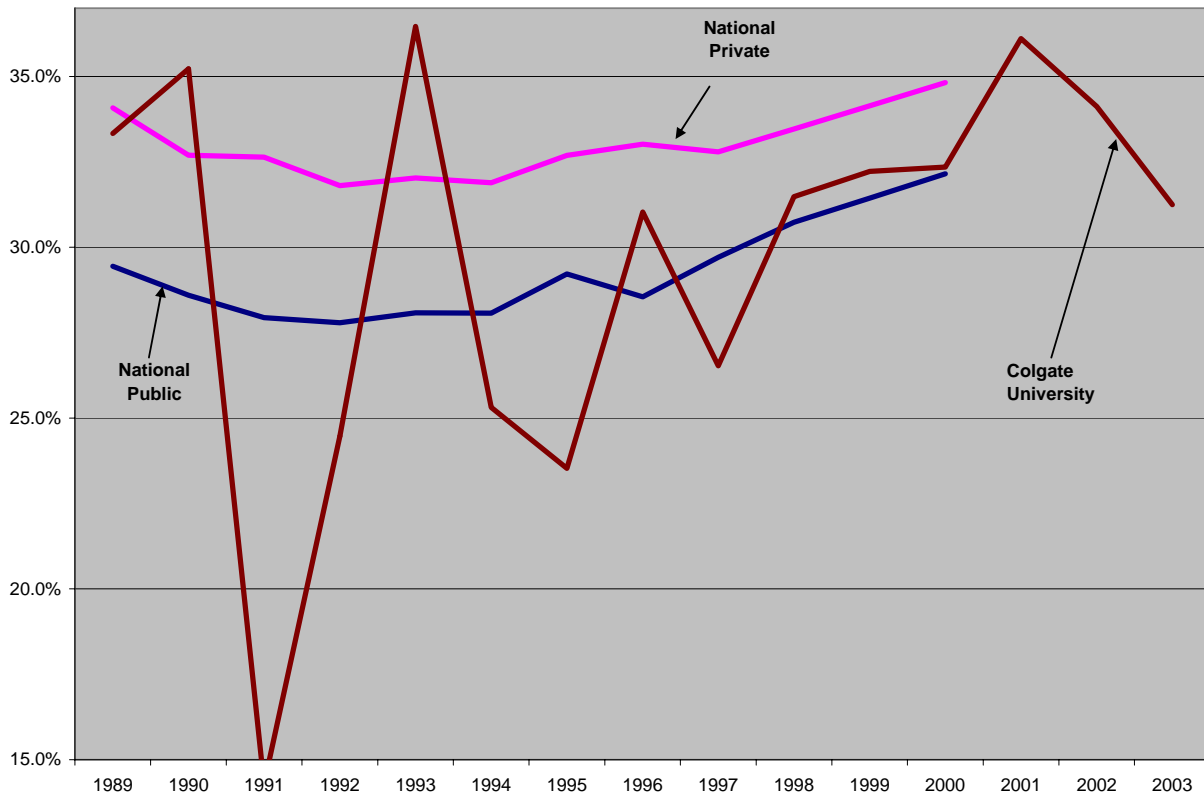
on the rank in relation to the class size. As the class size increases, at small class sizes a given relative rank receives a higher CRS. For example, a person ranked 2nd in a class of 20 receives a CRS=68. However, a person ranked 5th in a class of 50 receives a 64.⁴ The scale levels off for larger classes, with rank/class size combinations of 10/100, 20/200, 40/400, and 70/700 all garnering a CRS=63. The CRS is used by the Patriot League athletic conference in the computation of academic indexes to compare prospective students whose high schools report their GPAs differently.

III. Descriptive Results

Women are under-represented in economics at the undergraduate level, both nationally and at Colgate. Figure 2 shows female representation among undergraduate economics degrees at public and private universities nationally, as well as at Colgate. The figure shows that the trend at Colgate is similar to those at the national level (although, as expected, more variable). The percentages of female economics majors were trending downward in the early 90s; however, more recently, there has been a steady rise in the percentage of women among total economics majors (1999 data is not available from the IPEDs Completion Survey). Yet women continue to be significantly under-represented; in 2000, 32% of economics majors were women at public institutions compared with 35% at private institutions. At Colgate, women comprised 32% of economics majors that year.

⁴ The complete coding for the CRS is available from the first author upon request.

