Discussion Paper No. 3

Williams Project on the Economics of Higher Education
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Williamstown, MA 01267

The Implications of Grading Policies for Student Course Choice

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DP-3
November 1988

Grade Inflation and Course Choice

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November, 1988

We are grateful to Gordon Winston for his substantial contributions to the theory section, as well as for his helpful comments on earlier drafts of the paper. We also wish to thank David Ross for econometric advice and the seminar participants at Williams College for useful comments. In addition, we are grateful to the President of Williams College for providing research funds for this study.

Abstract

Utilizing panel data, we measure the responsiveness of student course choice to grades and assess the impact on the distribution of enrollments across departments of differences in grading policies. We show that grades strongly influence course choice; this influence remains powerful after accounting for student responsiveness to signals of comparative advantage contained in grades. Enrollments are being skewed towards high-grading departments. Finally, we present evidence that, if the aim of grading is to convey information about students' relative strengths and weaknesses, greater uniformity in grading policies should be achieved by lowering grades in high grading departments.

> "The nation depends upon undergraduate education to prepare not only the small number of students who will become research scientists and engineers, but also the many other students who will have to function effectively in an increasingly technological world. That is a difficult and very important task. And it is being carried out under the increasingly critical eye of a nation besieged with concerns about economic competitiveness and a declining technological edge.. .The college age population is shrinking. Declines (in science enrollments) are inevitable unless the proportion of students pursuing science and engineering increases -- and there is little evidence of that. Somehow, we must persuade more students to study science and engineering".
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> Ernest Bloch, Director, National Science Foundation in a speech at Carleton College, July 13, 1988

> "It's pretty hard to get below a B- in most humanities courses. I hear it's a little different in science classes, though. There aren't really F's anymore. People look at a C and think it's an F."
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> A Yale senior quoted in a May 22, 1988 New York Times article on honors and grade inflation.

I. Introduction

From 1970-71 to 1984-85, the number of students graduating from American colleges and universities who had majored in the sciences declined. both as a proportion of the steadily growing total and in absolute terms.[1] This decline has prompted forecasts of shrinking science departments, a nation of scientific illiterates and a loss of economic competitiveness in high technology. Other trends in student course choice, such as the rise in enrollments in "vocational" courses, have also elicited concern. The most common response by faculty and administration to these patterns of demand, considered to be suboptimal from the perspective of the institution or

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[1] According to the U.S. Department of Education (1987), in 1970-71, 81,956 graduates majored in the biological and physical sciences, 9.8 percent of the total. In 1984-85 the 77,323 graduates who majored in the sciences represented 7.9 percent of the total. The absolute decline in science graduates occurred while the total number of students graduating increased by more than 140,000.

society, has been quantitative restrictions: nearly all colleges and universities have distribution requirements and many have been altered recently with the aim of bolstering enrollments in the sciences.

It is the reluctant conclusion from our empirical analysis that faculty bear some responsibility for the patterns of student choice they bemoan. Students make their course choices in response to a powerful set of incentives: grades. These incentives have been systematically distorted by the grade inflation of the last two and a half decades. The result is often a conflict between the incentives offered to students and the objectives of our institutions, as reflected in quantitative restrictions.

Grades signal to students their relative strengths and weaknesses. They can be an integral part of the educational process, a feedback mechanism which helps the student define her comparative advantage and choose courses on that basis. But even if grades fail completely to perform this function --- even if a high mark in a subject is less an indication of the student's strength than of the weakness of the instructor's resolve --- grades, or more precisely the expectation of grades, are still likely to influence a student's course choice. High grades lead to rewards and are more desirable than low grades, which lead to sanctions.

An analysis of what has happened to grades at Williams College over the past two decades suggests that grade inflation has led to grade differentials between departments, thereby distorting incentives and influencing the pattern of course choice. Table 1 shows that the mean grade in the introductory courses of eight large departments has risen from 2.49 (a bit above C+) in 1962-63 to 2.93 (roughly B) in 1985-86; the proportion of students receiving less than B- has fallen from 47 to 26 percent and the proportion receiving more than B+ has risen from 11.9 to 20.6 percent over the same period.

While there has been substantial grade inflation at Williams, more central to our concern is the variation in the pace of inflation. In some departments the rate of inflation is high (in Political Science the mean grade has risen by .67 and the proportion receiving less than B- has fallen by nearly two thirds); in others the increase has been modest (the mean grade has risen by only 07 in Psychology while the proportion receiving less than B- declined by one fifth).

As a consequence of this differential grade inflation, the variation of mean grades across departments has increased. In 1962-63, with the exception of the Math department, there was little difference across departments either in mean grades or in the dispersion of grades. After 25 years of grade inflation the current situation, as summarized in Figure 1, is markedly different.

The College now divides itself into low grading departments, in which the mean grade is 2.66 and 42 percent of students receive less than B-, and high grading departments, in which the mean grade is 3.09 and only 17 percent of students receive less than B-.[2,3] Within a typical low grading department there is substantial dispersion of grades, on a par with the average level of dispersion in 1962-63. In the typical high grading department dispersion is much less. In other words, the distribution did not simply shift to the right in the high grading departments, it also

2 Significance tests on the difference in means between the low and high grading departments shows these differences to be signifcant at the 1% level.

