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ABSTRACT

This study makes use of detailed student-level data from eight cohorts of first-year students at Northwestern University to investigate the relative effects of tenure track/tenured versus non-tenure line faculty on student learning. We focus on classes taken during a student's first term at Northwestern, and employ a unique identification strategy in which we control for both student-level fixed effects and next-class-taken fixed effects to measure the degree to which non-tenure line faculty contribute more or less to lasting student learning than do other faculty. We find consistent evidence that students learn relatively more from non-tenure line professors in their introductory courses. These differences are present across a wide variety of subject areas, and are particularly pronounced for Northwestern's average students and less-qualified students.

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I. Introduction

The role of tenure in American higher education has been reduced dramatically in recent decades. In 1975, 57% of all faculty (excluding graduate students) were in the tenure system; by 2009 that figure had been cut almost in half to 30%.[1] Some observers predict that the share of tenured/tenure track faculty will bottom out at between 15-20%, with tenure being largely limited to the flagship public and private research universities and the wealthiest of the liberal arts colleges.[2]

There is evidence that this trend accelerated after January 1, 1994, when mandatory retirement for faculty was abolished by federal law. Ehrenberg (2012) reports that between 1995 and 2007, the share of part-time faculty rose at almost all institutional types while, among full-time faculty, the movement away from the tenure system has quickened. Especially notable is the rise of the full-time, non-tenure track professor at Ph.D. granting universities. Their representation within the entire group of full-time faculty went from 24% to 35% at public doctoral institutions and from 18% to 46% at private non-profit doctoral institutions.

This trend has led some observers to lament the potential blow to academic freedom dealt by the decline of tenure and to focus on the often challenging employment conditions under which many non-tenure track faculty work (see, for example, June (2012) and Wilson (2010)). Further, McPherson and Schapiro (1999) point to efficiency gains from tenure; they outline its positive role in influencing the distribution of authority within colleges and universities.

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[1] The American Association of University Professors website presents its Contingent Faculty Index summarizing data from the IPEDS Fall Staff Survey.

[2] There has been ongoing speculation about this topic in the educational press. Wilson (2010) is a good example.

While those considerations certainly have relevance in evaluating the impact of the growing demise of the tenure system, there is an educational outcome that may be measured more directly: do undergraduates taught by faculty outside the tenure system learn as much as those taught by tenured/tenure track faculty?

There have been a number of attempts to answer this question. On a national level, Ehrenberg and Zhang (2005) present evidence that hiring more part-time and non-tenured faculty lowers institutional graduation rates. This result is bolstered by Bettinger and Long (2006), who find a similarly negative effect on aggregate levels of persistence when they focus specifically on part-time adjuncts. These types of results indicate that even if non-tenure track professors are more popular with students – perhaps because of classroom behaviors that maximize student evaluations but not student learning – they nonetheless might not be successful in improving students' longer-term prospects.[3] To date, however, there exists little evidence on the effects of faculty tenure track status on genuine student learning.

The limited existing evidence on the relative performance of tenure track/tenured professors versus faculty outside the tenure system makes it difficult for college and university decision-makers to determine the optimal staffing of their classrooms. This is particularly relevant for research universities, which face a multi-tasking problem of maximizing an objective function that includes both the production of cutting-edge research and the provision of outstanding undergraduate teaching. While the paper closest to this one in the literature, Bettinger and Long (2010), presents a novel approach to measuring the effects of tenure line versus other instruction, their analysis is largely

[3] Carrell and West (2010) show that instructors who have better student evaluations tend to actually produce lower levels of "deep learning."