Figure 2: Percentage of Economics BAs Awarded to Women

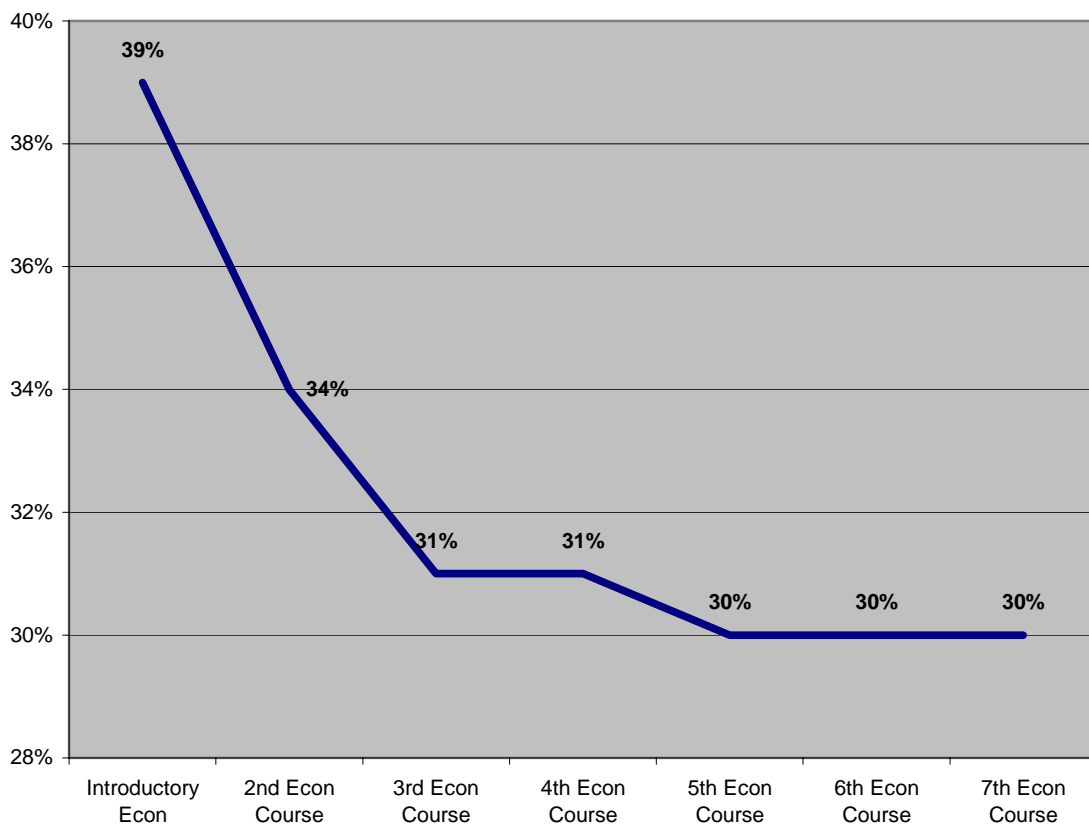


In order to understand why women are under-represented among economics majors, it is important to understand the representation of women at each of the stages in the progression through the economics curriculum. Are women under-represented because they choose not to take economics in the first place or because they are less likely to pursue additional courses in economics after the introductory course or sequence? That is, is it that women don't take economics or that they don't continue? Figure 3 shows the percentage of women in our sample at each stage of the progression through the economics major. Women represent 39% of students enrolled in introductory economics in our sample⁵. Given that women are approximately

⁵ Our analysis sample only counts those students who took introductory economics during their first two years at Colgate as potential majors. Because women are more likely to take economics later in their college career than men, the 39% figure under-represents the total percentage of women that take introductory economics (46%) at Colgate.

50% of the student body at Colgate, fewer women than men try economics. Women's representation in economics continues to decline from introductory economics to the second course (drops from 39% to 34%) and then continues to fall as students progress from the second to the third course (drops from 34% to 31%). After this point, the percentage of women remains relatively stable at around 30%. This last result is consistent with the work of Chizmar (2000), who finds that, after controlling for relative grades in economics and economics credit hours, female students who have declared an economics majors are just as likely to continue in the major as male students.

Figure 3: Percentage of Women Progressing through the Economics Curriculum



Why are women under-represented at each of these stages? One possible reason suggested in the literature for both the lower initial enrollments in introductory economics and

less persistence is that women have relatively poorer math preparation and/or math skills than men. Table 1 shows average SAT math and verbal scores for the men and women enrolled in each progressive stage in the economics curriculum.

