Is there a Need for Grading Reform? Differences in Grading Patterns between Departments in the College of Agriculture and Life Sciences at Texas A&M

Anna Yeritsyan
Department of Agricultural Economics
Texas A&M University
anna_y@tamu.edu

James W. Mjelde
Department of Agricultural Economics
Texas A&M University
j-mjelde@tamu.edu

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Abstract

Grade point averages (GPA) are used as differentiating factor among students, but grade inflation may distort the ability of GPAs to distinguish students as they move into the labor market. It, therefore, is important to universities to identify and assess possible grade inflation, and detect departments that may be responsible for grade inflation to design and implement effective grading policies. This paper examines factors influencing grades from STEM, economics, and education / communications related departments in College of Agriculture and Life Sciences (COALS) at Texas A&M University from 1985 to 2015. After accounting for the instructor effects and other factors impacting GPAs, the Department of Agricultural Economics (AGEC) shows an increase in grades, the Department of Biological and Agricultural Engineering (BAEN) did not demonstrate any distinct trend, while the Department of Agricultural Leadership, Education, and Communications (ALEC) grades decreased (but still remaining the highest among the three departments). In all three departments, increasing percent female students and increased performance in high school and the SAT leads to higher class GPAs. Classes that meet once a week on average have higher grades in ALEC and BAEN. In addition, morning classes result in significantly lower GPA in AGEC and ALEC.

Keywords: Economic Education, Agricultural Economics, Teaching, Grade Inflation

JEL Codes: A22, I21

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Agriculture may not be a field that young people perceive as "fashionable" and find attractive as a future specialization. The importance of supplying world economies with food production specialists, however, cannot be overstated. In an era of intense competition by universities for high school graduates, the quality of education becomes as important as ever before as recruiting as placement tools. One indicator for assessing the quality of graduates widely used by the labor market is the grade point average (GPA). Grades serve as a tool for differentiating student knowledge and ability; however, there are debates whether grades measure knowledge and ability (Peace 2017). One reason that gives rise to this concern is the increase in university grades. Is this a grade improvement or a grade inflation?

Jephcote, Medland, and Lygo-Baker (2020) mention this increase in GPAs gives mixed signal to the industry and labor market. If the increase is because of grade improvement (a positive shift in grade distribution because of increased learning (Mostrom and Blumberg, 2012)), then there is a clear signal of increasing quality of education. However, if the increase is the result of grade inflation (increases in grades not reflecting an increase in the quality of student work (Kostal, Kuncel, and Sackett (2016)), then grades mask valuable information about student abilities and knowledge. Grade inflation has the potential of distorting the choices made by the labor market. One additional complication of grade inflation is the misrepresentation in relative grading. Because increases in grades occur on a fixed scale with a ceiling, grade compression is observed at the top of that scale (Kohn, 2002). That is, when a B student moves to the A range, the difference between a good and exceptional student fades away, which compromises the ability to

differentiate between students. Importantly, this can dwindle student motivation to perform to the best of their ability and can further affect the image and reputation of the institution.

It is important to universities to identify and assess possible grade inflation and detecting departments that may be responsible for grade inflation. Information gained through identification of potential grade inflation can be used to help design and implement effective grading policies. This paper examines factors influencing grades from three very diverse departments in College of Agriculture and Life Sciences (COALS) at Texas A&M University. Primary objective is shedding light on differences in grading patterns in science/engineering, economics, and education/communications related departments in COALS to provide information for policies within COALS. Expanding on this notion, of interest is identifying factors affecting grades in each of the three departments. Specifically, the questions are:

1) Are there differences in grading patterns overtime between science/engineering, economics, and education/communications related departments in COALS, and
2) What are the key factors affecting grades in each departments?

Literature Review and Motivation

As noted, grade improvement is defined as a shift in grade distribution caused by increases in achievement; whereas, grade inflation is increases in grades do not reflect changes in the quality of students' performance (Birnbaum, 1977). Literature suggests different reasons for grade inflation. These reasons range from student and instructor personal characteristics to university, department or discipline-specific features. Differences in grading standards between education and non-education departments in several universities is assessed by Koedel (2011). After comparing the grades of over 80,000 students, the author concludes that average grades in education departments are significantly higher than those in non-education departments. A similar study

evaluating grades across different disciplines finds that the GPA in the science and economics related majors, on average, are lower relative to humanities and non-economic majors (Butcher et al, 2014). These findings suggest that even within the same university different departments have different grading norms that may be used to manage demand for courses and majors (Diette and Raghav, 2015).