centered on institutions whose principal purpose is teaching. In addition, while they find some evidence that non-tenure track faculty induce student interest in a subject, as measured by the likelihood that students take additional courses in that subject, they are not able to study how students perform in subsequent classes – an ideal way to see whether instructional quality has a lasting impact. When one only observes student evaluations of their instructors, or the likelihood that students take more classes in the subject, it is difficult to judge whether one type of instructor is genuinely better at education – that is, do they produce more "deep learning" in the words of Carrell and West (2010) – or just whether they are more popular. Hoffmann and Oreopoulos (2009) evaluate teacher quality in a Canadian research university setting but, like Bettinger and Long (2010), only observe the likelihood that students take additional classes in the same subject, rather than observe their academic performance in future classes.[4] They find no evidence that non-tenure track faculty are either better or worse at inspiring students to take more classes in their subjects. Carrell and West's (2010) analysis of professor quality examines follow-on classes, and has outstanding internal validity as it relies on the random assignment of students to classes, but it is also based at an institution (the U.S. Air Force Academy) where teaching, rather than research, is the dominant function. In addition, Carrell and West do not directly take on the question of whether non-tenure track faculty make for better or worse instructors.

[4] Hoffmann and Oreopoulos do study student performance in courses with standardized tests shared across individual class sections in the same term as their measure of instructor quality, but they do not perform a head-to-head comparison of lecturers versus tenure-track faculty members (their comparison controls for a measure of instructor quality) and they are not able to follow students into future classes to gauge "deep learning."

We bring to bear the first evidence within the research university setting regarding the relative effect of professors within the tenure system as opposed to those outside it where we can observe student performance in subsequent classes in the same subject. Specifically, we examine the initial classes taken by first-term freshmen in eight cohorts of undergraduates at Northwestern University, a mid-sized research university that is one of the twenty six private universities among the sixty two members of the Association of American Universities and which consistently ranks amongst the most selective undergraduate institutions in the United States. Our identification strategy involves observing whether a student who takes, say, introductory economics with a faculty member outside of the tenure system and introductory political science with a tenure track professor in his or her first term at Northwestern is (1) relatively more likely to take a second political science class than another economics class, and (2) conditional on taking more classes in both subjects, more likely to perform better in the political science class than in the economics class.

The answers to these questions should shed light on one of the most important outcomes relating to the dramatic change in the professorate – its impact on student learning.

II. Data and methods

We make use of data on all Northwestern University freshmen who entered between fall 2001 and fall 2008, a total of 15,662 students.[5] Our principal model for

[5] We limit our analysis to students who entered Northwestern in fall 2008 or before to give students sufficient time to complete their studies. 98 percent of students who ultimately earn an undergraduate degree at Northwestern do so within five years.

estimating the relationship between the tenure track/tenured versus non-tenure track status of a student's instructor and that student's level of learning in that subject is

$$G_{icst+1} = \alpha_i + \gamma_{cst+1} + \beta L_{ist} + \varepsilon_{ist} ,$$

where, for student i taking a first-term freshman-level class in subject s at time t, L represents whether the class taken is taught by a non-tenure track faculty member and G represents that student's grade (on a four point scale) the next time the student takes a class in subject s. The subscript c pertains to a specific instructor-class-term-year combination, so the inclusion of a fixed effect γ_{cst+1} means that we are comparing the relative performance in subsequent classes in subjects A and B of a student who took a class in subject A with a non-tenure track faculty member and subject B with a tenure track/tenured professor during his or her first term at Northwestern, holding constant all of the specifics of the subsequent classes in subjects A and B. This means that we are obtaining our identification from subjects where some first-term freshmen take their first classes from a tenure line professor and other first-term freshmen take their first classes from a non-tenure track faculty member. We also estimate linear probability models without the next-class fixed effect but with student fixed effects where the dependent variable is whether the student takes another class in subject s. We cluster standard errors at the student level to account for potential within-student error correlation.

We obtained data from several offices at Northwestern University for the purposes of this analysis. The registrar's office provided us with student transcript data, including student grades, subjects, and instructor information; the office of admissions provided us with information about the student's initial declared major and academic qualifications; and individual academic departments as well as the office of human

resources confirmed the tenure track/tenured versus non-tenure line status of all instructors.[6] Table 1 presents some descriptive statistics of the population of Northwestern students. Northwestern evaluates freshman applicants on a five-point academic indicator scale, where 1 is the strongest indicator and 5 is the weakest; 17% of entering freshman have an academic indicator of 1, 57% have a 2, and 26% have an academic indicator of 3 or higher (with the overwhelming majority of these students having an indicator of 3). The average SAT score (or converted ACT score) for beginning freshmen was 1392, and 17% of entering freshmen had not declared a desired major at their time of entry to Northwestern. In 74% of cases, students took another class in a subject that they took during their first term of freshman year, and when they took the subsequent class, they averaged a grade of 3.39 on a 4-point scale.