Table 1: SATs for Men and Women at Each Stage of the Economics Progression

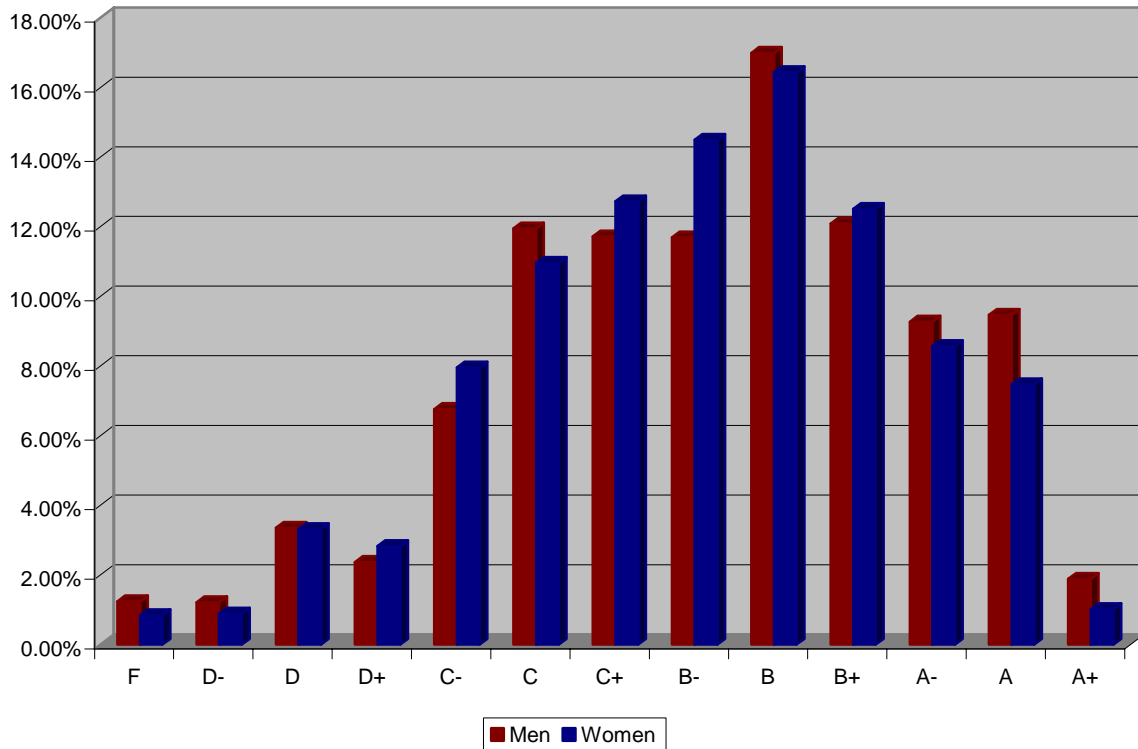
	College Average*	Intro	2 nd Sem.	3 rd Sem.	4 th Sem.	Minor	Major
Mean SAT Math:							
Men	646	653	662	668	670	658	672
Women	626	638	642	650	654	636	663
Mean SAT Verbal:							
Men	639	638	638	639	638	647	636
Women	641	641	640	637	635	631	637

* Average of all students who *graduated* in the classes of 1989 – 2004.

The data in Table 1 support the notion that math skills are a significant determinant of students choosing to take introductory economics and continuing in economics. For both men and women, the average SAT Math score increases with progression suggesting that those with weaker scores are less likely to continue. Given that women’s SAT math scores are significantly lower than men’s, math skills may partially explain the under-representation of women in economics courses.

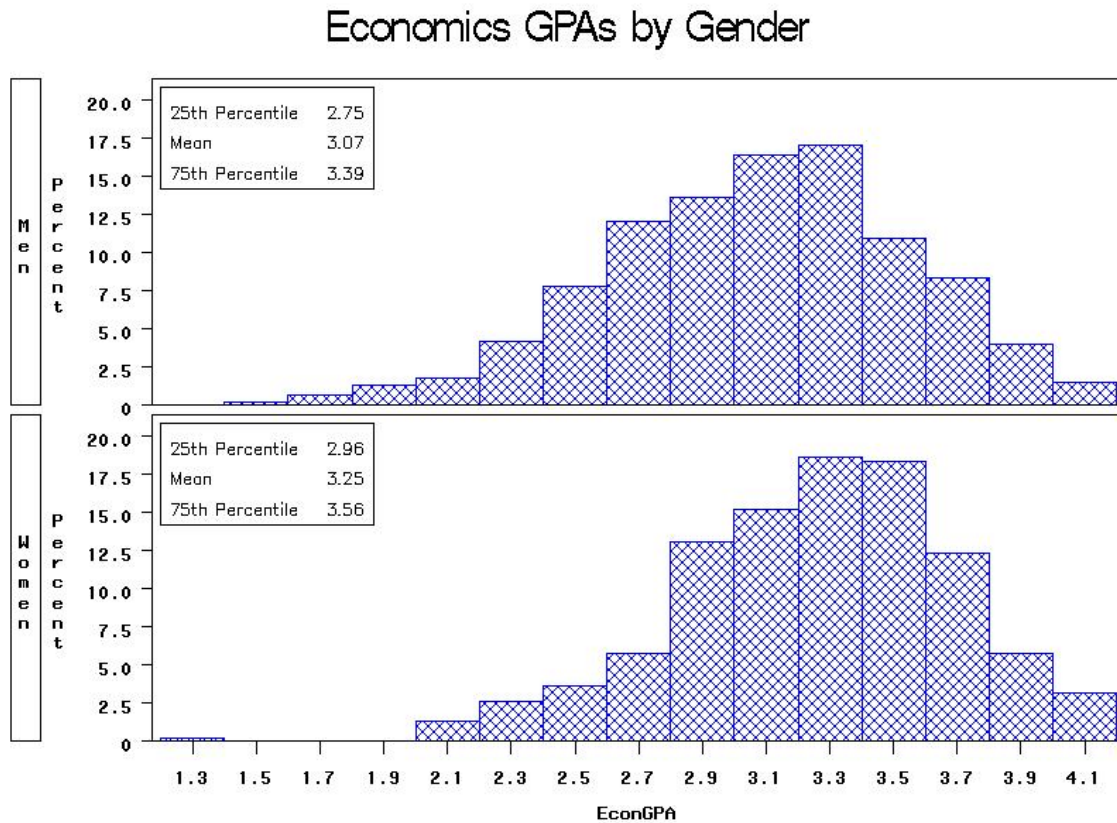
The literature also shows that students are very sensitive to the grades received in making the decision to continue studying a subject. If women do not do as well in economics courses as men, this effect may explain the under-representation of women among undergraduate economics majors. Figure 4 shows the gender distribution of grades in the introductory course among our sample students.