Chowdhury (2018) proposes three possible levels at which the grade inflation may be "allowed." At the educational system level, increased grades may contribute to improved access to education and better job placement for future students. At the institutional level, increased grades help attract and retain a larger student body. Larger student bodies are important, because part of universities' funding is obtained through student tuition and fees. At the instructor level, increased grades may result in higher student evaluation, which often affects part-time or visiting instructors' contracts and may accelerate the tenure for non-tenured faculty. This suggests that different types of instructors may demonstrate different grading patterns, thus instructor characteristics may explain increase in grades.

Grades may vary because of individual student characteristics. Past performances at high schools and admission test, (proxies for the ability and stamina of a student) may affect the average grades of university students (Huong et al, 2019). The literature also suggests grades in science-related disciplines may vary by student gender. A study among high school students reported that higher performance in sciences and mathematics related subjects is attributed to a higher percentage of male students (Hand et al, 2017). Although contrary to the stereotypical beliefs meta-analysis by O'Dea et al (2017) show that females outperform males at school in science, technology, engineering, and mathematics (STEM) subjects.

Finally, class settings related factors effect students' grades. Larger class size is shown to affect the students' grades negatively (Gaggero and Haile, 2020; Arias and Walker, 2004) and classes that are held earlier during the day result in higher grades (Pope, 2016). Skinner (1985), on the other hand, finds class GPAs are higher for afternoon and evening classes compared to morning classes.

Data Description and Summary

Differences in grading patterns for three diverse departments within COALS at Texas A&M University are examined. The three departments are chosen to represent STEM, economic, and education / communication oriented departments. They are the Department of Biological and Agricultural Engineering (BAEN), the Department of Agricultural Economics (AGEC), and the Department for Agricultural Leadership, Education and Communication (ALEC). All data are at the class level.

In addition to primary data obtained from Texas A&M University, information was obtained from departmental websites, undergraduate catalogs, open access web sources, and conversations with departmental staff. The data includes fall and spring semester classes from fall 1985 through spring semester 2015. Factors potentially affecting grades are separated into three groups; student-related (gender, SAT score, class load, high school rank, and percent of students not receiving A-F grade), instructor-related (gender and position at the time of teaching), and institutional factors (time and number of meeting days of the class, class level and type, number of students in the class, and semester). A description of the variables used in the analysis is provided in Table 1.

The number of observations (classes) for AGEC, ALEC, and BAEN are 1572, 1300, and 935. Among the three departments, the smallest mean departmental GPA overall years is 2.99 for

AGEC, while the largest is 3.51 in ALEC. For BAEN the overall mean GPA is 3.19. In AGEC, nearly 60% of classes are delivered by instructors with a rank of professor, in BAEN professors delivered approximately about 50% of the classes, while in ALEC only about 15% of the classes are taught by professors. Female and male instructors are equally represented in ALEC, while in AGEC 93% of instructors are male. Overall years, 81% of students in BAEN classes, 65% of students in AGEC classes, and 46% of students in ALEC classes are male. Finally, nearly 41% of all classes in ALEC are held only once a week. In contrast, in AGEC only 2% of classes are held once a week.

Methodology

Different instructors have different teaching styles and may grade differently which may make the assumption of independence of observations not hold. To account for the different styles, mixed effect models (Goldstein and Hoboken, 2011) are used. The models consider instructor-specific characteristics to estimate the average grade in each class. Previous studies have also used mixed effect models in examining grading patterns (Kokkelenberg, Dillon, and Christy, 2008; Beenstock and Feldman, 2016; Hernández-Julián and Looney, 2016). Mixed effect model estimation consists of fixed and random components:

$$y = X\beta + Zu + \varepsilon$$

where

y - is the vector of observations (grades) with mean $E(y) = X\beta$,

X – is individual class specific characteristics (see variables in Table 1),

β - is the vector of fixed effects,

Z – is individual instructor effect,

u - is the vector of random effects with mean $E(u) = 0$, and

ε - is the vector of random errors.

The model is estimated using mixed command in Stata 15 (StataCorp, 2017).