We limit our analysis to first-term freshman students because our identification assumption is that students select their first classes with limited knowledge about instructor quality or characteristics. We further condition on student fixed effects because we are concerned that students who take classes with one type of instructor versus another may be relatively strong or weak students. The majority of students take at least one course with a non-tenure track faculty member and at least one course with a tenure line professor during their first term at Northwestern; 20.1% of students take classes only with tenure track/tenured professors and 3.8% take classes only with non-tenure line faculty.

[6] We exclude graduate students and visiting professors who hold faculty appointments at other institutions from our analysis. Our results are fundamentally unchanged if we include these two groups, regardless of whether we assign them to the tenure track/tenured category or to the non-tenure line category of instructor.

The third through seventh rows of Table 1 break down descriptive statistics by the combination of a student's classes taught by tenure line versus non-tenure track professors. The small number of students who take only classes taught by non-tenure track faculty tend to be somewhat weaker than the other students; 36% come from the bottom ranks of students (as opposed to 26% for the other 96.2% of students), and their SAT scores average 1362 (as opposed to 1393 for the other students, and 1392 overall). But among the 96.2% of students who take at least one class from a tenure line faculty member, there is no apparent relationship between the division of tenure track/tenured versus non-tenure track classes and initial preparation. All four groups have 17% with academic indicator 1, 25% to 27% with academic indicator 3 or above, and SAT scores average between 1391 and 1395 depending on the group.

On the other hand, and foreshadowing our results, the four groups differ substantially in terms of their outcomes. The probability that a student takes another class in the subject generally increases with the number of non-tenure track taught classes that the student takes in his or her first term at Northwestern, as does the grade earned in the subsequent class. This latter pattern is especially remarkable, given that non-tenure track faculty appear to induce relatively marginal students, who might have been expected to perform worse in subsequent classes, to take those classes nonetheless. The bulk of this paper explores these relationships in a more systematic manner.

III. Estimated effects of non-tenure track faculty on subsequent performance

Table 2 presents our basic results. The unit of analysis is the student-class pair for first-term freshmen at Northwestern. To provide a basis for comparison, we report basic

OLS results in the first row of the table, and then successively add layers of fixed effects. The leftmost columns of the table are for all classes taken by all students, while the second set of columns restrict the analysis to the 89.9% of classes taken outside of a student's intended major.[7]

As can be seen in the first row of Table 2, the simple relationships between non-tenure track status of the teacher of a class and a student's likelihood of taking another class and the grade obtained in that next class in a subject are positive and strongly statistically significant. However, because these relationships could reflect unmeasured student characteristics, we compare subjects taken by the same student and estimate student fixed effects models; the estimated relationships remain reasonably large in magnitude – a non-tenure track faculty member increases the likelihood that a student will take another class in the subject by 7.3 percentage points (9.3 percentage points when limited to classes outside the student's intended major) and increases the grade earned in that subsequent class by slightly more than one-tenth of a grade point (with a somewhat greater impact for classes outside of the intended major).[8,9] We can further

[7] We show separate results for classes outside the student's major to isolate the group of students for whom the choice to take additional classes in the subject is most plausibly impacted by the quality of the first professor they encounter.

[8] Almost all classes taught by non-tenure track faculty at Northwestern are taught by those with a longer-term relationship with the university. When we exclude the temporary lecturers and adjuncts, the estimates barely change. Trimming the "one-off" lecturers and adjuncts, we find that for all students and all classes, a non-tenure track faculty member is estimated to increase the likelihood that a student takes another class in the subject by 7.5 percentage points and increases the grade by 0.12 grade points. The results are similarly nearly identical for all other rows in the table.