3 There are markedly greater differences in grades across instructors in high grading departments than in low grading departments; i.e. even in high grading departments, some instructors have not inflated their grades.

became more compressed -- indeed, compression was a necessary consequence of the former given a fixed upper grade limit.[4,5]

The departure from a uniform grading policy doesn't necessarily obscure signals to students of their comparative advantage. A student who receives a higher grade in English than in Math, but whose higher English grade is lower relative to her classmates than is her Math grade, may correctly conclude that her comparative advantage is in Mathematics.[6] Ceterus oaribus, she may then go with her relative strength and choose a second course in Math over a second course in English. Or she may choose a second course in the subject in which she is relatively weaker, English, over a second course in Math because of the expected consequences of that choice for her grade point average. So, whether course choice is influenced by differences across departments in grading policy depends on the weight students give to grades as signals of comparative advantage relative to the weight they give to grades as rewards.

In this paper we utilize panel data from Williams College to measure the responsiveness of course choice to grades, to assess whether students

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[4]With a fixed number of grading categories, and the grade distribution truncated at A+, the reduced number of grades in the categories below B- reduces the effective number of categories available to instructors and hence increases the concentration of grades in a few categories. There is a negative and significant correlation (-.886) between mean grade and the standard deviation of grades within departments.

[5]The difference in grades between these two groups of departments cannot be simply explained by a difference in the quality of students; there is no significant difference between students in high and low grading departments in either SAT scores or grades in other courses.

[6] The informational requirements for the student to determine her comparative advantage are substantially greater when grading policy differs across departments than when it is uniform. If grading policies are uniform, the student only needs to know her grade in each department. If grading policies differ across departments, to determine her comparative advantage the student needs to know the grade distribution in each department in addition to her own grades.

respond to signals of comparative advantage and, if so, whether and to what extent there is an independent effect on behavior of the extrinsic reward dimension of grades. We also attempt to measure the impact on the distribution of enrollments across departments of differences in grading policy. We use our course choice functions to simulate the answer to the following question: how many more students would low grading departments attract if they adopted the grade policy of high grading departments?

In section II we examine course choice in the context of a general model of activity choice. Section III describes the nature and sources of our data. In section IV the results of our probit models and simulations are presented and discussed. Section V presents some additional findings, draws out policy implications and concludes.

II. A Model of Course Choice

The activity choice model (Winston, 1988) on which we ground our analysis of course choice extends the familiar Becker (1965) analysis. An individual's choice among activities (in this case courses) throughout the time period (in this case the years in college) are described as the result of utility maximizing decisions. In the standard model, these decisions are made moment by moment; here they are made semester by semester.

The amount of learning done in a course depends on the person's own skill -- described by an individual production function -- in harnessing both his own efforts and the flow of purchased goods and services to that course. Each person has a different production function for each course, and each course yields a potential flow of satisfaction or dissatisfaction. The utility derived from taking a course is a function of the amount of learning which is done.[7]

Utility is maximized over the years in college if, each semester, the individual chooses those courses in which "the value of time" is the greatest, when that is defined as the Hamiltonian,

$$\mu(\tau) = u(a,z_a(\tau),g_a(\tau),\tau) + \Sigma_{i,j}(t-\tau)u(a(\tau),z_a(\tau),g_a(\tau),t)dt$$

The first term on the right hand side describes the rate of flow of satisfaction in semester τ as dependent on what course is being taken, a, how much is being learned, $z_a(\cdot)$, and on the grading function, $g_a(\cdot)$ which describes how the student's learning in this course maps into his grade. Grading functions are course specific, leaving open the possibility of differences in grading functions across departments. The second term describes any delayed results of taking course a, discounted back to τ. Maximizing $\mu(\cdot)$, then, leads to taking each semester those courses that give the highest flow of satisfaction, present and future.[8]

There are two subtle aspects of course choice highlighted by this model; one involves the complexities of motivation, the other involves the student's knowledge of her learning production functions. Taking a course yields not just the satisfactions or displeasures of the activity itself, but -- central to our concerns -- the satisfactions or displeasures of the grade received. Moreover, the satisfaction associated with both the learning process and the grade received can be either intrinsic or extrinsic. Learning a course can be intrinsically fun -- going to class and

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[7]More formally, in the context of the activity choice model, the "intensity" with which the student takes the course, where intensity - $z_a(\cdot)$, the individual's production function in that course.

[8]We have implicitly assumed in this specification that there is no difference among courses in their money or effort costs, that all pay a zero wage rate, and that the time spent in course activities is fixed in the original decision to go to school.

doing the reading may, in themselves, be a pleasure. Or it may not be much fun in itself, but still deemed useful -- organic chemistry or microeconomic theory are often considered a pain worth tolerating, because they lead to future courses or insights or careers that are expected to be highly pleasurable or profitable.

In the same way, good grades yield intrinisc satisfaction -- the A that brings the warm glow of achievement -- and extrinsic satisfactions -- Dean's list, Phi Beta Kappa, good jobs, graduate scholarships, etc. Bad grades, of course, yield negative utilities -- the intrinsic pain of disappointment, restrictions on participation in sports, academic probation, parental disapproval, etc.