Results

Differences among departments both in terms of grade changes over time and in terms of the contributing factors affecting grades are suggested by the results presented in Table 2. The trend variable is significant (p-value ≤ 0.05) in both AGEC and ALEC, but the sign differs with AGEC experiencing increase in GPA while ALEC has seen decreases in GPA over time. BAEN did not display a significant trend in GPA. Mean GPA by year for the three departments are shown in Figure 1. AGEC mean GPA increased from 1985 to 2001 then decreased until around 2009 when it starts to increase again. Mean GPA in ALEC was almost 3.8 for several years in the 1990s and then declined until 2007 when an upturn in GPA occurs. BAEN mean GPA is similar to ALEC, in that it reaches a minimum during 2006-2008. Although ALEC has decreased its mean GPA, its mean GPA is still higher than in the other two departments in any given year.

All three departments, are similar in the effects of student characteristics on class grades. Decreased percentage of males in a class results in higher GPA. This is clearly seen in the relationship (be it causal or otherwise) between the mean percentage of female students in class and mean class GPA in BAEN (Figure 2). Mean GPA and percentage of females clearly follow the same trends. Similar to Alyahyan and Dustegor (2020), better students' previous performances in high school and SAT scores significantly increases GPA. The larger the share of students who did not complete or did not get a grade for the class, the lower the class GPA. In addition to student specific characteristics, total number of students in a class negatively impacts the grades in all three departments.

Institutional characteristics have very diverse influences on GPA in the three departments. GPAs in BAEN are not impacted by the time of the class. In both AGEC and ALEC, morning classes, however, result in lower GPAs, compared to the base afternoon classes. Morning classes resulting in poor grades is also recorded by Dunster et al. (2018) and Marbouti et al, (2018). Compared to afternoon classes, ALEC students on average perform worse during evening classes as well. In addition, Wald test shows that on average morning class GPAs are not statistically different from evening class GPAs in ALEC. Both BAEN and ALEC have higher GPAs for classes that meet once a week compared to two or three times a week. AGEC classes show no number of times meeting a week effect. Compared to spring classes BAEN students obtain higher grades for classes held in fall, and they also have higher grades for lab classes. The combination of lab and lecture classes is also shown to increase student learning and grades in an experiment carried out by Itzek-Greulich et al (2015). Finally, grades for the upper division classes in ALEC on average are lower than grades for the lower division classes. This contradicts Achen and Courant (2009) who suggest that the grades in the upper division are higher because of student self-selection and increased instructor support.

In all departments, individual instructor effects are significant, indicating variability in how instructors grade. Contrary to Ehrenberg, Goldhaber and Brewer (1995) gender of the instructor does not affect grades in any of the departments, which sends a positive signal to administration. In AGEC, classes taught by assistant professors and associate professors have GPAs that are significantly higher than for classes taught by professors. In ALEC, classes taught by graduate students have higher GPAs. With regard to this finding, the literature suggests that non-tenured faculty may be tempted to inflate the grades in anticipation of better students' evaluations and, subsequently, accelerated tenure procedure (Chowdhury, 2018).

Conclusions and Discussions

The objective of this study is shedding light on differences in grading patterns in science/engineering, economics, and education/communications related departments in COALS to provide information for policies within COALS. To achieve this objective, two questions are asked. The first is "are there differences in grading patterns over time." Grading patterns differ between the departments. Grades in BAEN (STEM department) do not show any significant change, grades in AGEC (economics) increased over time, while grades in ALEC (education/communication) decreased over time.

In terms of the second question "what are the key factors affecting grades," there are differences and similarities between the departments. In all three departments, student variables had the same positive or negative effects on class GPA. Significance of the student variables is also the same in the three departments. Significant instructor effects are found indicating, as expected, there are differences in how instructors grade. Of the institutional variables only number of students had the same effect and is significant in all three departmental models. Instructor rank, time of day the class meets, class level, and semester differ in significance and or effect among the departments.

Because the percent of females in a class, high school performance, as well as SAT score show significant effects for class GPA in all three departments, these three variables are contrasted changes to grades over time. In BAEN, average SAT scores are increasing over time, which would be an indicator increases in grades are contributed to grade improvement although such an improvement is not seen or is buffered by other factors. Interviews with BAEN staff revealed that the classes offered once a week are either classes that are offered to students in their final year to give them specialized knowledge in their area of interest or introductory classes that are offered to

freshmen in their first year of studies to contribute to student retention in and recruitment to the program. In the first case, because interested students are self-selected for those classes, higher grades may imply grade improvement. However, in the second case, when the class is not meant to be stressful and difficult, higher grades may indicate grade inflation.