[9] The results are also robust when we limit our analysis to each of the specific colleges (there are six undergraduate colleges at Northwestern) where the classes were offered. In student fixed effects regressions, the relationship between non-tenure track status and the probability that a student will take another class in the subject is positive and statistically significant in three of the four colleges (arts and sciences, music, and engineering, but not

restrict our analysis to students with "no choice" – classes that are always taught either by tenure track/tenured faculty or by non-tenure line faculty during the entire time period considered. In this restriction, we explicitly eliminate the possibility that a student is "shopping" across instructors teaching a certain class. This occurs in 35.2% of classes taken by first-term freshmen. The results are quite similar whether or not we make this restriction.[10]

In the last row of Table 2 we introduce our preferred model specification – one with both student fixed effects and next-class fixed effects. In this model we cannot study the relationship between non-tenure track status and the likelihood of taking another class in the subject because by default all students have taken another class in the subject. Moreover, we cannot limit ourselves to students with "no choice" because we must compare those who took the introductory class in subject A with a non-tenure track faculty member to those who took that same class with a tenure line professor to have variation when we control for next-class fixed effects. When we estimate this highly-parameterized model, we still find that having an initial experience in a subject with a

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communications) that teach almost all of the first-semester freshman students, and the relationship between non-tenure track status and the grade earned in the next class in the subject is positive and statistically significant in all four colleges. In section IV of the paper we also break down our results by the grading standards of the subjects and the qualifications of students who intend to major in those subjects.

[10] We can also limit ourselves to the small number of cases – 17% of students, 15% of student-class observations – in which a student declares no intended major preference at the time of entry to Northwestern. The results for this very restricted group are similar to those reported in the table: in models with student fixed effects, the coefficient on non-tenure track faculty is 0.120 (0.138 for students with "no choice") when the dependent variable is the probability of taking another class in the subject and 0.089 (0.088 for students with "no choice") when the dependent variable is the grade in the next class taken in the subject. All of these coefficient estimates are statistically significant at the five percent level or better. However, we do not have sufficient power to estimate our preferred specification – with both student fixed effects and next-class fixed effects – with the restricted set of students who are undeclared at the time of entry.

non-tenure track faculty member increases a student's performance in subsequent experiences with the subject. The point estimates are around half the size of those found in the student fixed effects only specification, but are still statistically significant and sizeable in magnitude given that the typical student's grade in the next class is a robust 3.39 out of 4.

Because Northwestern relies somewhat more on non-tenure line faculty today than it did a decade ago,[11] and because Northwestern freshman classes have become progressively more qualified over time, we also investigate whether the estimated impact of having a non-tenure track faculty member are trending over time. (Of course, we are estimating all models with student fixed effects and next-course fixed effects, which would rule out the primary effects of temporal trends). As can be seen in Figure 1, when we estimate our highly-parameterized model year-by-year we still observe a positive relationship between having a non-tenure line faculty member and subsequent grades in the subject in every year. In addition, there is no evidence of a temporal pattern in these results, suggesting that any over-time trends in the use or utility of non-tenure track versus tenure line faculty members is not driving the findings that we report.[12]

[11] The typical freshman in fall 2001 took 38.9% of first-term courses from non-tenure line faculty, as compared with 41.6% for the typical freshman in fall 2008.

[12] One might also be concerned that changing grading standards over time are potentially driving our results. However, grading standards have remained quite flat at Northwestern during this time period. While the average next-course grade did rise modestly from 3.33 for fall 2001 entrants to 3.41 for fall 2008 entrants, student qualifications also rose during this time period, with SATs increasing from 1376 for fall 2001 entrants to 1421 for fall 2008 entrants, so that average qualifications-adjusted grades actually fell slightly over our time horizon. We describe in section IV our method for adjusting grades for student qualifications.