In addition to entering the student's utility function directly, grades may have an indirect influence as signals of the student's strengths and weaknesses. The usual assumption of a fully informed decision-maker is not appropriate in a model of course choice. The student's knowledge must be incomplete -- otherwise he wouldn't need to be in college. An important aspect of that incomplete knowledge is that students do not typically know what they are good at -- which subjects they learn efficiently and which they learn relatively inefficiently.

An important dimension of education is to learn more about one's comparative advantage. A student has to discover his production functions in various disciplines, whether he is good at Physics or English and poor at History or Art. Grades are potentially a major source of information about one's comparative advantage. They convey signals that may permit the student to better specify her course production functions, $z_a(\cdot)$.

If grade functions were uniform across departments, maximizing grades and exploiting comparative advantage would be mutually consistent; by choosing those subjects she's good at a student would both learn more and get better grades. But what if grade functions do not uniformly map learning into grade? What if she gets better grades in the subjects in which she is a relatively inefficient learner? The fact that grade functions are specific to courses makes such an outcome feasible. In this case, the student must choose between maximizing her grades and exploiting her comparative advantage. The intrinsic and extrinsic benefits derived from higher grades may outweigh the benefits derived from learning more. Student course choice would then be skewed towards high grading departments.

III. The Nature of the Panel Data

Our sample consists of a panel of 376 students enrolled at Williams College during the academic year 1985-86. The data are from three sources: student transcripts, student files including application forms, and a survey which we administered to these students -- the Adjective Check List, (Gough, 1952) which yields a measure of the student's "need for achievement".

For each student we have data on all courses taken through June, 1987 -- 6842 total course choices -- and their grades in those classes. In addition we have demographic and family background data, indicators of abilities, cognitive skills and academic performance prior to enrolling at Williams, as well as indicators of course preference and academic motivation. Since this study builds on a previous analysis of the determinants of performance in Introductory Economics (Sabot and Wakeman-Linn, (1988)) the 376 students consist of all students who took Economics 101 in the academic year 1985-86. Roughly 80 percent of each cohort of Williams students, which numbers on average 500, takes this course. Moreover, comparisons between the grade distributions of our sample and of all Williams students in each of the courses we examined in our study show no significant differences. This suggests that our sample is representative of the student body.

We focus our analysis on five departments with relatively large enrollments in the introductory course(s): Economics, English, Math, Political Science and Psychology. Each of these departments had over 180 students from our sample taking their introductory course. Our data set is extremely rich but it is hardly unique. Similar data are to be found in the Registrars' Offices of all colleges and universities. While this study represents one of the first attempts by economists to exploit these data, replication and extension of our study at other institutions should be quite simple.

IV. Course Choice and Grading: Incentives and Comparative Advantage

Our probit course choice functions measure the influence of the grade received by a student in the introductory course on the probability of that student taking a second course in the same department. We hypothesize a positive and monotonic relationship: *ceterus paribus*, a student with an A in Math 101 is more likely to take another Math course than a student who receives a B, who is more likely to take more math than a student who receives a C, and so forth.

In the two departments in which we have the most observations -- Economics, a low grading department, and English, a high grading department -- we also assess the independent influence on course choice of a measure of comparative advantage We hypothesize a positive relationship: standardizing for the absolute level of the grade received in Economics 101, a student whose place in the distribution of Economics grades is higher than his place in the distribution of grades in his other courses is more likely to take additional Economics than a student whose rank in Economics is lower than his rank in other subjects; i.e. in assessing his comparative advantage the student deflates the grades he receives in high grading departments.

In every case when measuring the influence of grades we attempt to standardize for such other influences on course choice as intrinsic interest in the discipline, beliefs concerning the level of rewards associated with one discipline relative to another, prior evidence of comparative advantage, and the student's need for achievement. We focus here first on the equations without the comparative advantage variable and then on the two departments for which it was feasible to take account of comparative advantage.

1. Results (Abstracting From Comparative Advantage)

For all five introductory courses, we derived maximum likelihood estimates of the parameters in the following reduced form equation:

$$\text{Prob}(Y=1) = D(X'B)$$

where Y is a dichotomous variable which takes the value 1 where the individual took a second (or more) course(s) in the discipline and 0 where she did not,[9] X is a vector of exogenous variables, and D(X'B) is the cumulative normal distribution function.

The exogenous variables are:

I - a dummy variable which takes the value 1 where the student indicated, on their college application, an intention to major in the department, and 0 where he did not. A student's intention to major in a discipline may reflect interest in the discipline, the student's beliefs about rewards in that discipline or that he has a comparative advantage in the subject. Cur expectation is that,

[9] We focus here on the decision to take at least one more course, rather than on the actual number of additional courses taken or on the choice of major, because the decision to take a third course or to major depends on the grade received in the second course.

standardizing for grades, the probability of taking a second course will be higher among students who intend to major in the discipline than among those who do not.

S - a dummy variable which takes the value 1 where the student is female and 0 where the student is male. This variable could capture sex-correlated differences in interest in particular disciplines, in career prospects or in perceived comparative advantage. There is no strong prior regarding sign.

