AIR 2003 Forum
Changing our Attitudes, Expanding Our Latitudes
Tuesday, May 19. 2003, 3.20 PM, Tampa, Florida (best paper series)
Published: ERIC collection of AIR 2003 Forum Papers

The Effect of Advanced Placement Credit on Time to Degree at the University of California

By Paul W. Eykamp, Ph.D.
University of California, Office of the President
Academic Affairs, Planning and Analysis

Abstract

A cohort of University of California students is examined to see what effect Advanced Placement units have on time-to-degree, course load, and propensity to double major. Regression analysis fails to find any significant relationship, but other analysis shows that AP units do matter, but not in a way that can be predicted for individual students *a priori*.

High school students are accumulating large numbers of Advanced Placement and other college credits before matriculating, particularly at research universities. At the University of California, well over half of the students have AP units, and many of them have the equivalent of an academic quarter or more. Some even have close to a year's worth of units when they matriculate.

There is much conventional wisdom about how students use Advanced Placement Units (AP) at the University. Many people assume that students who have gone to the effort to accumulate all of these units will use them to graduate more quickly, and that a quarter's worth of AP means a quarter less time spent enrolled. Others observe that despite all of the AP units being brought into the University, students do not seem to be getting out much faster than they used to, and that a large number of students still take more than four years to graduate.

Anecdotal evidence indicates that many students use AP scores to place out of introductory courses and start at a more advanced level. This may not speed up their time to degree, but rather give them a better university experience. This is an important use of the AP exam, if nearly impossible to measure at the System

level. Indeed, this was the original purpose of the AP exam.[1] AP units can also be used to lighten loads, allowing the student to do more research or drop a class that turns out to be a poor match without incurring an increased time to degree. Furthermore, AP units can be used to support double majors.

Although at the System level it is not possible to determine if students placed out of lower level courses, this can be determined through campus level transcript analysis, which is now being conducted. However, at the System level, it is possible to study time to degree, the average number of units taken per term, and other general measures of student activity in relation to the number of AP and other university units brought in at matriculation.

This study seeks to find out, at the macro level, how students are using the AP and other college units they bring with them when they enter the University of California. It does not analyze why students do what they do, or describe individual paths. Individual campuses alone have the data to do that analysis. The goal of this study is to provide policy makers with basic guidance as to the likely effects of changes in broad policy toward AP units, such as changing the minimum score required on tests to grant credit, or the predictive effect of changes in the number of AP credits earned by students over time on continuing student enrollment.

First, to place this in perspective, some general numbers are provided to show the size of the data set, and the general tendencies of University of California students. Almost all University of California students attend full time and most are more or less continuously enrolled. This study looks at the 1994 cohort of entering first-time freshmen. This cohort is tracked for six years after they entered. Technical problems prevented the use of the 1995 or 1996 cohort in time for this paper. However, as the number and distribution of AP units by University of California students has been fairly stable for the last decade, the results should apply generally to more recent cohorts of students.

There were 15,667 students in the cohort, who were enrolled an average of 13 quarters, with 40 percent graduating in 12 enrolled quarters (four years), 16 percent in 13 quarters, and 9.5 percent graduating in less than 12 quarters. About

[1] http://apcentral.collegeboard.com/article/0,1281,150-155-0-8019,00.html

43 percent take some or all of a fifth year. Thirty-four percent take more than 13 enrolled quarters to finish.[2]

Three-fifths (60 percent) of the incoming freshmen had AP or other university credit when they matriculated.[3] A convenient way of thinking about the amount of AP credit is to convert it into class equivalents as shown below (where 4 AP units equals one class).[4] A normal course load is between 3 and 4 courses per quarter (3 being the minimum for acceptable progress and 4 being the more normal load). Seminars and laboratory classes carry other unit values but typically cannot be replaced by AP units.

Number of Class Equivalents	Number of Students	Percentage	
None	6,229	39.76	
Less than 1	full class	2,248	14.34
1-2	1,724	11.00	
3-4	2,284	14.58	
6-8	872	5.57	
8-12	807	5.15	
12-16 +	193	1.23	

Many students have a small amount of AP credit, with 25 percent of those with units having two or fewer course equivalents. On the other hand, some 4,000 students have enough units to potentially replace a quarter's worth of work or more.