IV. Differences by subject and student qualifications

Are the results the same for all students and for all subjects, or are they present in some cases but not in others? In order to investigate these questions, we next divide the course subjects along two dimensions. First, we split the subjects into thirds based on the SAT scores of incoming students who intend to major in that discipline; we interpret this as a measure of the perceived challenge of a subject by incoming students. Second, we split the subjects into thirds based on a measure of the grading standards of faculty teaching that subject. We calculate grading standards by regressing grades against observed student qualifications;[13] we call the departments that award higher-than-predicted grades "higher-grading subjects."[14] These two measures are highly negatively correlated – the correlation between the average SAT scores of intended majors in a department and the grades that the department awards is -0.69 – but there is enough of a discordance between the two to make reporting both measures meaningful. For instance, though the highest-grading subjects generally fall into the low-SAT subject group, 33.3% of the subjects with the highest grades are in the middle-SAT group, and 4.1% are in the highest-SAT group.

We report the results of these splits for our preferred model specification – with student fixed effects and next-class fixed effects – in Table 3. As can be seen, the estimated effects of non-tenure line instructors for an introductory course are positive for all sets of subjects, regardless of grading standards or perceived challenge. That said, the estimated effects are strongest for the subjects with tougher grading standards (that is, the

[13] Betts and Grogger (2003) and Figlio and Lucas (2004) measure grading standards in similar ways, by comparing grades awarded to some external benchmark of predicted grades.

[14] We are restricted by the registrar from identifying specific departments in this paper.

relatively low-grading classes) and for those that attract the most qualified students. The estimated effect of having a non-tenure line faculty member on subsequent grades is more than twice as large in the high-SAT subjects as in the low-SAT subjects, and is also substantial when comparing the hardest-grading to the easiest-grading subjects.

This pattern of results could either be due to the effects being strongest for these groups of classes or because of ceiling effects – perhaps in the easiest-grading subjects most students earn top grades and there is little opportunity for distinction. As can be seen in Table 4, it's not the case that everyone earns a top grade, even in the relatively easy-grading subjects. This table presents the percentage of students earning a grade of A- or A in each group of subjects, broken down by the student's academic indicator, the admission office's pre-enrollment prediction of a student's academic success at the university. We see that in the easiest-grading third of subjects, 13% of students with an academic level 1 earn grades of B+ or lower compared with 28% of level 3+ students.[15] While there is certainly more room for grade dispersion in the toughest-grading subjects, where 45% of level 1 students earn a B+ or lower and 78% of level 3+ students do the same, the point is that in no subject and for no group of students is a grade of A or A- a foregone conclusion. Nonetheless, while we cannot say for certain whether the stronger results for harder-grading subjects and those attracting higher-rated students is due to the effects of faculty status truly being greater for those subjects or whether there is simply more room for grade dispersion in those subjects, the key finding is that we observe

[15] It is important to recall that even the relatively marginal students at Northwestern are still very highly qualified. The average SAT (or ACT equivalent) amongst those students with an academic index of 3+ is still a very robust 1316.

advantages for non-tenure line faculty across all subjects, regardless of our measure of perceived challenge or grading standards.

In Table 5 we split the population of students by student academic preparation and then by both academic preparation and subject type. While we find that the best-prepared students at Northwestern appear to perform about the same regardless of whether their first class in the subject was taught by a non-tenure line or tenure track/tenured professor, the estimated positive effect of having a non-tenure line faculty member is present and strongly statistically significant for all other groups of students. Moreover, there appears to be an interaction between class type and student qualifications: while there is no apparent relationship between instructor type and student outcomes for the top-rated students, a clear pattern emerges for the other two groups of students. For students with academic indicator 2, the estimated relationship between instructor type and subsequent outcomes is about the same for the subjects attracting relatively low and mid-level students but substantially larger for the subjects attracting the most-qualified students, and about the same for easiest and middle-grading subjects but considerably larger for the toughest-grading subjects. For students with academic indicator 3+, the monotonic relationships are even more pronounced, with by far the strongest estimated results of all observed for the relatively marginal students at Northwestern taking the toughest-grading subjects and those attracting the most qualified students. Note from Table 4 that the gap in the percentage receiving an A or A- between the toughest-grading and the easiest-grading subjects is 49.7 percentage points for those with academic indicator 3+, but nearly as high (44.3 percentage points) for academic indicator 2 and still quite high (32.9 percentage points) for academic indicator 1.

Therefore, this pattern of estimated effects of instructor type broken down by student qualifications and subject type suggests that these findings are likely due to genuinely differential effects of instructor type across subject and student preparation, rather than just pure ceiling effects or differential likelihood of earning higher grades in some subjects versus others.