N - a continuous variable, the student's score on the adjective list test, signifying his "need for achievement". There is no strong prior regarding the sign of this variable, which was shown to be positive and highly significant in the production functions estimated for Economics 101 (see Sabot and Wakeman_Linn,(1988)). We might, however, expect the sign to be positive in low grading departments on the presumption that students with a strong need for achievement will tend to choose courses in which earning a high grade is more of an achievement.

G_3 - a set of four dummy variables, A,B,C,D, signifying the grade **received by** the student in the introductory course, with A as the **base**.[10]

Table 2 presents the mean values of the independent variable. There are substantial differences across departments in the proportion of students who intend to major, yet this number is quite low in most departments. The proportion of females is somewhat higher in low than in high grading departments While there is little difference across departments in mean need for achievement, there is substantial variance within each department.

Table 3 presents our results. As expected, intended majors are more likely than other students to take a second course in the department: in each of our five estimated course choice functions the coefficient on the variable signifying the student's intention to major is positive and highly

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[10] The dummy A applies to students receiving A+,A or A-; similarly for the dummies B and C. The dummy D applies to students receiving a grade below C-. The grade distribution for each department is given in Table 2. The principal distinction between high grading and low grading departments is not in the proportion that are awarded an A but in the proportion given a C or D.

significant. *Ceterus paribus* women are significantly less likely to take a second course in Economics or Political Science; in psychology women are more likely to take a second course, but not significantly so. In English and Math, though negative, the coefficient on the sex variable is insignificant. The coefficient on the need for achievement variable is significantly positive in Economics and positive but not significant in Psychology; it is negative and not significant in the other three subjects.[11]

The estimates for Economics, English and Math conform closely to our expectations regarding the influence of grades on course choice. The coefficients on eight of the nine variables signifying grades are significant, negative and their monotonic ranking is as predicted: the probability of taking a second course in the subject is lower for students who receive low grades than for students who receive high grades.[12]

With one exception the sign and ranking of the coefficients on the grade variables in Political Science and Psychology also conform to expectations, though none of them is statistically significant. These two departments have the fewest observations and experiments with the largest two departments showed that the significance levels of the coefficients on

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[11] When making course choices those students with a greater need for achievement may place more weight on differences among subjects in expected rates of return after college. This may explain why only in Economics does a greater need for achievement significantly increase the likelihood of taking a second course.

[12] Only the coefficient on D in English does not conform and is insignificant, the likely explanation being the small number of observations: of the 302 students in our sample who took the introductory English course two received a D.

grades are sensitive to the number of observations.[13] This provides some justification for viewing the coefficients on grades in these departments as best estimates. Moreover, all five equations correctly predict for two out of every three observations whether a student chooses a second course in the subject, and four of the five equations are significant at the 1% level.

While grades affect course choice in the manner hypothesized, it is not possible to assess the magnitude of their influence directly from the probit functions. Table 4 presents, by grade, the derived probabilities of taking an additional course in Economics, the largest low grading department, and English, the largest high grading department. The probabilities are stratified by sex and the intention to major.

Of the students in Economics 101 who do not intend to major in the subject (the large majority) and who are male (also the majority), the probability of taking a second course is 18.2 percent less if he received a B than if he received an A and 27.6 percent less if he received a C than if he received an A.[14] Students in English 101 are also responsive to their grade, though somewhat less so than students in Economic 101. Of those who do not intend to major in English (the large majority) and are male (again the majority) the probability of taking a second course in English is 14 percent less if he received a B than if he received an A and 20.3 percent less if he received a C than if he received an A.[15] Though the predicted

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[13] Course choice functions were estimated using random sub-samples of the Economics (and English) students in our sample. The coefficients on the grade variables became insignificant as n declined from 375 to 200.

[14] Responsiveness to grade is lower for males (and females) who intend *to* major in Economics than those who do not. Responsiveness to grades is higher for female than for males students in Economics 101.

[15] As in Economics, responsiveness to grade is lower for males (and females) who intend to major in English than those who do not. In contrast to Economics, males and females in English 101 do not differ in their degree

probabilities for students in introductory courses in Math, Political Science and Psychology are not presented in the table, the results are similar to Economics and English.

From the perspective of our policy simulations the most notable pattern to emerge from the predicted probabilities are the differences in responsiveness between students in low-grading and high-grading departments.[16] There are two differences, as illustrated by Figure 2: the slope of the course choice function with respect to grades is steeper in low- than in high-grading departments, but at each grade level the function for high-grading departments lies above that for low-grading departments.

On average, in low grading departments B students are 31.3 percent less likely to take another course than A students, while in high grading departments, B students are only 5.2 percent less likely to take another course than A students. C students in low grading departments are 36.3 percent less likely to take another course than B students; the figure is 7.3 percent in high grading departments.

2) Policy Simulations

We conducted simulations with the probabilities generated by our course choice functions as a means of assessing the implications for enrollments in various courses beyond the introductory level of the differences among departments in grading policy. In particular we address questions such as the following: how many more students would enroll in

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of responsiveness to grades.