Figure 4: Gender Distribution of Grades in Introductory Economics



The figure indicates that women are slightly under-represented among the top students in introductory economics but that they are also under-represented in the very bottom of the grade distribution. Overall, women do only slightly worse than men in introductory economics with an average grade of 2.61 compared with men's average grade of 2.73. However, women who continue beyond introductory economics do, on average, better in their economics courses than men who continue. In the second course, women's average grade is 2.81 compared with 2.67 for men. Women continue to outperform men at each additional stage of progression through the major. Figure 5 shows the economics GPAs of male and female majors. It is clear that men are over-represented in the bottom of the GPA distribution. The average economics GPA for graduated male majors is 3.07 compared to 3.25 for graduated female majors.

Figure 5: Gender Distribution of Economics GPA for Economics Majors



The data presented in Figures 4 and 5 suggest that men with lower grades are more likely to persist in economics than women with low grades. Further evidence of men’s relative persistence in economics is the evidence on course retakes. At Colgate, students must receive a C or better in three of the core courses – intermediate microeconomic theory, intermediate macroeconomic theory, and the statistics/econometrics course. Students who do not receive a C or better are allowed to retake the course. The data indicate that approximately 77% of those who receive grades of C- or below in these courses are men and that 85% of those who retake these core economics courses are men.

The descriptive evidence shows that women are both less likely to enroll in introductory economics and less likely to continue in the discipline after taking the introductory course.

However, the data also suggests that while women perform comparably to men in the introductory course, they perform better than men in subsequent economics courses. The conclusion that we draw from these observations is that women are more sensitive to the grade that they receive in economics as a determinant of the decision to continue in the discipline than are men. As a result, the weaker economics students tend to be men and women are over-represented among the strongest students. In the following section, we more rigorously test this hypothesis by examining the effect of the relative grade for men and women on the decision to continue in economics, holding other factors constant.

IV. Empirical Model and Results

In order to test the hypothesis that women are more sensitive to relative grades than men, we estimate a series of selection models (probits) where the binary decision at each stage is whether or not to take another economics course. Each of these decisions has with it a selection equation that conditions the decision on the fact that the student took a previous semester of economics. For example, Equation 1 and 2 illustrate the first stage of the decision process. The probability of progressing to a second semester of economics is modeled conditional on the fact that the student took introductory economics⁶.

Stage 1:

$$(1) \quad P_p(2^{nd} Econ) = A + \beta_1 Seniority + \beta_2 SATm + \beta_3 SATv + \beta_4 GradClass + \beta_5 Female + \beta_6 Minority + \beta_7 IntroGrade + \beta_8 RelativeIntroGrade + \beta_9 Female * RelativeGrade + \beta_{10} FemaleStudent * FemaleFaculty + \beta_{11} MinorityStudent * MinorityFaculty + \varepsilon_i$$

$$(2) \quad P(Intro) = A + \beta_1 SATm + \beta_3 SATv + \beta_4 GradClass + \beta_5 Female + \beta_6 Minority + \beta_7 CRS + \mu_i$$

⁶ Colgate has a one-semester combined micro/macro introductory course, so the usual 2nd semester would be an intermediate micro theory (56%), macro theory (19%), or econometrics course (15%).

Of particular interest are the parameter estimates for the influence of gender (β_5), the absolute grade (β_7), the relative grade (β_8), and the interaction term between gender and relative grade (β_9). How each of these factors impact the decision to progress in economics is important in discovering the sources of the under-representation of women in economics departments.