Regression Analysis

The first analysis attempted was to run a simple linear regression analysis of a cohort of students to see if there was any predictive value in the number of AP

[2] The University of California Berkeley is on the semester system. For purposes of comparison, the Berkeley semester units have been multiplied by 1.5 to convert them to the quarter units used by the other campuses in the system.

[3] Technical note: The University of California Systemwide student data system does not currently track AP or other university units brought in separately, so these numbers have to be estimated by subtracting UC enrolled units from the year-to-date totals at the end of freshmen year. This means that Advanced Placement units are lumped in with whatever other university credits an entering freshman might bring. Hereafter in this paper, AP units will referrer both to College Board AP units by examination, and any other non-University of California units a freshman brought in when matriculating.

[4] Except at UC Santa Cruz where the conversion is 5 units per class.

units on time to degree. It seemed plausible that if many students were using their AP credit to replace University of California credits, larger number of AP units should be clearly associated with shorter degree times.

H_0: AP Units should be strongly positively correlated with shorter time-to-degree.

The first regression runs were quite disappointing in this regard. A simple regression of the number of AP or other units at matriculation against the total enrolled quarters yielded a parameter estimate in the right direction, but with a small magnitude – one third of a quarter expected reduction in time to degree per quarter's worth of AP units. However, the adjusted R^2 was only 0.0349. The intercept was also one third of a quarter larger than the dependent mean. This means that while for the University of California system there was some correlation between AP units and time-to-degree and the tendency was in the hoped for direction, there was almost no predictive value and a steep discount on the value of AP units.

On the theory that the large numbers were hiding something going on among sub-groups such as engineers and physical science students (who are generally more constrained in using AP units), regressions were run against only non-science and Engineering students, and against only science and engineering students. Regressions were also run for each campus for all students and again for those with at least four AP units. A regression model with the student's academic index[5] was also run (to control for student quality) but that model had very similar results.

In case the relationship was not linear at the extremes, the model was also run for a variety of sub-groups toward the middle of the distribution (i.e., between 4 and 24 AP units, 8 and 24, 8 and 34, etc.) None of these produced significantly better outcomes.

For most permutations of the type of student (science/non-science) or AP unit count, the coefficients stayed in the 0.02-0.05 quarters per unit range and the R^2 hovered between 0.03 and 0.09. The higher values were found for science, Math,

[5] ((high school GPA *1000) + SAT I + SAT II)

or Engineering students with at least four AP units[6]. Average time-to-degree was very slightly lower (about 0.1 quarter) for students with at least four AP units.[7]

This was somewhat unexpected, since typically these students have the most restrictions on the use of AP credit to replace courses. It was expected that they would have the lowest parameter estimate and a lower R^2 but the opposite was the case. Possibly the correlation was higher because science and engineering students have more structured programs which make their use of AP units more consistent. In any case, the R^2 was very small, and there was little predictive power available.

So for the entire system, the first hypothesis failed, there was only a weak negative correlation between the number of AP units and time-to-degree. It is not possible to draw Systemwide conclusions from regression analysis about the effect of changes in number of AP units on student's time to degree, except in the loosest possible terms. Clearly AP units were having some effect in reducing time to degree, but there was a lot of noise overwhelming whatever signal was contained in the data. Even for students graduating in four years or less there was not much predictive power in the number of AP units brought in. Apparently summer school and other factors outweighed AP units for fast completion times.

On a campus-by-campus basis, the story was much the same, very low R^2 and small negative parameter estimates. The exception was University of California Riverside, which had a much stronger correlation.

Riverside's regression model produced an adjusted R^2 of 0.19 for all students and 0.24 for students with at least four AP units. The parameter estimate was higher as well, with 0.05 fewer quarters per AP unit estimated (0.75 quarters per quarter of AP units). In addition to a stronger R^2 was the significant difference in the average number of enrolled quarters between all students, and students with at least four AP units – 12.7 quarters for all students and 12.3 for students with at least four AP units. This was a much greater difference than was seen for a similar division either Systemwide or at other individual campuses.