[16]We pooled the regressions for the English and Economics departments and conducted likelihood ratio tests on the coefficients as a means of assessing the statistical significance of the difference in responsiveness. The null hypothesis that all the coefficients in the two regressions are the same is rejected at the 1% level. The null hypothesis that just the coefficients on grades are the same is rejected at the 5% level.

post-introductory courses in low-grading Economics if that department adopted the grading policy followed in introductory English?

Equation 1) provides the basis for our simulation procedure:

1) $n_{econ} = \Sigma_{ij}(p_{econ,i,j} \cdot g_{econ,i,j}) \cdot z_{econ,j}$

where n_{econ} = the number of students who took a second economics course;

$p_{econ,i,j}$ = the probability of an Economics student in group j who receives grade i taking another course, where there are four groups (males and females who intend to major; males and females who do not intend to major);

$g_{econ,i,j}$ = the proportion of economics students in group j who received grade i;

$z_{econ,j}$ = the number of students of type j in the introductory economics course.

Equation 2 simulates the number of students who would have taken a second course in Economics if the Economics department had adopted the English department grading distribution while students maintained the same pattern of responsiveness to grades:

2) $\hat{n}_{econ} = \Sigma_{ij}(p_{econ,i,j} \cdot g_{eng,i,j}) \cdot z_{econ,j}$

where $\hat{n}_{econ}$ = the predicted number of students who would have taken a second economics course;

$g_{eng,i,j}$ = the proportion of English students in group j who received grade i.

We have noted the difference in responsiveness to grades between students in high- and low-grading departments. Further, we present evidence in section V which suggests that responsiveness to grades by rational students depends on grading policy. This implies that if the Economics department adopted the grading distribution of the English department, students in Economics 101 would adopt the responsiveness of students in English 101. Equation 3 is therefore our preferred simulation:

$$3)\ \hat{n}_{econ} = \Sigma_{ij} (p_{econ,A,j} [1-(p_{eng,A,j} - p_{eng,i,j})/p_{eng,A,j}] \cdot g_{eng,i,j}) \cdot z_{econ,j}$$

where $p_{eng,i,j}$ = the probability of an English student in group j receiving grade i taking another English course.

The probability of A students taking a second course is consistently greater in high- than in low-grading departments. This simulation makes the conservative assumption that none of the difference between A students in Economics and English in the probability of taking a second course is a result of the difference in grading distributions.[17] With respect to Figure 2 the implicit assumption is that, as the grading distribution in Economics assumes the form of the distribution in English, the responsiveness of students in Economics shifts from a-a to a-c, rather than to b-b.[18]

Simulation 3) indicates that if Economics 101 grades were distributed as they are in English 101, there would be an increase of 11.9 percent in the number of students taking one or more courses beyond the introductory course in Economics. Roughly half of the increase is due to the direct effect of the change in grades and half to the change in responsiveness.

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[17] Other possible explanations for this difference include preferences and differences in expected returns beyond Williams.

[18] The assumption is conservative because some of the difference between a students in Economics and English in the probability of taking another course is likely to be due to the higher expected grades in English. Thus even simulation 3 underestimates the impact of grading policy on enrollments.

Conversely, if grades in English 101 were distributed as they are in Economics 101, the simulation indicates a 14.4 percent decline in the number of students taking one or more courses beyond the introductory course in English. In this case just over 1/5 of the decline is due to the direct effect of the change in grades.

The results of applying this method to the Math department are more striking. If the Math department adopted in its introductory course the English 101 grading distribution, our simulation indicates an 80.2 percent increase in the number of students taking at least one additional Math course! Ninety percent of the increase would be due to the direct effect of the change in grades. Alternatively, if the English department adopted the Math grade distribution, there would be a decline of 47 percent in the number of students taking one or more courses beyond the introductory course in English and about half of the decrease would be due to the direct effect of the change in grades.

There are two reasons why exchanging Math and English grade policies produces markedly greater impact on enrollments than does the exchange of Economics department and English department grading policies. Grades in Math are substantially lower than grades in the introductory Economics course, hence the direct impact of a change to the distribution of grades in English 101 is greater in Math. Moreover, Math students are more responsive to grades than are Economics students. The greater reduction in responsiveness for Math than for Economics students resulting from a shift to the English distribution of grades implies a greater increase in enrollments.

Our simulations underestimate the influence of differences among departmental grading policies in introductory courses on the pattern of enrollments in advanced courses. First, we have assumed that the probability of an A student's taking another course is unaffected by the distribution of grades. As we noted above, this is unlikely. If the Economics department adopted the grade distribution in English 101, the proportion of A students taking another Economics course would increase; making high grades easier to obtain in itself increases the incentive to take courses in that department.

Second, our simulations ignore the impact of grading distributions on the prior decision to take the introductory course itself. Just as expected grades influence the decision to take a second course, so they are likely to effect the decision to take an introductory course. We have no way of taking account of this effect of grading policy on enrollments, which may be substantial.

3) Results (Taking into Account Comparative Advantage)

To take account of comparative advantage, we add to our list of variables the following:

Rc-Rgpa = a continuous variable signifying the difference between the student's relative performance in the introductory course and his relative performance in all his courses, as measured by his GPA up to and including the semester in which the introductory course is taken. Rc is defined to be the percentage of students who receive a grade in that course less than or equal to the grade the student receives; Rgpa is the percentage of students whose GPA is less than or equal to that of the student. Our expectation is that this variable will have a positive coefficient.