Subsequent estimations follow the same general format as in stage 1. In stage 2 the probability of taking a 3rd semester of economics is modeled conditional upon having taken a 2nd semester. Stage 3 models the probability of taking a 4th conditional upon having taken the 3rd, and stage 4 models the multinomial decision of no minor or major, minoring in economics, or majoring in economics. Equations 3 and 4 illustrate the second stage estimation, and equation 5 illustrates the multinomial logit estimation of the final decision to major or minor.

Stage 2:

$$(3) \quad P_p(3^{rd} \text{ Econ}) = A + \beta_1 \text{Seniority} + \beta_2 \text{SATm} + \beta_3 \text{SATv} + \beta_4 \text{GradClass} + \beta_5 \text{Female} + \beta_6 \text{Minority} \\ + \beta_7 2^{nd} \text{ EconGrade} + \beta_8 2^{nd} \text{ EconRelativeGrade} + \beta_9 \text{Female} * 2^{nd} \text{ EconRelativeGrade} + \\ \beta_{10} \text{FemaleStudent} * \text{FemaleFaculty} + \beta_{11} \text{MinorityStudent} * \text{MinorityFaculty} + \varepsilon_i$$

$$(4) \quad P_p(2^{nd} \text{ Econ}) = A + \beta_1 \text{Seniority} + \beta_2 \text{SATm} + \beta_3 \text{SATv} + \beta_4 \text{GradClass} + \beta_5 \text{Female} + \beta_6 \text{Minority} \\ + \beta_7 \text{IntroGrade} + \beta_8 \text{RelativeIntroGrade} + \beta_9 \text{Female} * \text{RelativeGrade} + \\ \beta_{10} \text{FemaleStudent} * \text{FemaleFaculty} + \beta_{11} \text{MinorityStudent} * \text{MinorityFaculty} + \mu_i$$

Stage 3:

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Stage 4:

$$(5) \quad P_p(\text{No} / \text{Min} / \text{Maj}) = A + \beta_1 \text{Seniority} + \beta_2 \text{SATm} + \beta_3 \text{SATv} + \beta_4 \text{GradClass} + \beta_5 \text{Female} + \beta_6 \text{Minority} \\ + \beta_7 4^{th} \text{ EconGrade} + \beta_8 4^{th} \text{ EconRelativeGrade} + \beta_9 \text{Female} * 4^{th} \text{ EconRelGrade} + \\ \beta_{10} \text{FemaleStudent} * 4^{th} \text{ EconFemFac} + \beta_{11} \text{MinorityStudent} * 4^{th} \text{ EconMinFac} + \varepsilon_i$$

Table 2 shows the partial probabilities from estimating the equations determining the decision to progress further along in the economics curriculum. The results of the selection equation for the first stage (whether or not the student enrolled in introductory economics) along with the full results for the probit and multinomial logit models are presented in the appendix⁷. The first column of results indicates the factors that are significant in students' decision to take another economics course beyond the introductory course. The remaining columns show the results for the decision to take subsequent semesters of economics, and the final two columns show the results from the multinomial logit model of the decision to minor or major in economics. All estimations are undertaken using Stata/SE v8.2 econometrics software.

Table 2: Binary Probit Selection Model Partial Probabilities*

Variable	2 nd Econ	3 rd Econ	4 th Econ	Minor	Major
Seniority	-0.0293**	-0.0695**	-0.0560**	0.0596**	-0.1699**
SAT Math	0.0005**	0.0003**	0.0002	-0.0004**	0.0005**
SAT Verbal	-0.0006**	-0.0003**	-0.0002**	0.0003**	-0.0009**
Graduating Class	0.0012	0.0010	0.0005	-0.0096	-0.0025
Female	-0.1469**	-0.0914*	-0.0498	0.0142	0.0079
Minority	0.1076**	0.0326*	0.0290*	-0.0327*	0.0530
Absolute Economics Grade	0.1173**	0.0121	0.0160	0.0264**	0.0426*
Relative Economics Grade	0.1239**	0.1552**	0.1152**	-0.1264**	0.2649**
Relative Grade*Female	0.0522	0.1033**	0.0475	-0.0052	0.0086
Female Student&Faculty	-0.0329	0.0333*	0.0118	-0.0151	0.0008
Minority Student&Faculty	-0.0597	0.0287	0.0369	-0.0326	0.0664
<i>Wald Test of Independent Equations (p-value)</i>				<u>Multinomial Logit: n=1,782</u>	
	.83	.00	.15	Minors (9% of sample)	
<i>Number of Observations</i> ^{la}	5,221	3,042	2,120	Majors (74% of sample)	

* Parameter estimates with ** have p-values $\leq .05$ and those with * have $.05 < p\text{-value} \leq .10$.

^{la} Observations do not exactly match those in Figure 1 because of missing observations for SATs and CRSs.

