QUARTERS AND SEMESTERS: AN ANALYSIS OF CALIFORNIA POSTSECONDARY
SCHOOL SYSTEMS

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1. Introduction

The debate surrounding the postsecondary academic calendar is a small fragment of a larger discussion regarding the value of higher education. In an economic climate where a college degree functions as a minimum prerequisite for employment, colleges and universities are clamoring to sell the ultimate "college experience" to potential students. What constitutes the best learning environment is difficult to quantify without significant reliance on the individual preferences of students, faculty, and administrators. Thus, an investigation of the advantages and disadvantages of the quarter system versus its semester counterpart must be qualified by its significant reliance on subjective inputs. Furthermore, underlying institutional factors such as university reputation, professor quality, and class size convolute the unique effect of academic calendar year on student success. It is important to retain these considerations when evaluating statistical output and survey results.

It is the goal of this paper to explore the effect of academic calendar year on four-year graduation rates for both the University of California (UC) and California State University (CSU) school systems throughout the years 2004-2013. Employing a multiple linear regression model, explanatory variables such as full-time first-year retention rate, prevalence of undergraduate financial aid, year, and portion of men and women on each campus, will be included in addition to academic calendar year to describe the trends in graduation rates. In accordance with the modest collection of existing research, the author is interested in evaluating whether one academic calendar is more conducive to student learning and success. This paper deviates from the published literature in that it takes a primarily objective approach as opposed to the popular perceptual methods used by those before it. Student success for the purposes of this paper will refer to the percentage of students who have graduated with a bachelor's degree within four years at each

institution. All the data used in this study was collected from the Integrated Postsecondary Education Data System of the U.S. Department of Education. Previous studies have measured student perceptions of their learning environment under both the quarter and semester systems using survey response techniques. The following section will explore those insights.

2. Review of the Literature

Perhaps the most comprehensive analysis of the quarter-semester dichotomy was conducted at Iowa State University in the early 1980s throughout its transition from a quarter calendar to a semester system. As part of a three-phase longitudinal study, researchers surveyed students on their perceptions of the learning environment before, during, and after an institutional transition from quarters to semesters. The first of the studies was published as a dissertation by James Moore and focused specifically on ISU student perceptions of their learning environment under a quarter calendar. For purposes of his research, Moore defined learning environment as "the interaction among institutional characteristics, human relationships and campus events as they affect the process of learning" (Moore 1982, 11). Through use of a Likert five-point survey with responses ranging from "strongly agree" to "strongly disagree," Moore was able to isolate from his 1,340 respondents four primary factors that shaped student perceptions of learning. Specifically, he identified grade point average, classification (year in school), level of organizational involvement, and college affiliation as significant independent variables (Moore 1982).

One of the major findings of Moore's analysis emerged in the relationship he observed between grade point average and student perceptions of their learning environment relative to a change in academic calendar. Specifically, whether the respondent was an "excellent" or "poor"

student by definition of their GPA range had a significant impact on how they viewed each calendar system. Moore described the "excellent" student as one who maintained a GPA in the 3.5-4.0 range and who was succeeding in the quarter system learning environment. Those within this GPA cohort "found the curriculum challenging and broadening, and experienced a high degree of interaction with the faculty" (Moore 1982, 89). Interestingly, this type of student generally opposed the transition from a quarter system to a semester system. Conversely, the "poor" student with a GPA below a 2.0, perceived "more fragmentation and pressure in the learning environment" and thus favored semester conversion. Moore noted a similar pattern between freshmen and senior students, with the younger students being more optimistic towards a calendar change than the more experienced senior students. Overall, Moore's key insight was that student perceptions of their learning environment were significantly shaped by factors at work in that environment (Moore 1982).

Building upon the foundation set forth by Moore, David Kelley continued the longitudinal research of student perceptions during the transition period from quarters to semesters at ISU. Following the same survey methodology employed by Moore, Kelley expanded the previous model to address the purported advantages and disadvantages offered by each calendar. Common pros associated with the semester system included: more time to study topics in depth, extended projects, stronger relationships with professors, and increased opportunities for faculty research. Among the perceived benefits of the quarter system were more frequent class meetings, greater variety of course offerings, smaller class sizes, and increased flexibility in scheduling. Disadvantages centered on the structural nature of each calendar, with semesters promoting procrastination due to the longer instruction period and quarters enabling the "cramming" habits of students because of more frequent examinations (Kelley 1983).