[6] Four AP or other college units at matriculation was chosen as a cut off since most classes are four units and this is the least number of units likely to be useful. Anecdote has it that a fair number of students find themselves about four units short of the 180-quarter units needed to graduate at the end of their fourth year.
[7] All of the data was normally distributed, even in smaller sub groups

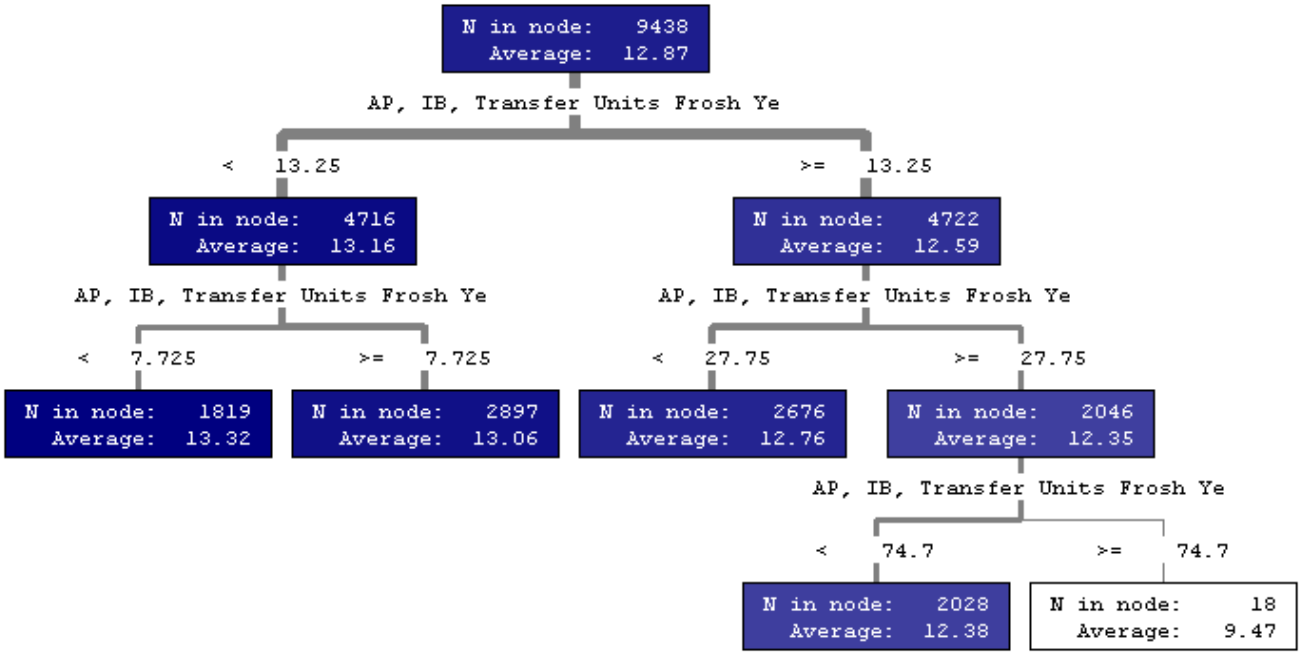
For some reason, Riverside students alone in the system can be predicted as a group to use their AP and other college credits brought in at matriculation to reduce their time-to-degree and are much more efficient at converting AP units into reduced time-to- degree. There is no immediate obvious difference in Riverside students that might explain this. Like the system as a whole, Riverside had a large fraction of students with at least four AP units, about 53 percent (verses 56 percent for the system). It also has a similar fraction of science and engineering students.

One theory was that lower income students (which are somewhat more predominant at Riverside) might have a higher propensity to use their AP units. However, when parental income was added to the regression equation for the system as a whole, the R^2 remained very low. Additional research is needed to determine what is different at Riverside and if there is a result than can generalized.

Since there was no clear Systemwide regression model with predictive power, and anecdotal evidence indicates that a significant number of students were using AP units, a different analytical approach was needed.