Interestingly, the results indicate that women are significantly less likely to progress in economics after the introductory course, and marginally (p-value=.09) after the second semester, but not beyond that. In addition, as shown in the selection equation presented in the appendix,

⁷ Notice the estimates for the probit equation in stage n are not quite identical to those for the selection equation in stage n-1, even though the equations appear identical. This is because of the inclusion of the analogue to the Heckman selection correction in the stage n estimation, which is not present in the selection equation (n-1).

women are significantly less likely to enroll in the introductory course during their first two years. These results are consistent with Horvath et al. (1992) and Robb and Robb (1999) who find that women are less likely to continue after introductory economics and also with Chizmar (2000) who finds that women who have already declared economics as their major (which typically happens after several economics courses have been taken) are just as likely to continue in the major as are men. The results also show that, holding all else constant, multicultural students are more likely to continue in economics than white students. This is an interesting result that deserves more attention in the literature.

As found in previous work, students are sensitive to both their absolute and relative grades in terms of making the decision to continue in economics. A higher absolute grade encourages a student to pursue more economics after the introductory course, but this effect disappears in the intermediate course progression. However, it is again significant later on in the decision to major or minor in economics. Holding constant the absolute grade, the relative grade also matters to students. The relative economics grade is an important and statistically significant factor in students' decisions to continue after introductory economics and throughout each stage modeled here. The major goal of this paper is to examine the relative impact of grades on women compared with men. The results support our hypothesis that women are more sensitive to the relative grade, but only after the second course, which is typically an intermediate theory course. Women who do poorly in the second economics course relative to the other grades they received that semester are significantly less likely to continue in economics than men who received the same relative grade.

The role model effect of most interest here, given our focus on gender, is the effect of women students being matched with women faculty. The results show weak evidence of a role

model effect for women after the second stage. Women who have a female faculty member during their second semester of economics are marginally more likely to continue on than women who have a male professor (p-value=.10). There is also not a significant effect of minority students and minority faculty in the same classroom. These results run somewhat counter to those found in Rask and Bailey (2002); however, the small numbers of female and minority faculty in the economics department at Colgate might account for this result.

The other results support the existing literature on undergraduate persistence and achievement in economics. Students with higher SAT math scores are more likely to continue in economics at each stage while students with higher SAT verbal scores are significantly less likely to continue in economics at each stage. Given that the relative and absolute grades are being held constant, the results suggest that the ease with which students comprehend economics or their interests in the application of mathematical techniques may explain why students choose economics. Not surprisingly, at each stage, students who have progressed further in their Colgate career when they take the course are less likely to take another course or choose economics as a major.

V. Conclusions and Suggestions for Further Work

There is a significant gender imbalance in undergraduate economics with women typically representing between 30 and 40 percent of majors. The literature has explored several possible causes of the under-representation of women including the gender composition of the economics faculty, women's poorer math preparation, women's lower relative performance in introductory economics courses, the topics that are included in the typical economics curriculum, and the teaching techniques used in introductory economics classes as possible explanations for the shunning of economics by female undergraduates. In this paper, we examine many of these

potential causes as well as another that has gone unnoticed – that women are more sensitive to the relative grade in economics than are men and, therefore, men are likely to persist in the discipline despite low relative grades while women who perform poorly are more likely to find a major that better suits their talents.

Our results provide some support for the existing literature and also indicate that sensitivity to relative grades in economics may be another important factor in explaining the gender imbalance in undergraduate economics. As found in previous studies, we find that women are significantly less likely to enroll in the introductory course and to progress in economics after introductory economics, but not beyond that. These results are consistent with Horvath et al. (1992) and Robb and Robb (1999) who find that women are less likely to continue after introductory economics and also with Chizmar (2000) who finds that women who have already declared economics as their major. We also support the existing literature on major choice that suggests that students' decisions to continue in economics are significantly impacted by their grades. Our important new finding is that women are more sensitive to the relative grade than are men. This result suggests that some of the gender imbalance may result because some men receive low grades but continue with economics while women who receive low grades take the signal and drop economics. It is important to note that these results are most relevant for economics departments at institutions with traditional undergraduate liberal arts curriculum. Economics departments in institutions with undergraduate business majors are less likely to face such persistence from men.

Why are men less responsive to the grade received than women? Why do many men persist in economics even though they do not do well and, in some cases, even have to repeat required courses? There are several possible explanations. First, men may be more interested in

the topics covered in the traditional economics curriculum and, therefore, may continue in the major even if they don't do well because they enjoy it. Another possible explanation is that men have more focused career ambitions and are more interested or concerned (perhaps because of parental pressure) with their future earning power. In institutions with traditional liberal arts curriculums (no undergraduate business or engineering), economics is often viewed by students as a major with higher potential earning power and more job opportunities.