AGEC has also experienced an increase in applicants' SAT scores; however, the high school rank of the students has declined. Implications of these two variables contradict each other. The department might consider evaluating the reasons why higher grades are granted by assistant professors and associate professors than professors. If the reason is related to anticipated higher students' evaluations to help with the tenure process, then the department may want to revisit tenure requirements.

Although student high school rank and the SAT scores have decreased over time, mean GPA in ALEC is still higher than in the other two departments. ALEC is also different from the other two departments in that it increased number of students enrolled in all classes from around 500 in 1986 to well over 4,000 in 2014[1]. In comparison, the number of students enrolled in all classes went up from 3,822 to 4,137 in AGEC and from 1,212 to 1,414 in BAEN from 1986 to 2014. Number of students enrolled in all classes in ALEC and GPA dynamics (Figure 3) show that the variables may be interrelated. These numbers indicate increasing enrollment may come at the expense of the quality and motivation of the department's student body. While the ALEC department recorded grade deflation, this is most likely because in mid-90s average GPA was high (3.75 in 1994) and restructuring of the department. Interviews with ALEC staff revealed in the mid

[1] Number of students enrolled in all classes is calculated based on the total numbers of all students taking all classes in a given department for a given year, i.e. a class size is summed over number of all classes/sections offered by a department during a particular year. For example, if a student took four different classes in the same department during the fall 2014, and 4 classes in the spring 2014, then he/she will show being enrolled in eight classes at the particular department in 2014.

2000's ALEC increased the number of majors and introduced additional minors. There were a high share of athletes within Department in the 2000's which may have contributed to the decrease in GPA. The literature suggests athletes usually have weaker academic performance than the rest of the student body (Maloney and McCormick, 1993). The finding that upper level classes in ALEC have lower grades may be the result of inflow of transfer students from other departments. The transfer students may not be as motivated as those that initially applied to ALEC as the major of their choice.

Mean GPA dynamics in Figure 1 may suggest that there may have been an informal adjustments in grading strategies in the three COALS departments during years 2006-2008. But it appears any incentives to control for the grade inflation (if present) were short-lived. Enforcing any changes requires caution. A policy on reducing average grade to B+ was introduced in Wellesley College, which resulted in unhealthy competition between the students. It increased racial gaps in grades, reduced enrollments and majors, and lowered student ratings of professors (Butcher, 2014). Further, lowering grades may affect business perception of students if other universities do not lower grades.

Under the assumption GPA is an indicator of the quality of education, several policy recommendations arise. First consistent with the literature, decreasing the number of students in a class, is a good strategy for improved student learning. Departments should examine the time of day and meeting length for classes. This may improve quality of learning, which may be especially important for basic building block classes if they are held at the most advantageous time for learning. Moving AGEC department's classes from morning hours to afternoon, for example, may contribute to increase student learning. Increasing the number of students taught, which is primarily through increases in enrollment in a department, has implications for the quality and

motivation of students. Transfer students and athletics, generally, may be less motivated. These aspects need further investigation. Imposing stricter standards (GPA thresholds) for incoming transfer students could improve quality of department graduates. Another possibility for differentiating students might be introducing student's rank in each class in addition to the grade listed in the transcript, but such a change would most likely have to be implemented at the university and not college level. With the introduction of rank, teachers would use their role as observers of student work to provide information about students' relative performances (Kamber and Biggs, 2003). Again concerns arise, namely among disciplines the average student performance may be very diverse. Finally, changes in grading policies may be difficult to maintain and come with unintended consequences. These issues must but addressed before meaningful changes can be made. The university's GPAs relative to other universities also needs to be addressed to inform employers who are considering graduates from various universities.

One thing is clear, besides formal admission policies grading can be used as an informal tool used for controlling student's admissions to the specific department, or even to specific majors within the department. So the question to be answered in further research becomes does a department want to stop grade inflation or it would rather use it as an informal tool for attracting more students.

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Appendix 1. Variable Description and Mean Values by Department for the Years Fall 1985 – Spring 2015.