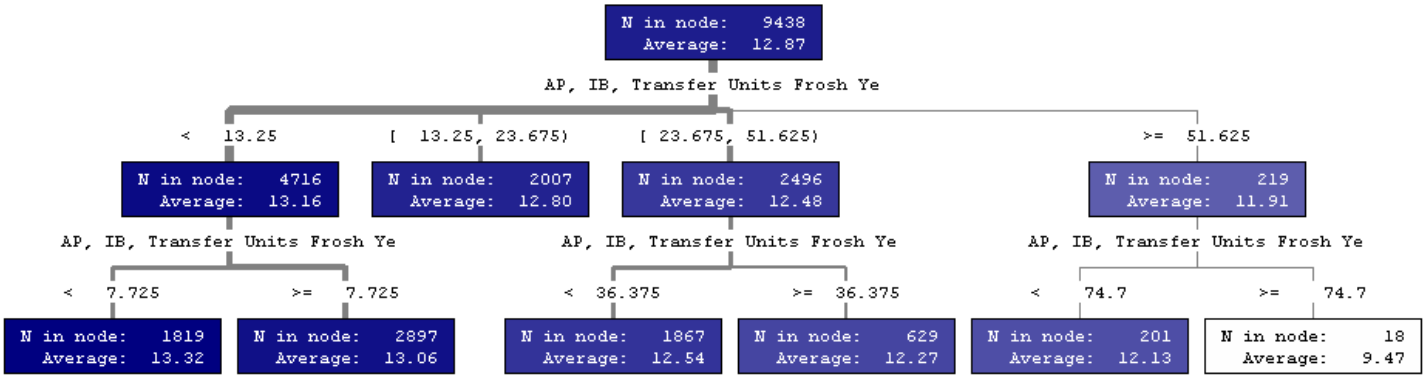
Other Ways of Looking at AP Units and Time to Degree

Using decision tree analysis in SAS Enterprise Miner, which splits observations in to groups using recursive partitioning to find observations that are most closely related to a target variable – in this case total quarters enrolled. Using this tool, it was possible to look for breaking points and find the point at which AP units were associated with reduced time to degree. Students with more than 13 AP units had a shorter time to degree than those who had less than 13 units, and those with more than 27.75 had about half a quarter less time enrolled than average for all students with AP units. A small number of students who had more than 74 units of AP graduated very quickly.



This analysis confirmed the results of the regression model and provided a better way of finding the points at which having as certain number of AP units seemed to matter in terms of affecting the number of quarters enrolled. It further illustrated that having a lot of AP units, almost two quarters worth, only netted an average reduction in time enrolled of half a term. A small group of student (18) who had a very large number of AP units (>= 74.7), did graduate much faster.

Using a four leafed tree, it could more clearly be seen that there were linear reductions in time to degree as AP units went up, but the rate of reduction of time enrolled was uniformly very slow in comparison with the number of AP units. Time enrolled did not fall below four years until the 51 unit point was reached (3.4 quarters)



Additional analysis of parental income, academic index, high unit majors, average course load, and double majors failed to yield any groups that deviated from this general trend that large numbers of AP units yielded small reductions in the number of quarters enrolled and that attributes that one would expect would increase time to degree (lower income, double majors, lower average units enrolled per term, etc. had the same effect at all levels of AP unit completion. This seems to indicate (again) that students that have large numbers of AP units may (or may not) use them to reduce their time to degree, but not in a consistent manner.

Central Tendencies and Sub-Group Behavior

If the whole group was masking individual student behavior behind its noise, perhaps there were identifiable subgroups of students where having AP units sped up time-to-degree compared to similar students without AP or the entering cohort as a group.

Going back to basics: we should first ask whether any students actually need AP units to graduate. If they did, did they take more or less time than average to complete their degree? We know that some students graduated in less than four years with fewer than 180 University of California units. So they seem like likely candidates for AP unit users. Can we predict who will finish early based on their characteristics? We can also look at the average course load taken by students with and without AP units, and see if students are substituting AP units for University of California units as they go along.

Students Needing Non-University of California Units to Graduate

University of California degrees require at least 180-quarter units to graduate and the University's data systems differentiate between University of California units and units earned at other institutions. Clearly, students who graduated with less than 180 University of California generated units would have had to use either AP units or other Units that were transferred in after freshman year (i.e., Summer Session units,[8] Community College, or other institutions units taken over the summer or concurrently).

The Systemwide collected data does not record whether AP units were used to fulfill specific requirements; it simply records their presence for fulfilling the minimum number of units. Thus, it is possible that a student with 20 AP units and 179 University of California units will still not be able to graduate because they are missing a specific course that the AP units do not replace. Because of this, there is a certain amount of guesswork involved in determining exactly which AP units were used. This again, is a matter best researched at the campus level. However, it is still possible to generate some approximate values for the role of AP units.

In the 1994 cohort of entering first-time freshmen who graduated, 6,117 (39 percent) needed AP or transfer units earned after their freshman year to bring them up to 180 units. Not all of these students had enough AP units to make up the deficit. Some students actions toward the end of their undergraduate careers allow us to know with some certainty that they did or did not utilize AP units.