Another important contribution of our paper is that it disputes the notion that the major reason that women are under-represented in economics is that they don't do as well. Our results show that the grades received in introductory economics by men and women are comparable, despite the fact that the enrolled women have lower SAT math scores than the men. More importantly, because of the bias in the attrition of men and women reported here, women majors significantly outperform male majors in subsequent coursework in economics. By the time of graduation, female majors average an economics GPA of 3.25 compared to 3.07 for men.

What are the implications of our results for economics departments that want to rectify their gender imbalances? First, for departments with large numbers of majors, the gender imbalance may be more of a problem of too many men rather than too few women if those women who drop out are likely to be those who haven't done as well in economics. While faculty would not want to discourage male majors who persist in economics despite low grades if their motivation is interest in the subject matter, they might want to consider ways to discourage these men if biased notions about future job and financial outcomes are driving their persistence. Increasing the grade requirements in the intermediate theory courses and disallowing repeats would be a way to discourage the weakest majors and, at the same time, both lower class sizes and improve the gender balance. Interestingly, our results also indicate that relative grade

inflation by economics departments over time would likely increase the percentage of female majors as women are more responsive to the relative grade received.

Another important implication of our research for departments interested in encouraging more female majors (especially those with low enrollments that do not want to discourage any majors) is that it appears that the difference in behavior between men and women is centered on the first and second economics courses, which are likely to be introductory economics and intermediate micro theory at Colgate. The negative female effect is strongest in the decision to continue after the introductory course but the gendered relative grade impact is at the second stage. Both of these effects disappear after the third course is taken and women and men behave similarly after this point. Departments that want to encourage more women to continue should take a look at their introductory and intermediate theory courses. Are there ways to restructure these courses to include more applications and topics that would appeal to women? What is the standard pedagogy in these courses? Is there any reason to think that what is being done (straight lecture format, mostly quantitative problems on exams, etc.) would discourage female majors? Another potential solution is to think about offering alternative paths of proceeding through the major that might be more attractive to women. Perhaps taking an applied topics course after introductory economics but before or concurrently with the intermediate theory course would appeal to more potential female concentrators.

Further work that (1) analyzes why men are less responsive to the relative grade in economics courses than women, and (2) looks at why much of the female attrition in economics follows the first and second economics course would be important contributions to further dissecting the causes of the under-representation of women in economics. In addition, the analysis presented here should be extended to other undergraduate majors in which women are

under-represented. Is the persistence of relatively low-achieving men a partial explanation for the under-representation of women in other disciplines such as the sciences and engineering? In addition, is the under-representation of men in some majors, such as English or Arts, a result of men being less responsive to high grades in these disciplines?

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VII. Appendix

Stage 1 Selection Model:

Variable	Estimate	Robust SE	t-statistic	p-value
<i>Progress to 2nd Economics</i>				
Constant	-6.5560	9.2488	-0.71	0.478
Seniority (Intro)	-0.0746	0.0175	-4.25	0.000
SAT Math	0.0013	0.0006	2.11	0.035
SAT Verbal	-0.0017	0.0004	-4.00	0.000
Graduating Class	0.0031	0.0047	0.65	0.515
Female	-0.3762	0.1626	-2.31	0.021
Minority	0.2819	0.0698	4.04	0.000
Absolute Economics Grade (Intro)	0.2988	0.0370	8.07	0.000
Relative Economics Grade (Intro)	0.3156	0.1254	2.52	0.012
Relative Grade*Female (Intro)	0.1331	0.1536	0.87	0.386
Female Student&Faculty (Intro)	-0.0832	0.0833	-1.00	0.318
Minority Student&Faculty (Intro)	-0.1506	0.1486	-1.01	0.311
<i>Take Introductory Economics</i>				
Constant	40.8555	4.0127	10.18	0.000
Female	-0.4644	0.0186	-24.95	0.000
Graduating Class	-0.0208	0.0020	-10.32	0.000
SAT Math	0.0039	0.0002	24.90	0.000
SAT Verbal	-0.0019	0.0001	-12.50	0.000
CRS	-0.0040	0.0016	-2.50	0.012
Minority	-0.0659	0.0317	-2.08	0.038

Stage 2 Selection Model:

Variable	Estimate	Robust SE	t-statistic	p-value
<i>Progress to 3rd Economics</i>				
Constant	-6.6988	9.9970	-0.67	0.503
Seniority (2 nd)	-0.2836	0.0178	-15.91	0.000
SAT Math	0.0014	0.0004	3.22	0.001
SAT Verbal	-0.0013	0.0004	-3.14	0.002
Graduating Class	0.0040	0.0050	0.80	0.426
Female	-0.3599	0.1964	-1.83	0.067
Minority	0.1407	0.0933	1.51	0.131
Absolute Economics Grade (2 nd)	0.0496	0.0477	1.04	0.298
Relative Economics Grade (2 nd)	0.6335	0.1516	4.18	0.000
Relative Grade*Female (2 nd)	0.4214	0.2135	1.97	0.048
Female Student&Faculty (2 nd)	0.1455	0.0949	1.53	0.125
Minority Student&Faculty (2 nd)	0.1245	0.1602	0.78	0.437
<i>Take 2nd Economics</i>				
Constant	-6.7034	4.9394	-1.36	0.175
Seniority (Intro)	-0.2943	0.1011	-2.91	0.004
SAT Math	0.0031	0.0025	1.24	0.215
SAT Verbal	0.0012	0.0002	5.87	0.000
Graduating Class	-0.0017	0.0002	-7.77	0.000
Female	0.2560	0.0408	6.27	0.000
Minority	0.2887	0.0202	14.27	0.000
Absolute Economics Grade (Intro)	0.4458	0.0555	8.03	0.000
Relative Economics Grade (Intro)	0.0191	0.1032	0.18	0.853
Relative Grade*Female (Intro)	-0.0418	0.0133	-3.13	0.002
Female Student&Faculty (Intro)	-6.6988	9.9970	-0.67	0.503
Minority Student&Faculty (Intro)	-0.2836	0.0178	-15.91	0.000

Stage 3 Selection Model:

Variable	Estimate	Robust SE	t-statistic	p-value
<i>Progress to 4th Economics</i>				
Constant	-4.4490	16.3358	-0.27	0.785
Seniority (3 rd)	-0.3914	0.0528	-7.41	0.000
SAT Math	0.0013	0.0008	1.71	0.087
SAT Verbal	-0.0015	0.0007	-2.03	0.042
Graduating Class	0.0033	0.0082	0.41	0.684
Female	-0.3226	0.3665	-0.88	0.379
Minority	0.2309	0.1410	1.64	0.102
Absolute Economics Grade (3 rd)	0.1118	0.0858	1.30	0.193
Relative Economics Grade (3 rd)	0.8045	0.2750	2.93	0.003
Relative Grade*Female (3 rd)	0.3314	0.3987	0.83	0.406
Female Student&Faculty (3 rd)	0.0867	0.1367	0.63	0.526
Minority Student&Faculty (3 rd)	0.3236	0.2956	1.09	0.274
<i>Take 3rd Economics</i>				
Constant	-18.3783	6.5395	-2.81	0.005
Seniority (2 nd)	-0.3711	0.0137	-27.12	0.000
SAT Math	0.0027	0.0003	8.99	0.000
SAT Verbal	-0.0023	0.0003	-8.25	0.000
Graduating Class	0.0095	0.0033	2.89	0.004
Female	-0.6206	0.1721	-3.61	0.000
Minority	0.2972	0.0559	5.31	0.000
Absolute Economics Grade (2 nd)	0.1940	0.0309	6.27	0.000
Relative Economics Grade (2 nd)	0.6680	0.1027	6.50	0.000
Relative Grade*Female (2 nd)	0.5884	0.1833	3.21	0.001
Female Student&Faculty (2 nd)	-4.4490	16.3358	-0.27	0.785
Minority Student&Faculty (2 nd)	-0.3914	0.0528	-7.41	0.000

Stage 4 Multinomial Logit Model:

Variable	Estimate	Robust SE	t-statistic	p-value
<i>Outcome=No Major/Minor in Econ</i>				
Constant	-153.9	31.5	-4.88	0.000
Seniority (4 th)	0.876	0.066	13.28	0.000
SAT Math	-0.002	0.001	-1.31	0.189
SAT Verbal	0.005	0.001	3.93	0.000
Graduating Class	0.074	0.016	4.70	0.000
Female	-0.143	0.726	-0.20	0.844
Minority	-0.195	0.251	-0.78	0.437
Absolute Economics Grade (4 th)	-0.462	0.137	-3.37	0.001
Relative Economics Grade (4 th)	-1.170	0.418	-2.80	0.005
Relative Grade*Female (4 th)	-0.031	0.762	-0.04	0.967
Female Student&Faculty (4 th)	0.080	0.268	0.30	0.765
Minority Student&Faculty (4 th)	-0.306	0.522	-0.59	0.558
<i>Outcome=Minor in Economics</i>				
Constant	203.7	36.5	5.58	0.000
Seniority (4 th)	0.905	0.079	11.51	0.000
SAT Math	-0.005	0.001	-3.16	0.002
SAT Verbal	0.004	0.002	2.77	0.006
Graduating Class	-0.105	0.018	-5.72	0.000
Female	0.145	0.939	0.15	0.877
Minority	-0.505	0.308	-1.64	0.100
Absolute Economics Grade (4 th)	0.242	0.168	1.44	0.151
Relative Economics Grade (4 th)	-1.789	0.524	-3.41	0.001
Relative Grade*Female (4 th)	-0.071	0.968	-0.07	0.942
Female Student&Faculty (4 th)	-0.185	0.337	-0.55	0.582
Minority Student&Faculty (4 th)	-0.541	0.879	-0.62	0.538