The sample size necessary for significant results is increased by the inclusion of the comparative advantage variable; exercises with the largest departments indicate sample sizes below 300 produce insignificant results.[19] Therefore, our analysis focuses on the two departments with more than 300 observations. Table 5 presents results from our probit analysis of Economics and English, and Table 6 presents derivative

[19] As with our earlier assessment of sensitivity to sample size (see footnote 12), this exercise involved a random exclusion of cases.

predicted probabilities,

There are two notable findings. First, the comparative advantage variable is significant in Economics (and almost so in English), and of the expected sign; as a student's rank in the introductory class increases relative to her GPA rank, so her probability of taking a second course increases. Despite discrepancies across departments in grading policies, students are able to derive from their grades a signal of comparative advantage. And they choose to respond to that signal.

Second, the probabilities derived from the variables signifying absolute grade are virtually unchanged. Taking account of comparative advantage appears only marginally to reduce the incentive effects of grades. While students do take account of comparative advantage, the incentive effects of absolute grades on course choice are far more powerful. Where the incentive effect of grades and the comparative advantage signal are in conflict, the incentive effect will dominate. A change in a student's grade in Economics from B to A would increase his indicator of comparative advantage in Economics, and as a consequence would increase his probability of taking another course by about 4.5 percent. That same change in grade would increase his grade incentive to take a second Economics course, increasing the probability of doing so by about 15 percent.

Taking account of comparative advantage does not alter our earlier conclusions regarding the importance of grading policy, as simulations based on probits including the comparative advantage variable illustrate.[20] Our earlier simulations indicated that, if the Economics department adopted

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[20] Changing grade distributions somewhat alters signals of comparative advantage. Our simulations took account of this effect.

the English 101 grade distribution, the number of students taking a second Economics course would increase by 11.9 percent; taking account of comparative advantage reduces this increase to 9.7 percent. Similarly, if the English department adopted the Economics 101 grade distribution, accounting for comparative advantage would reduce the decline in enrollments in a second course from 14.4 percent to 12.1 percent.

V. POlicy Implications and Conclusion

Grades strongly influence course choice. The influence remains powerful after accounting for student response to signals of comparative advantage contained in grades. Over the past two decades the pace of grade inflation has varied among departments. As a consequence there are, at present, high-grading departments and low-grading departments. Our results indicate that enrollments are being skewed towards the high-grading departments; students who are relatively stronger in Economics than in Political Science, and are aware of their comparative advantage, nevertheless are more likely to choose additional courses in Political Science than in Economics, as a means of maximizing their grade point average. This division of the college into high- and low-grading departments was not conscious policy but the result of decisions by individual departments and instructors. The consequent impact on the pattern of enrollments is an unintended side effect of this unplanned division. There are, as noted, conflicts between implicit grading policies and the explicit policy of the institution. To the extent that Science departments are among the low-grading departments, the skew in enrollments resulting from divergent grading policies is in direct opposition to attempts to increase enrollments in the sciences.

The policy implication seems clear: arbitrary differences in grading policies among departments should be eliminated (although there may well be reasons colleges choose to have planned differences in grading policies). Our findings are not neutral, however, with respect ***to*** the issue of whether low grading (high variance) departments should raise their grades or high grading (low variance) departments should lower their grades.

Students in high-grading departments have been shown to be consistently less responsive to grades than students in low-grading departments. This appears to be a consequence of the necessarily more compressed distribution of grades in high-grading departments; the compression results in grades that provide less accurate signals of comparative advantage and are more random.

Two stylized facts support this conclusion. First, grades in high-grading departments are less accurate predictors of subsequent performance. Comparing grades received in the first and second courses we found the average correlation to be .6147 and highly significant in three low-grading departments in our sample, but only .3681 and occasionally insignificant in five high-grading departments. This suggests that a student's expected grade in the high-grading departments will be more influenced by the mean grade than by the grade received.

Second, various indicators of ability, prior level of skill, and motivation are poor predictors of grades in high-grading departments. Sabot and Wakeman-Linn (1988), estimate production functions to determine what factors contribute to success in introductory courses. In low-grading Economics the model works well; it explains between a third and a half of the variance in final grades. Among the variables shown to have a significant influence on performance are Math and Verbal SAT's, education level of parents, the student's need for achievement, performance in high school and sibling rank. By contrast, in high-grading English, the R^2's are between .05 and .l0, and wit4 the exception of Verbal SAT's, no variable is shown to be significant.

Why do the more compressed grading distributions in high-grading departments convey cruder signals? It is partially a result of the fewer grading categories available to instructors; fewer categories of necessity imply cruder distinctions. Also, instructors may grade less carefully; if there is little difference in the grade received by the top and the bottom students in the class, there is less incentive for the instructor, and less pressure from students, to make accurate distinctions among students.

If the aim of grading is to convey information to students about their relative strengths and weaknesses, then grading distributions with more dispersion are preferable to those with less dispersion. Hence, lowering the grades in high-grading departments as a means of achieving uniformity in grading policies is preferable to raising grades in low-grading departments. Our results indicate that such a change to a uniform grading policy may be an effective response to Ernest Bloch's entreaty to "persuade more students to study science and engineering."