In sum, we estimated models with both student fixed effects and next-class fixed effects, and found strong and consistent evidence that Northwestern faculty outside of the tenure system outperform tenure track/tenured professors in introductory undergraduate classrooms. Moreover, the results held for all subjects, regardless of grading standards or the qualifications of the students the subjects attracted, though we found that the results were particularly strong for tougher-grading subjects and those that attracted the most qualified students. In addition, we found that the apparent benefits of taking classes from non-tenure track faculty were enjoyed more by the less academically-qualified students than by the more academically-qualified students – the biggest gains to faculty outside the tenure system were for relatively weak students taking courses in the toughest-grading subjects.

V. Conclusion

Our findings suggest that non-tenure track faculty at Northwestern not only induce students to take more classes in a given subject than do tenure line professors, but also lead the students to do better in subsequent coursework than do their tenure track/tenured colleagues.

How generalizable are these results? Because a key part of our identification strategy is to limit our analysis to first-term freshman undergraduates, the evidence that non-tenure track faculty produce better outcomes may not apply to more advanced courses. Further, Northwestern University is one of the most selective and highly-ranked research universities in the world, and its ability to attract first-class non-tenure track faculty may be different from that of most institutions. Its tenure track/tenured faculty members may also have different classroom skills from those at other schools. Finally, Northwestern students come from a rarefied portion of the preparation distribution and are far from reflective of the general student population in the U.S. That said, our findings that the benefits of taking courses with non-tenure track faculty appear to be stronger for the relatively marginal students at Northwestern indicate that our findings may be relevant to a considerably wider range of institutions.

There are many aspects relating to changes in the tenure status of faculty – from the impact on research productivity to the protection of academic freedom. But certainly learning outcomes are an important consideration in evaluating whether the observed trend away from tenure track/tenured towards non-tenure line faculty is good or bad. Our results provide evidence that the rise of full-time designated teachers at U.S. colleges and universities may be less of a cause for alarm than some people think, and indeed, may actually be educationally beneficial. Perhaps the growing practice of hiring a combination of research-intensive tenure track faculty members and teaching-intensive lecturers may be an efficient and educationally positive solution to a research university's multi-tasking problem.

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Table 1: Descriptive statistics, by number of classes taken with non-tenure line faculty in fall quarter of freshman year

	Count	Academic indicator = 1	Academic indicator = 2	Academic indicator = 3+	Mean SAT score	Undeclared at entry	Took another class in subject	Mean grade in next class in subject
Full sample	**15,662**	**17%**	**57%**	**26%**	**1392**	**17%**	**74%**	**3.39**
By number of non-tenure line classes								
0 non-tenure line	3,144	17%	56%	27%	1391	13%	72%	3.24
1 non-tenure line	5,978	17%	58%	25%	1395	17%	72%	3.32
2 non-tenure line	4,019	17%	56%	27%	1395	20%	74%	3.41
3+ non-tenure line	1,925	17%	57%	26%	1392	14%	82%	3.62
Only non-tenure line	596	14%	51%	36%	1362	19%	77%	3.46

Notes: Data include all students who enrolled in their first quarter at Northwestern University during the fall terms between 2001 and 2008. Northwestern evaluates freshman applicants on a five-point academic indicator scale, where 1 is the strongest indicator and 5 is the weakest. SAT score is on the 1600 point scale and converted ACT score is used where applicable.