Variable Name	Variable Description	Mean Value AGEC	ALEC	BAEN
	Dependent and Grade Inflation Variables			
GPA	Class mean GPA	2.992	3.513	3.190
Ln trend	Natural logarithm of trend	3.319	3.666	3.349
	Institutional Variables			
Morning	Equals 1 if class starts before 12:01, 0 otherwise	0.631	0.608	0.751
Afternoon	Equals 1 if class starts between 12:01 to 15:59, 0 otherwise (dropped to avoid perfect collinearity)	0.333	0.325	0.245
Evening	Equals 1 if class starts at 16:00 or later, 0 otherwise	0.036	0.067	0.004
Meet 1	Equals 1 if the class meets once per week - class duration is 2.5 hours for a three credit class, 0 otherwise	0.020	0.408	0.207
Meet 2	Equals 1 if the class meets twice per week - class duration is 75 minutes for a three credit class, 0 otherwise	0.600	0.504	0.558
Meet 3	Equals 1 if the class meets three times per week - class duration is 50 minutes for a three credit class, 0 otherwise (dropped to avoid perfect collinearity)	0.380	0.088	0.234
Lower division	Equals 1 if the class is listed as a 100 or 200 level class, 0 otherwise (dropped to avoid perfect collinearity)	0.129	0.132	0.230
Upper division	Equals 1 if the class is listed as a 300 or 400 level class, 0 otherwise	0.871	0.868	0.770
Total Students	Number of students receiving a grade A – F in the class	64.882	46.306	33.574
Lecture	Equals 1 if the class type was listed as a lecture, 0 otherwise	0.997	0.947	0.928
Semester	Equals 1 for classes held in the fall and 0 for spring classes	0.503	0.505	0.521
Y85-88	Equals 1 if the year is 1985, 1986 or 1987, 0 otherwise	0.052	0.012	0.047
Y85-88*SAT	Interaction term between Y85-88 and SAT - defined under student variables	27.165	6.3127	24.97

Y85-88*HS	Interaction term between Y85-88 and High School - defined under student variables	4.019	0.952	3.820
	Instructor Variables			
Instructor	Instructor name used as a level (number of instructors)	117	105	58
Gender	Gender of the instructor, male = 1 and female = 0	0.930	0.5	0.859
Prof	Equals 1 if the position at the time of instruction was professor, 0 otherwise (dropped to avoid perfect collinearity)	0.594	0.15	0.496
Assoc prof	Equals 1 if the position at the time of instruction was associate professor, 0 otherwise	0.146	0.22	0.267
Assist prof	Equals 1 if the position at the time of instruction was assistant professor, 0 otherwise	0.127	0.295	0.121
Lec Grad	Equals 1 if the position at the time of instruction was graduate student, 0 otherwise	0.069	0.247	0.021
Other	Equals 1 if the position at the time of instruction was other lecturer, 0 otherwise (includes visiting faculty, lecturers, non-graduate instructors)	0.055	0.082	0.093
	Student Variables			
Percent Male	Percentage of male students in the class	0.653	0.463	0.810
SAT	Class average students' SAT - mathematics score	540.901	527.187	573.388
Load	Average number of credits students in the class are enrolled	13.960	14.160	14.131
High School rank	The average high school rank of students in the class, calculated as the percentile of students in the school that rank below the given student	75.134	74.481	81.216
Share	Share of students who enrolled in the class but did not receive an A – F grade for the class. Includes students who dropped beyond the initial drop date, received an incomplete grade, took the class pass / fail, or was dropped from the class by the dean's office divided by total students	0.033	0.019	0.019

Table 2. Estimated Coefficients and Standard Errors (in parenthesis) of the Mixed Effects Model by Department

Variable Name	AGEC	ALEC	BAEN
Constant	1.141*	2.603*	3.432*
	(-0.307)	(0.295)	(0.353)
	Grade Inflation Variables		
Ln trend	0.058*	-0.086*	0.035
	(0.0203)	(0.034)	(0.031)
	Institutional Variables		
Morning	-0.042*	-0.048*	0.041
	(0.015)	(0.020)	(0.029)
Evening	-0.024	-0.079*	0.052
	(0.038)	(0.036)	(0.162)
Meet 2	-0.049	-0.106*	-0.287*
	(0.065)	(0.020)	(0.031)
Meet 3	-0.067	-0.079**	-0.289*
	(0.067)	(0.031)	(0.039)
Upper division	0.052	-0.056*	0.016
	(0.038)	(0.028)	(0.037)
Total Students	-0.001*	-0.002*	-0.006*
	(0.0002)	(0.0003)	(0.001)
Lecture	0.211	0.030	-0.225*
	(0.125)	(0.037)	(0.048)
Semester	-0.006	-0.001	0.048*
	(0.013)	(0.015)	(0.021)
Y85-88	-0.586	-1.206	-0.257
	(0.835)	(1.575)	(0.661)
Y85-88*SAT	0.002	0.002	0.001
	(0.002)	(0.003)	(0.001)
Y85-88*HS	-0.006*	0.001	-0.002
	(0.002)	(0.004)	(0.005)
	Instructor Variables		
Gender	-0.042	0.085	-0.001
	(0.074)	(0.055)	(0.093)
Assoc prof	0.077*	-0.054	0.004
	(0.025)	(0.041)	(0.047)
Assist prof	0.078*	-0.007	-0.005
	(0.033)	(0.048)	(0.051)
Lec Grad	-0.048	0.103*	-0.200
	(0.055)	(0.060)	(0.138)
Other	-0.079	-0.066	-0.067
	(0.076)	(0.083)	(0.150)
	Student Variables		
Percent Male	-0.553*	-0.362*	-0.604*
	(0.072)	(0.066)	(0.088)
SAT	0.003*	0.002*	0.001*