Summer Degree Students

Some of these students received their degree over the summer and needed eight or fewer units. Since the normal summer course load is eight units, it seems reasonable to assume that students getting their degrees over the summer who needed only two classes would not take summer school if their other non-University of California units would fulfill the requirements.

There were 2,603 students who got their degrees over the summer, 1,541 needed eight or fewer units, most of whom (1,236) had no AP units. So the assumption that none of them used AP units seems fairly safe. This brings the total number of students not directly using AP to shorten time-to-degree (or at least the 180

[8] Prior to pre-state buyout of Summer session. For those campuses with State funded Summer session, Summer classes count as University of California units. In the past, (and for this cohort) they counted as transfer units.

units of University of California workload) to 11,090 or 70 percent of the entering cohort who graduated within the six years of the study.

On the other hand, we can be fairly certain that the 1,062 students who needed more than eight units and received summer degrees used some non-University of California units. There were also 281 students who did not appear to have enough units from any source to graduate. Presumably some of these were errors caught after the data tapes were sent, and some are students who "found" courses that they had taken outside of the University of California and transferred in at the last minute. This leaves us with 1,343 students who needed non-University of California units (including AP) of those who graduated over the summer. These students may have used AP units in order to graduate and their analysis is handled in the next section.

Students with Unit Deficits

After taking into account students who got degrees in the summer (removing those who only needed eight units and apparently took them over the summer), there were 3,260 students who needed more non-University of California units than they had AP units in order to graduate. This does not help determine which students used AP units, but does illustrate the magnitude of units brought in from outside the regular University program to help meet requirements; moreover, it shows that AP units are not the largest source of non-University of California units.[9]

Students Without 180 University of California Units Requiring Units Beyond Advanced Placement Units

Units Required To Graduate beyond AP	Number	Percent
01-04	779	23.90
04-08	542	16.63
08-12	840	25.77
12-20	596	18.28
20-28	252	7.73
28-36	123	3.77
More than 36	128	3.93

[9] For this cohort University of California Summer programs are treated like external transfer units.

Total	3,260	100.00

Moving back to the original question, a matrix of unit deficits and AP units available indicates that there were 2,984 students who could meet all of their unit deficits with AP units. There is no data to indicate whether they actually used AP (or other units brought in when they matriculated) or if they used other transfer units earned after matriculation. Students may or may not have had the option of using AP units since requirements for specific courses and other limits may have precluded their use.

One way of getting around this problem is to assume that transfer units earned after matriculation would have a greater chance of being used as compared to AP units since presumably the student had a better idea of what courses were needed after he or she started college as compared to what they may have earned prior to enrolling. Presumably students would not go to the trouble and expense of getting additional units from an outside institution once they had started at the University unless they had a clear need for them. Therefore, it is assumed that units transferred after freshman year will be used first to make up the deficit.

Starting with that assumption, the total number of non-AP units earned (i.e., those transfer units earned after the freshman year) was subtracted from the non-University of California units needed to graduate. The balance represents units that had to be filled from the AP unit stock. If the above assumption is true, then these represent the minimum number of AP units utilized.

The actual number will be somewhat higher, since it is likely that not all transfer units were utilized if an AP unit fit better (or got counted first). Additionally, some post-freshman year transfer units may have been taken for interest rather than for need, or for a need that never materialized. However, the number of such units should be small.

Students Who Needed AP Units to Graduate
Having Exhausted Transfer Units Earned After Freshman Year

AP Units Required To Graduate	Number	Percent	
01-04		969	6.27
04-08	1,206	7.81	

08-12	699	4.52
12-20	922	5.97
20-28	413	2.67
28-36	161	1.04
More than 36	118	0.76
Total needing AP	**4,488**	**29.05**
Total needing no AP	10,962	70.95
Missing[10]	217	0.95

If we assume that these were the only AP units used to replace University of California units, and that all other units required came from other post-freshman year sources, we expect that AP units shortened time to degree by at least one quarter for 2,874 students (18.3 percent of the total number of freshmen in the cohort). An additional 1,335 students (8.5 percent) should have reduced their time-to-degree by two quarters and about 279 (1.8 percent) saved three or more quarters. Actual quarters not enrolled depend upon the number of units per quarter earned – 12 is approximately the minimum needed to count as making adequate progress. Total number of person-quarters saved would be about 6,161 or 2,054 FTE.[11]

Average Course Load

Another way students might make use of AP units is to reduce their course load while they are enrolled, that is, take the normal amount of time to graduate, but reduce their average number of courses per term.