Kelley classified the perceived advantages of both the semester and quarter calendars into separate factors in his survey using the same five-point response scale implemented by Moore. He conducted a t-test to assess the difference in mean factor scores from the time before the semester conversion to after the transition was complete. Of the 603 respondents to Kelley's new survey, 531 were students who had also responded to Moore's initial survey instrument. Kelley contributed to the longitudinal research in that he found a significant difference in the factor of perceived semester advantages before and after the conversion process. Specifically, the perceived advantages of the semester system were rated significantly lower (at the 0.001 level) in the year after conversion than in the year before a change in calendar was implemented. Additionally, there was a significant difference in the quarter advantages factor after the transition when compared to the perceptions expressed before the shift. Overall, the study highlighted the negative trend in the favorability of semesters after ISU converted from its quarter system. Kelley recommended that further research be conducted to investigate how his observed change in student perceptions impacted student success and performance (Kelley 1983).

In search of an answer to Kelley's question, researchers at the University of Minnesota-Twin Cities conducted a study to compare biology student performances before and after the school converted from quarters to semesters in 1999. Specifically, the researchers used chi-square tests to compare student performances two and a half years before and after UMNTC underwent an academic calendar change. In the context of the study, student performance was assessed by "mean final course scores, grade distributions, and question-specific performance on exam questions that were asked both before and after the change in calendar" (Gibbens et al. 2015). Despite a general favorability towards semesters, the researchers discovered that the students performed collectively better under the quarter calendar. Specifically, students studying under the

quarter system "earned significantly more A's and B's and fewer C's, D's, and F's (p<0.00012) than did the students enrolled in the semester calendar" (Gibbens et al. 2015). Furthermore, the researchers found that the students appeared to perform worse during the semester system even though they spent approximately 39 percent more time on each topic than did their peers under the quarter system. Although the differences in student achievement proved to be individually significant, the researchers concluded that their results could not be extrapolated to provide assertion of one calendar's superiority to the other in terms of student performance (Gibbens et al. 2015).

Taken in tandem with the responses from Moore and Kelley's longitudinal surveys, the findings at UMNTC uncover some of the ambiguity surrounding the impact of academic calendar on student performance. The perceptual methods used heavily in the earlier research are given additional quantitative support through the objective measure of student performance before and after the transition period at UMNTC. Although the cited works skew slightly in favor of a quarter-based calendar, immense limitations exist in the preferential ordering of each institutional transition from quarters to semesters. Since no natural experiment exists in which a school transitioned from semesters to quarters, it becomes difficult to discern if perceptions and student performance were negatively impacted by virtue of the semester calendar or simply because of a change in the general environment. Perhaps identical results would be observed for the quarter system had each case initially started from the baseline of a semester designation. The importance of this nuance cannot be overlooked when evaluating the results of the existing literature.

This paper will attempt to address the issue of ordering bias through impartial examination of four-year graduation rates for the UC and CSU school systems without the pretense of transition from one calendar to the other. Each institution will operate under the same academic calendar

from its base year in 2004 throughout the ten year period extending to 2013. Additionally, the scope of the research will follow objective analysis as opposed to the perceptual response methods utilized by Moore and Kelley. The author will explore the possible effect of academic calendar year on student success as measured in the trends of four-year graduation rates across time. The methods used in this paper differ from the existing literature in that its sample includes 32 institutions throughout the California postsecondary public sector. The following section outlines the respective conditions and assumptions of the economic model used for this empirical study.

3. Economic Model

In order to analyze the effect of academic calendar year on student performance, the author will employ use of the multiple linear regression model of the form: $Y = B0 + B1x1 + B2x2 + . . . Bkxk + u$. In this model, the dependent left-hand variable Y will represent the percentage of students receiving a bachelor degree within four years at each institution. The explanatory slope parameters will include: full-time retention rates of first-year students, percentage of full-time first-year undergraduates receiving any financial aid, year, and the portion of male to female students attending each school. In addition to the continuous variables, binary or "dummy" variables will be used to describe whether an institution is a UC or CSU, and if it operates on a quarter or semester system. In this case, a "1" value will be assigned to the UC institutions and "0" to schools in the CSU subgroup. The same methodology will be used to distinguish "1" for quarter schools and "0" for semester schools respectively.