	(0.0004)	(0.0004)	(0.0004)
Load	0.003	0.013	-0.010
	(0.012)	(0.012)	(0.014)
High School rank	0.004*	0.005*	0.005*
	(0.001)	(0.001)	(0.002)
Share	-1.669*	-2.053*	-1.504*
	(0.178)	(0.253)	(0.293)
	Random-Effects Parameters		
Instructor	0.053*	0.058*	0.064*
	(0.009)	(0.011)	(0.016)
Residual	0.052	0.070	0.090
	(0.002)	(0.003)	(0.004)
	Overall Model Fit		
Wald Test	$\chi^2 = 559.25$	$\chi^2 = 404.36$	$\chi^2 = 510.00$
	P-value 0.000	P-value 0.000	P-value = 0.000
Likelihood Ratio vs. Linear	$\chi^2 = 796.70$	$\chi^2 = 368.07$	$\chi^2 = 274.62$
Model	P-value 0.000	P-value 0.000	P-value = 0.000

* *denotes significance at 0.05 level.*

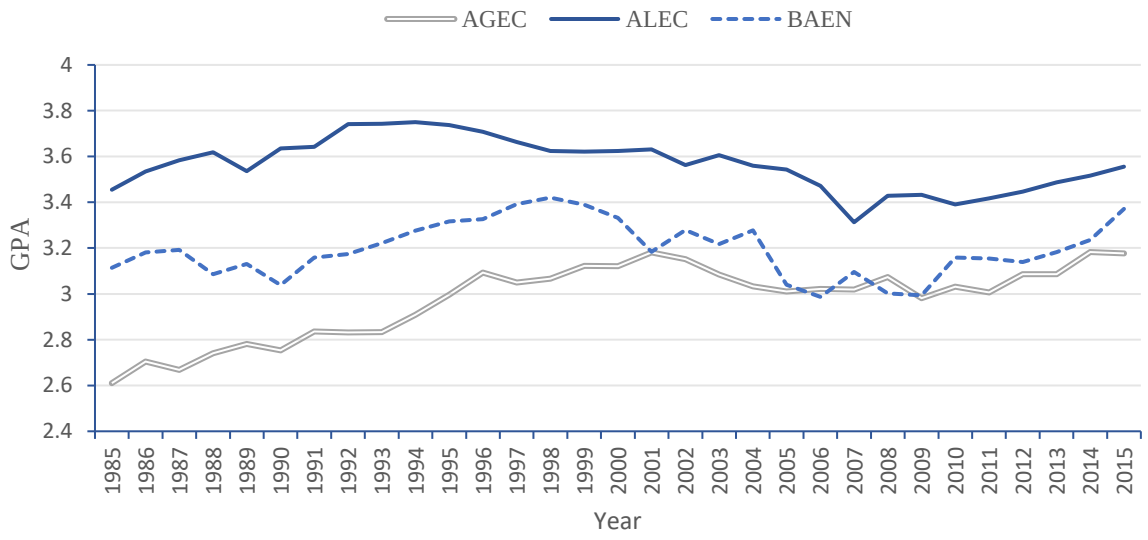

Figure 1. Weighted (by class size) Average GPA in AGEC, ALEC and BAEN by year from Fall 1985 to Spring 2015.