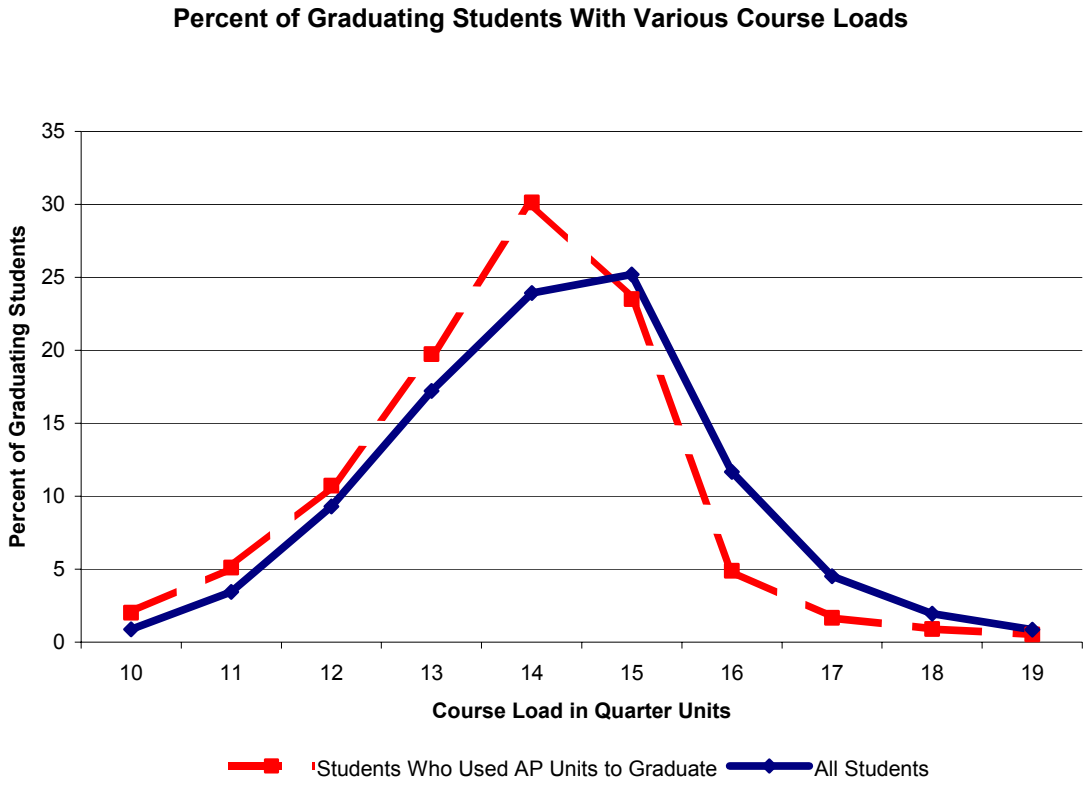
Since a linear regression is the most straightforward (more AP means fewer courses taken per term) the analysis again started there. And again, the results were significant, in the correct direction, and had a very tiny adjusted R^2. This was true for a number of restrictions on the number of AP units (all, middle range, non-zero, etc.), and on the average number of units taken, for total-to-date, the last term enrolled, and for restricted sets.

[10] Believed, based on conversations with Registrars, to have used some transfer units, which were found at the end of the student's career and accepted, or to be the result of data error. The numbers of units needed to graduate for almost all of these students was very small.

[11] This does not mean that students graduated faster, some of them may simply have taken fewer University of California units, reducing the University's workload, but not its headcount.

However, if the average course load for all students is compared to those who needed to use AP units in order to graduate, then a pattern of lighter course load is clearly observed. It is not evident why there is no predictive relationship on an individual student level since plotting the averages seems to generate a clear result. (figure 1).