Important assumptions that apply to multiple linear regression models provide expectations about the unbiasedness of data collection. Specifically, a population model must be linear in parameters where each Bk follows the linear model $Y = B0 + B1x1 + B2x2 + . . . Bkxk + u$.

Additionally, a random sample size of *n* observations is critical to provide meaningful regression results. The independent *xk* variables must not be constant or have relationships which display perfect multicollinearity. Perfect multicollinearity results when two variables are perfect linear combinations of one another and are included in the regression together; in this case the percentage of male and female students at each institution. The issue of imperfect multicollinearity is also important as it refers to the incidence of high correlation between two *xk* variables. Finally, for the results of a multiple linear regression to be adequately interpreted, we must assume that all of the independent *xk* variables are uncorrelated with the error term *u*; formally $E(u|x_1, x_2, \ldots x_k) = 0$. If the aforementioned assumptions apply, interpretation of *B1* can be described as the change in *Y* for a unit change in *x1* holding all other variables constant. In this sense, each *Bk* represents the partial effect of its *xk* variable.

To support a multiple linear regression model, the author will use the econometric software Stata for variable inputs and statistical analysis. Specifically, the effect of each parameter on four-year graduation rate will be evaluated as a t-statistic output with a respective p-value at the 0.05 significance level. Summary statistics for subgroups will be used in addition to graphical plots to illustrate data outcomes.

4. Empirical Analysis

Before conducting the regression analysis, it is useful to review the independent variables of interest as they relate to the dependent variable of four-year graduation rate at each institution. Particularly, this paper focuses on the partial effect of the binary variable *quarter* to determine if academic calendar has a significant impact on graduation rate. Also included in the regression are factors describing the full-time retention rate of first-year students, portion of full-time first-year

undergraduates receiving any financial aid, year, and the proportion of male to female students on each campus. At this point, it is important to note that of the 23 CSU schools included in the regression, only 6/23, or 26 percent operated on a quarter system. Conversely, 7/9, or 78 percent of the UC schools functioned on a quarter calendar (omitting UC San Francisco from the dataset). This phenomenon presents a unique issue in that the four-year graduation rates for the UC subgroup were notably higher than that of their CSU counterparts. The implication of this pattern yields a potential favoring of the quarter system by nature of the UC subgroup. Figure 1 illustrates a plot of the graduation rates for each group, with 0 representing the CSU schools and 1 representing the UC campuses.

Figure 1

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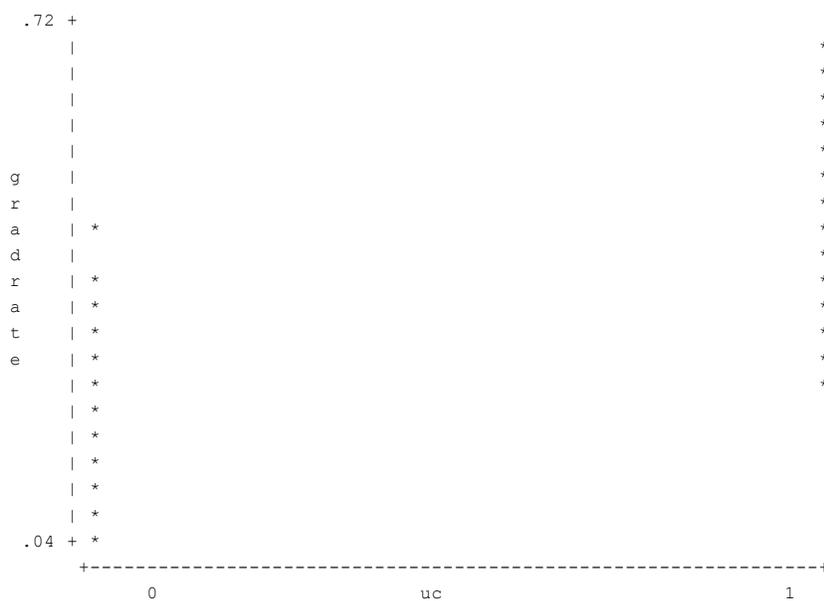
The results of Figure 1 prove to be statistically significant when a two-sample t-test is conducted on the mean four-year graduation rates for both the UC and CSU school systems. Figure 2 presents the statistical output describing the differences between the mean four-year graduation rates for the UC (53.2%) and CSU (15.3%) groups respectively. The data convey an astounding t-statistic of -29.2 and a corresponding p-value of zero when evaluated at the 0.05 level. Effectively,