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Figure 1

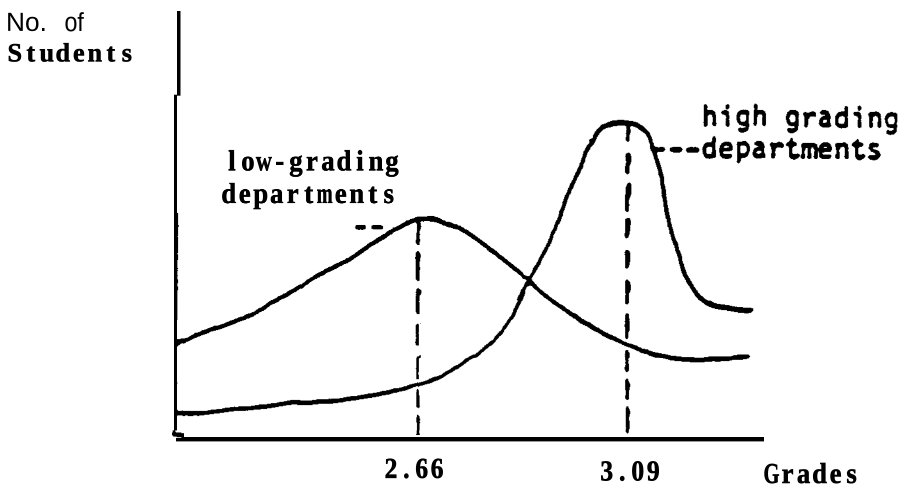

Figure 2

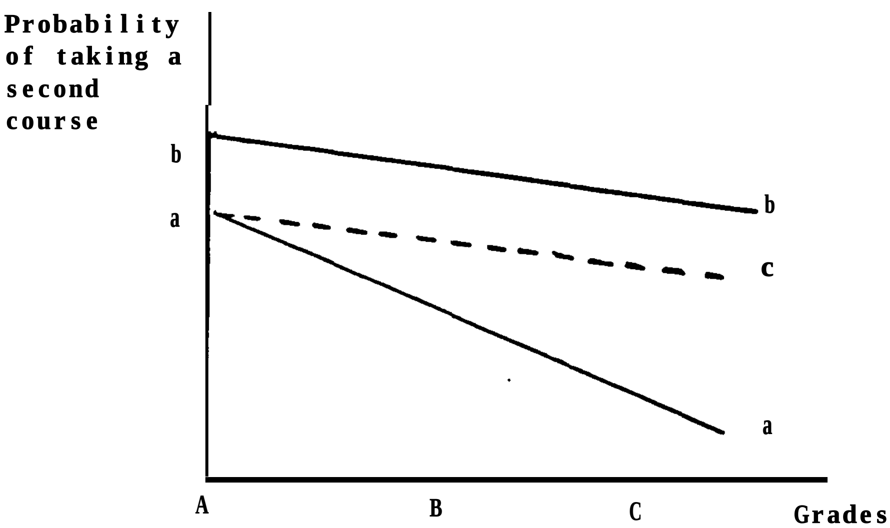

Table 1: Mean Grades and Their Distributions in Introductory Courses in Eight Departments, 1962-3 and 1985-6.

	mean grade	standard deviation	% below B-	%Above B+
		1962-63		
Departments:				
Art	2.62	.7033	32%	9%
Economics	2.40	.9600	49%	17%
English	2.58	.6767	48%	10%
Math	2.09	1. 063	65%	9%
Music	2.74	.6600	37%	14%
Philosophy	2.38	.7200	46%	13%
Political Science	2.43	.6967	55%	8%
Psychology	2.64	.7933	44%	15%
Aggregate Average	2.49	.7858	47.0%	11.9%
Standard Deviation	.1916			
		1985-86		
High Grading Departments:				
Art	3.00	.6500	20%	23%
English	3.13	.5467	12%	25%
Music	3.26	.5733	17%	28%
Philosophy	2.94	.6067	17%	20%
Political Science	3.10	.5300	19%	17%
Average	3.09	.5800	17%	22.6%
Standard Deviation	.1105			
Low Grading Departments:				
Economics	2.67	.7333	42%	15%
Math	2.61	1.0033	44%	20%
Psychology	2.71	.8733	37%	17%
Average	2.66	.8700	41%	17.3%
Standard Deviation	.0411			
Aggregate Average	2.93	.6887	26%	20.6%
Standard Deviation	.2239			

Table 2: Mean Value of Independent Variables By Course

	% A's	% B's	% C's	% D's	% Female	% Intended Majors	Needed for Achievement (Standard Deviation)
High Grading Departments:							
English	19.6	65.2	14.6	0.6	33.7	1.9	31.8 (23.6)
Political Science	17.8	64.2	10.7	5.3	33.7	26.7	33.6 (23.9)
Low Grading Departments:							
Economics	14.4	44.5	36.3	4.8	37.1	15.7	32.6 (23.6)
Math	21.2	27.1	26.4	26.4	40.3	10.1	32.7 (23.1)
Psychology	16.0	44.1	32.4	7.5	44.1	9.0	34.9 (22.8)

Notes: Discrepancies between Table 1 and 2 result from the fact that all students taking the course are included in Table 1, while only those in our sample are included in Table 2.