Figure 1

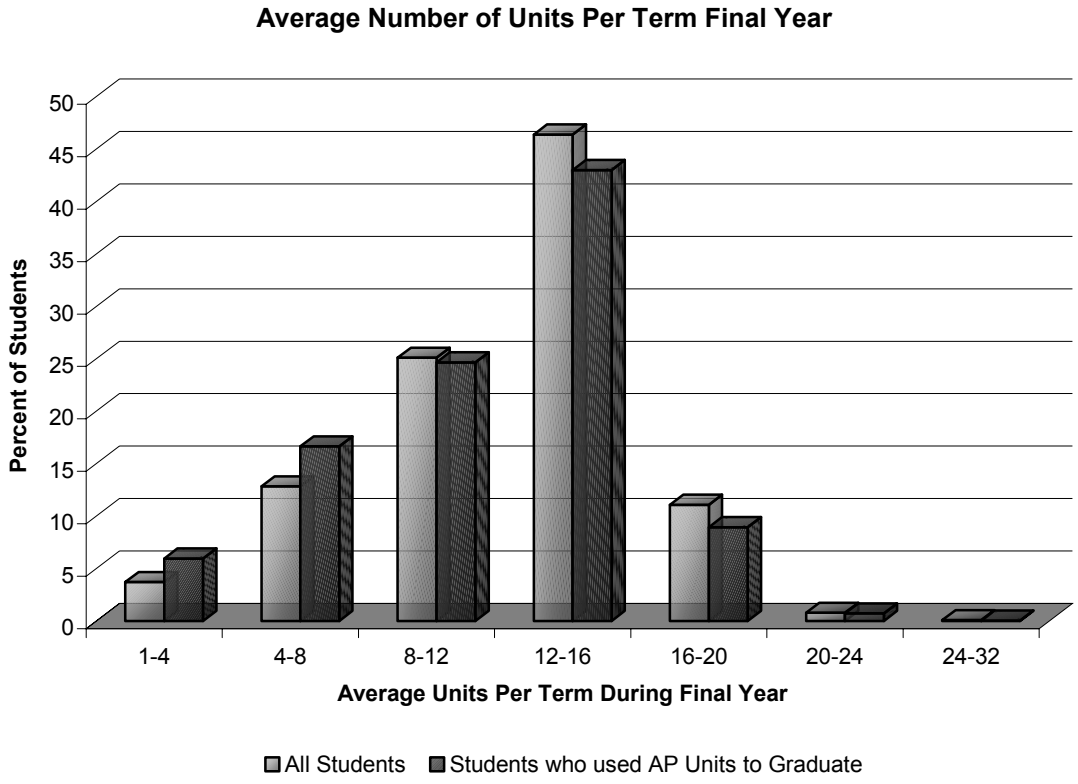


If one only looks at the last year the student was enrolled before earning a degree, it is apparent that there exists a tendency for students who used their AP units to take a slightly lighter load than did students in general (figure 2).[12]

[12] The dataset did not allow examining individual quarters, so an average of quarters actually enrolled was used instead.

Decision tree analysis also failed to identify any particular other characteristic determining which students would chose to use their AP units to reduce their course load other than the tautology that some that could, did in fact reduce their average load.

Figure 2



High Unit Majors and Double Majors

Another belief commonly held was that students who take majors that have a large number of requirements, leading to more than 180-quarter units required to