one can reject the null hypothesis that the four-year graduation rates for the UC and CSU systems fall within the same normal distribution.

Figure 2

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Two-sample t test with unequal variances
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Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	225	.1528444	.005562	.0834303	.1418839	.163805
1	83	.5316867	.0117106	.1066887	.5083906	.5549829
combined	308	.2549351	.0108808	.1909576	.2335246	.2763455
diff		-.3788423	.0129644		-.4045088	-.3531758

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    diff = mean(0) - mean(1)                                        t = -29.2218
Ho: diff = 0                          Satterthwaite's degrees of freedom =  120.916

   Ha: diff < 0                       Ha: diff != 0                       Ha: diff > 0
 Pr(T < t) = 0.0000          Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
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A similar result occurs when comparing the mean four-year graduation rate across institutions operating on a quarter system versus a semester calendar. Again employing use of a two-sample t-test, it is clear that the average four-year graduation rate for schools on a quarter system (34.8%) are significantly greater than the average for the semester schools (18.7%). The t-statistic of -7.6 and zero p-value indicate that the quarter schools in the sample graduate a significantly higher portion of students within four years than the semester schools in the sample. The issue with these results is that the effect of the quarter calendar is being influenced in large part by the nature of the UC subgroup. For this reason, it is important to include in the regression an interaction term between the dummy variable distinguishing the UC schools and the binary indication for whether a university operates on a quarter or semester system. Such an interaction will be critical in order to isolate the individual influence of academic calendar year on the four-

year graduation rates for all institutions. Figure 3 displays the two-sample t-test by academic

calendar year for the sample.