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Table 3: Probit Course Choice Function: The Influence of Grades

	Economics	English	Math	Political Science	Psychology
Constant	.1026	.6266***	.2633	.4134	-.1396
	(.515)	(2.67)	(1.17)	(1.64)	(-.470)
Sex	-.3294**	-.0936	-.1421	-.6284***	.2998
	(-2.38)	(.603)	(-.743)	(-3.33)	(1.57)
Intended Major	.9526***	.7388***	1.115***	.7261***	.6428*
	(4.78)	(2.84)	(4.42)	(3.29)	(1.87)
Need For Achievement	.0075***	-.0013	-.0023	-.00338	.00398
	(2.66)	(-.399)	(-.532)	(-.856)	(.943)
B	-.436**	-.387*	-.506**	.195	-.174
	(-2.19)	(-1.83)	(-2.06)	(.857)	(-.629)
C	-.6066***	-.5237*	-.8826***	-.0751	-.2258
	(-.294)	(-1.96)	(-3.86)	(-.251)	(-.770)
D	-.8828**	5.156	-1.579***	-5.347	-.3056
	(-2.49)	(.002)	(-4.94)	(-.002)	(-.740)
Significance Level	.82*E-11	.0098	.15*E-12	.0004	.2086
Predictions (correct/N)	256/375	194/302	179/243	154/227	115/188

T-Statistics in Parentheses

* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level

Table 4: Probability of Taking Additional Courses, By Grade

Economics

	A	B (% Decline from A)	C (% Decline from A)	D (% Decline from A)
Intending to Major, Male	.900	.798 (11.3%)	.745 (17.2%)	.647 (28.7%)
Intending to Major, Female	.797	.691 (13.3%)	.636 (20.2%)	.527 (33.8%)
Not intending to Major, Male	.534	.444 (18.2%)	.387 (27.6%)	.287 (46.2%)
Not intending to Major, Female	.481	.378 (21.5%)	.324 (32.6%)	.219 (54.5%)

English

	A	B (% Decline From A)	C (% Decline From A)
Intending to Major, Male	.953	.861 (9.7%)	.819 (14.0%)
Intending to Major, Female	.987	.896 (9.2%)	.855 (13.4%)
Not intending to Major, Male	.722	.621 (14.0%)	.575 (20.3%)
Not intending to Major, Female	.761	.660 (13.3%)	.614 (19.3%)

Note: There is no D category for English, because only 2 people in our sample received below C - in English

Table 5: Probit Course Choice Functions: The Influence of Grades and Comparative Advantage

	Economics	Economics	English	English
constant	.0887	.1702	.5228	.5403**
	(.410)	(.794)	(2.16)	(2.26)
Sex	-.1696	-.2361	.0914	.0838
	(-1.14)	(-1.62)	(.553)	(.506)
Intended Major	.8126***	.8610***	.7593***	.7594**
	(4.00)	(4.28)	(2.90)	(2.91)
Need For Achievement	.00612**	.00593**	-.0010	-.0009
	(2.09)	(2.04)	(-.305)	(-.270)
B	-.3584*	-.4362**	-.3032	-.3269
	(-1.69)	(-2.08)	(-1.39)	(-1.52)
C	-.4281*	-.5526**	-.3123	-.3282
	(-1.86)	(-2.43)	(-1.04)	(-1.11)
D	-.6434*	-.8216**	5.50	3.560
	(-1.699)	(-2.21)	(.002)	(.126)
Comparative Advantage	.00912***		.0043	
	(2.966)		(1.59)	
Comparative Advantage Squared		**.0001***		.00007
		(1.67)		(1.55)
Significance Level	.96*E-11	.52*E-9	0.0070	0.0073
Predictions Correct/Total	245/375	243/375	196/302	194/302

T-statictics Parentheses
* Significarrt at the 10% level
** Significant at the 5% level

Table 6: Probability of Taking Additional Courses, by Grade Controlling for Comparative Advantage (Squared)

Economics

	A	B (% Decline from A)	C (% Decline from A)	D (% Decline from A)
Intending to Major, Male	.923	.814 (11.8%)	.785 (14.9%)	.718 (22.2%)
Intending to Major, Female	.823	.714 (13.3%)	.685 (16.8%)	.617 (25.0%)
Not intending to Major, Male	,564	.462 (18.1%)	.434 (23.0%)	.371 (34.2%)
Not intending to Major, Female	.510	.406 (20.4%)	.378 (25.9%)	.314 (38.5%)

English

	A	B (% Decline From A)	C (% Decline From A)
Intending to Major, Male	.933	.861 (7.8%)	.861 (7.8%)
Intending to Major, Female	.964	.892 (7.4%)	.892 (7.4%)
Not intending to Major, Male	.692	.614 (11.3%)	.614 (11.4%)
Not intending to Major, Female	.740	.660 (10.9%)	.614 (10.9%)

Note: There is no D category for English, because only 2 people in our sample received below C - in English