Table 2: Estimated effects of having a non-tenure line faculty member on subsequent course-taking and performance in the subject: Linear probability models

	All classes		**Classes outside of intended major (89.9% of classes)**	
	Probability of taking next class in subject	Grade in next class taken in subject	Probability of taking next class in subject	Grade in next class taken in subject
OLS regression	0.077***	0.185***	0.085***	0.218***
	(0.004)	(0.007)	(0.004)	(0.008)
Regressions with student fixed effects				
All first year fall classes	0.073***	0.120***	0.093***	0.159***
	(0.005)	(0.009)	(0.006)	(0.010)
Students with no choice (35.2%)	0.108***	0.095***	0.139***	0.148***
	(0.009)	(0.015)	(0.010)	(0.018)
Regressions with student fixed effects and next-class fixed effects				
All first year fall classes	N/A	0.060***	N/A	0.079***
		(0.007)		(0.008)

Notes: Data include all students who enrolled in their first quarter at Northwestern University during the fall terms between 2001 and 2008. Each cell represents a different model specification. Standard errors adjusted for clustering at the student level are reported in parentheses beneath coefficient estimates. Next-class information is recorded for the first time a student takes a second class in a given subject area. Intended majors are recorded by the Office of Admissions. Coefficients marked ***, **, and * are statistically distinct at the 1, 5, and 10 percent levels, respectively. Data come from 15,662 students taking 56,599 first-quarter classes.

Table 3: Estimated effects of having a non-tenure line professor on subsequent performance in the subject: Differential effects by major "challenge"; Student fixed effects and next-class fixed effects

	All classes	**Classes outside declared major**
Subjects divided by SAT score of students (divided into thirds)		
Highest SAT subjects	0.084***	0.099***
	(0.012)	(0.013)
Middle SAT subjects	0.063***	0.091***
	(0.014)	(0.015)
Lowest SAT subjects	0.030***	0.043***
	(0.011)	(0.012)
Subjects divided by typical grade (divided into thirds)		
Lowest-grading subjects	0.077***	0.097***
	(0.012)	(0.013)
Middle-grading subjects	0.056***	0.071***
	(0.012)	(0.013)
Highest-grading subjects	0.041***	0.061***
	(0.012)	(0.014)

Notes: Data include all students who enrolled in their first quarter at Northwestern University during the fall terms between 2001 and 2008. Each cell represents a different model specification. Standard errors adjusted for clustering at the student level are reported in parentheses beneath coefficient estimates. Next-class information is recorded for the first time a student takes a second class in a given subject area. Intended majors are recorded by the Office of Admissions. Coefficients marked ***, **, and * are statistically distinct at the 1, 5, and 10 percent levels, respectively. Data come from 15,662 students taking 56,599 first-quarter classes. Grading levels of subjects are determined by comparing average residuals of a regression of grades on observed student characteristics; results are qualitatively unchanged if grading levels are unadjusted.

Table 4: Percentage of students earning A- or better in a class, by subject and academic indicator