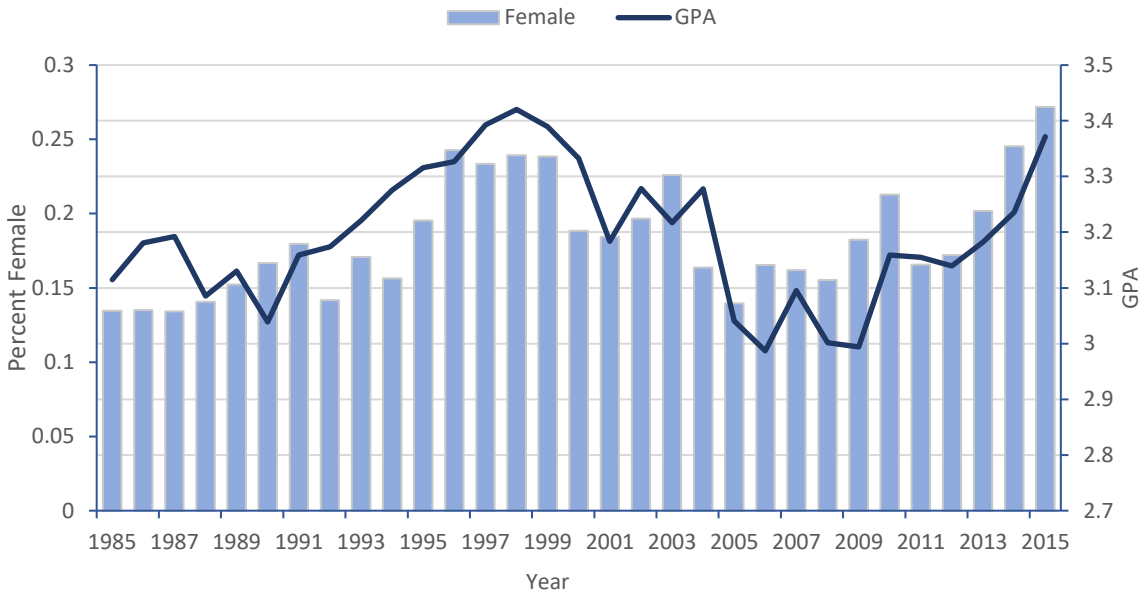

Figure 2. Average GPA and Female Enrollment in BAEN by Year from Fall 1985 to Spring 2015.

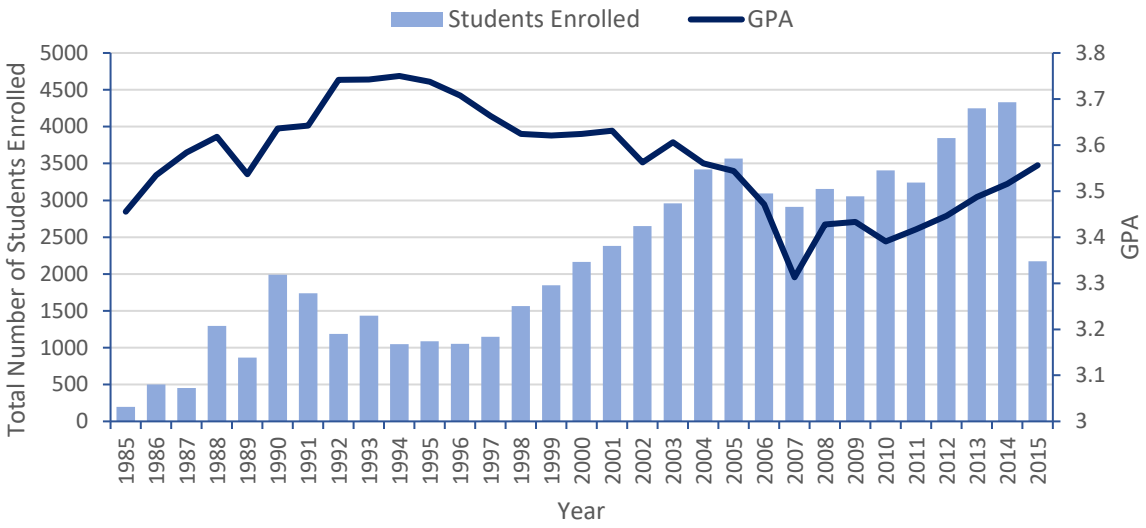

Figure 3. Average GPA and Total Number of Students Enrolled in all Classes in ALEC from 1985 to 2015. (Note: Data for 1985 Includes only Spring Semester and Data for 2015 Includes only Fall Semester).