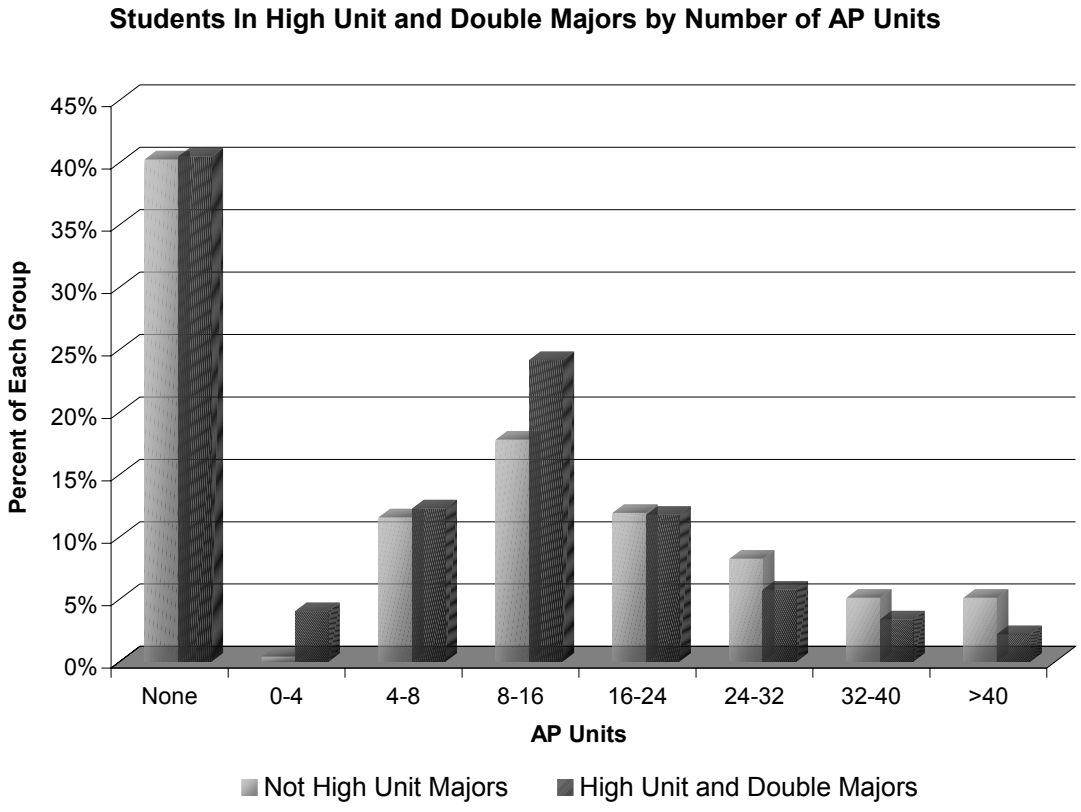
graduate, or students taking double majors will tend to be the students with the most AP units.

The next chart (below) shows that the opposite seems to be true. Students with large numbers of AP units tend to be slightly less likely to graduate with high unit or double majors as compared with those graduating with normal 180-quarter unit majors.

Students without any AP units seemed equally likely to take high unit or double majors as to major in a field without any special requirements (figure 3).

Regression analysis failed to show any relationship between AP units and the academic index ((high school GPA *1000) + SAT I + SAT II), which was also an expected relationship. This was true for all students and the subset of students with more than 20 AP units.

Figure 3



Conclusions

The failure of the regression model to show a clear, strong, linear relationship between time-to-degree and the number of AP and other college units brought into the University of California at matriculation indicates that a simple model of straight unit for unit replacement is incorrect. Some students clearly substitute AP units for University of California units and we can determine with some degree of certainty that about one-third of the entering freshman cohort uses at least a few units of AP to substitute for coursework they would otherwise have to take at the University. Some students, about ten percent, substitute more than one quarter's worth of courses. It is also clear that about 70 percent of students do not need the AP units (if any) that they brought in with them since they earn 180 or more University of California units.[13]

Decision tree analysis shows that students with large numbers of AP units (more than 27 units) tend to enroll for slightly fewer quarters than those with fewer AP units, but the two quarters worth of units is associated with only half a quarter less time enrolled and an average that still exceeds four years. Only about two hundred students with vast numbers of AP units (>51.) form a coherent group that (just) beat the four year mark. While it appears that AP units have a linear relationship with reduced time to degree from decision tree analysis the relationship is clearly very weak and there are large number of students at each level of AP unit holding that do not appear to use their AP units to reduce their time to degree.

While there is no apparent predictable relationship between the number of AP and other college credits brought in by an entering freshman on the average number of units taken per term, there is an overall effect on the total number of student quarters enrolled and total courses taken per student term. Students who earn less than 180 University of California units and need their AP units to graduate, do take fewer units per term compared to the overall cohort population.

From this, we can infer that about a third of University of California students make use of their AP units to graduate and many of them take a slightly lighter course load as a way of utilizing their AP units. At this level of analysis, we

[13] Since double majors and certain high unit majors require more than 180 units, these figures are not exact, and the number of students requiring AP and transfer units to graduate is understated.

cannot predict which individual students will use their AP units, or how they will use them if they choose to do so. In fact, it appears that the factors influencing student use of AP units are nearly entirely exogenous to the fact that they have them and do not appear to be related to income.

Additional transcript level analysis at the campus level may provide better answers about the conditions under which students decide to use AP and other transfer credits they brought with them as incoming freshmen, but the Systemwide data does not provide clear answers, other than to show that in aggregate, AP units do matter, but not in a way that can be predicted for individual students *a priori*.