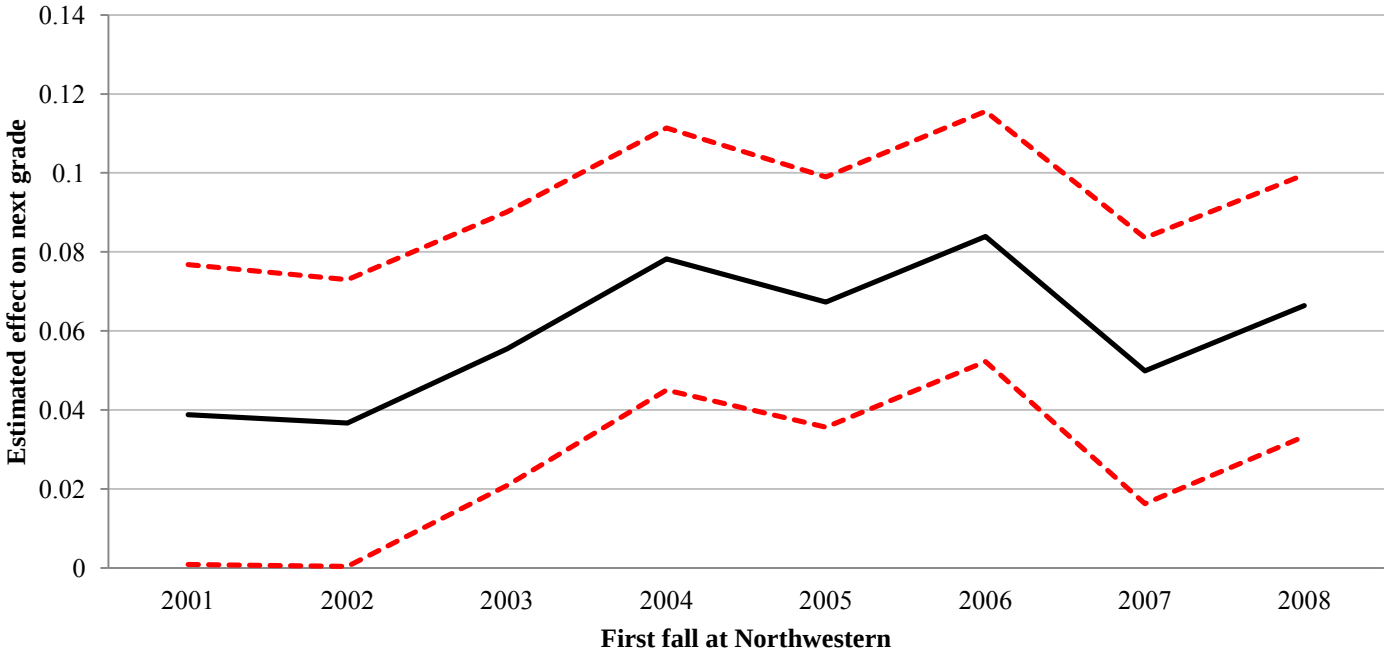
	Academic indicator = 1	Academic indicator = 2	Academic indicator = 3+
All classes	67.2%	56.3%	46.3%
Subjects divided by the average SAT scores of freshmen with declared majors (divided into thirds)			
Highest SAT subjects	56.0%	38.1%	23.6%
Middle SAT subjects	76.2%	64.0%	47.6%
Lowest SAT subjects	82.7%	73.1%	61.5%
Subjects divided by typical grade in classes (divided into thirds)			
Lowest-grading subjects	54.5%	36.5%	21.8%
Middle-grading subjects	71.4%	57.5%	40.4%
Highest-grading subjects	87.4%	80.8%	71.5%

Table 5: Estimated effects of having a non-tenure line professor on subsequent performance in the subject: Differential effects by student academic preparation; Student fixed effects and next-class fixed effects

	Academic indicator=1	Academic indicator=2	Academic indicator=3+
All classes	0.028	0.062***	0.058***
	(0.020)	(0.010)	(0.019)
Classes outside declared major	0.024	0.073***	0.098***
	(0.022)	(0.011)	(0.023)
Subjects divided by the average SAT scores of freshmen with declared majors (divided into thirds)			
Highest SAT subjects	0.013	0.099***	0.168***
	(0.026)	(0.018)	(0.036)
Middle SAT subjects	0.055	0.059***	0.126***
	(0.064)	(0.022)	(0.047)
Lowest SAT subjects	0.029	0.051***	0.003
	(0.043)	(0.016)	(0.033)
Subjects divided by typical grade in classes (divided into thirds)			
Lowest-grading subjects	0.007	0.094***	0.175***
	(0.026)	(0.018)	(0.036)
Middle-grading subjects	0.075	0.058***	0.068*
	(0.053)	(0.017)	(0.037)
Highest-grading subjects	0.013	0.058***	0.028
	(0.046)	(0.019)	(0.039)

Notes: Data include all students who enrolled in their first quarter at Northwestern University during the fall terms between 2001 and 2008. Each cell represents a different model specification. Standard errors adjusted for clustering at the student level are reported in parentheses beneath coefficient estimates. Next-class information is recorded for the first time a student takes a second class in a given subject area. Intended majors are recorded by the Office of Admissions. Coefficients marked ***, **, and * are statistically distinct from zero at the 1, 5, and 10 percent levels, respectively. Data come from 15,662 students taking 56,599 first-quarter classes.

Figure 1: Estimated effects of having a non-tenure line professor on subsequent performance in the subject: By freshman year cohort



Note: These estimates are computed for the model with student fixed effects and next course fixed effects. Data include all students who enrolled in their first quarter at Northwestern University during the fall terms between 2001-2008. The black line shows the estimated next-grade effect, with the dashed red line indicating a 90 percent confidence interval.