Figure 3

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Two-sample t test with unequal variances
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Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	178	.1870225	.0108368	.1445805	.1656366	.2084084
1	130	.3479231	.0181916	.2074156	.3119306	.3839155
combined	308	.2549351	.0108808	.1909576	.2335246	.2763455
diff		-.1609006	.0211747		-.2026351	-.1191661

```
    diff = mean(0) - mean(1)                                  t =   -7.5987
Ho: diff = 0                        Satterthwaite's degrees of freedom =   216.893

    Ha: diff < 0                    Ha: diff != 0                    Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
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Despite the preliminary propensity towards the quarter system, a linear regression reveals

interesting relationships between the left-hand variable of four-year graduation rate and the

independent variables in the model.

Figure 4

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Linear regression                            Number of obs     =        308
                                             F(7, 300)         =     265.74
                                             Prob > F          =     0.0000
                                             R-squared         =     0.8536
                                             Root MSE          =     .07391
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gradrate	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf. Interval]	
quarter	-.0155618	.0093598	-1.66	0.097	-.0339809	.0028573
uc	.3674874	.0431071	8.52	0.000	.2826568	.452318
ucquarter	-.0187787	.0397481	-0.47	0.637	-.096999	.0594416
year	.0078519	.0016684	4.71	0.000	.0045686	.0111352
retentionrate	.3232762	.092802	3.48	0.001	.1406508	.5059015
financialaid	-.1983607	.0481503	-4.12	0.000	-.2931157	-.1036056
undergrad_women	-.3315469	.0864737	-3.83	0.000	-.5017188	-.161375
_cons	-15.56234	3.326794	-4.68	0.000	-22.10915	-9.015529

The output in Figure 4 provides many important insights to the effect of various independent factors on students' ability to graduate within four years. Foremost, the regression reveals that the quarter system negatively impacts four-year graduation rates across all institutions. The inclusion of the interaction term *ucquarter* allows the coefficient for the variable *quarter* to be interpreted as the partial effect on four-year graduation rate for CSU schools operating on the quarter system. The coefficient for the variable *uc* reflects the effect of being a UC school, while the interaction *ucquarter* represents the effect of the quarter system for the UC subgroup. In this way, the coefficient for the variable *uc* reports the outcome for UC schools operating under the semester system only. Finally, the base group in the regression are CSU semester schools as represented by the coefficient on the *_cons* variable, or the y-intercept in the model.

Following the guidelines for the binary variables, the coefficient for *quarter* informs that the quarter system decreases four-year graduation rates by roughly 1.6% for CSU schools holding all other variables constant. In conjunction with the t-test for the CSU and UC subgroups, being a part of the UC system significantly improves the four-year graduation rate for students. Specifically, UC schools operating on semesters increase the four-year graduation rate by an incredible 36.7%, while UC's on the quarter system improve four-year graduation rates by 34.9% holding all else constant. Perhaps the most powerful insight from the regression comes from coefficient for the *ucquarter* variable. Despite the earlier preference for quarters in the two-sample t-test, it is clear that UC schools operating on a quarter system experience a 1.9% decrease in four-year graduation rate when compared to the UC semester schools. This finding is surprising given that a majority of the UC schools operate on a quarter system, the most notable being UCLA. The coefficient for the base group is confounding in that it describes a negative four-year graduation rate of 15.6% for CSU semester schools. However, the regression as a whole provides

overwhelming evidence that the quarter system negatively affects four-year graduation rates for both the UC and CSU school groups.

The remaining independent variables in the regression offer an important understanding of the effect of some of the "institutional characteristics" on four-year graduation rates for both the UC and CSU schools. First, the coefficient for the variable *year* explains that the four-year graduation rates for both the UC and CSU groups have been trending upward by roughly 0.008% each year holding all else constant. Additionally, for every 1 percent increase in the rate of retention of full-time first-year students, the four-year graduation rate can be expected to increase by 0.3% across all institution holding all other variables constant. Conversely, for every 1 percent increase in the portion of full-time first-year students receiving any financial aid, the four-year graduation rate can be expected to fall by roughly 0.2% all else constant. This is not surprising in that students receiving financial aid may have trouble affording tuition and might be exposed to other financial barriers. Interestingly, the regression also reports that for every 1 percent increase in the portion of undergraduate women, four-year graduation rate can be expected to fall by 0.3% for all institutions holding other variables constant. This decline is particularly confounding considering the fact that women on average have been graduating at higher rates than men in recent years. It should be noted that the coefficients for all of the variables above had t-statistics that were significant at the 0.05 level.

Overall, the variable with the most significant impact on four-year graduation rate was the *uc* binary with a t-statistic of 8.52 and a p-value of zero. This result agrees with the two-sample t-test for the difference in mean four-year graduation rates between the UC and CSU subgroups. Although the coefficient for the variable *quarter* was not significant at the 0.05 level, its t-statistic of -1.66 and p-value of 0.097 could be considered significant at an alpha level of 0.10. Such a

finding is a direct contradiction to the earlier works of Moore and Kelley, as well as the researchers at UMNTC, in that it provides considerable evidence in support of the semester system over the quarter alternative. It should be noted that the statistical output of the regression in this paper must be evaluated with caution due to the small nature of the sample size. An extension of the analysis to include data for the states of Washington and Oregon is recommended.

5. Conclusion

It is clear from the results of the linear regression that the quarter system has a negative impact on the four-year graduation rates for both the UC and CSU subgroups. This finding is important not only because it challenges the existing literature, but also because it provides evidence in support of a national transition to the semester system. In a postsecondary environment where roughly 90 percent of universities operate on a semester calendar, it is critical that students, faculty, and administrators seriously consider the advantages of conversion (Mayberry 2009). Despite the immediate perceptual red flags raised by Moore and Kelley, the semester system could substantially improve student outcomes in the long term. Additionally, the analysis of student performance at UMNTC may have been more conclusive if it extended beyond the two-year period before and after the university converted from quarters to semesters.

This paper has significant implications for stakeholders at California Polytechnic State University in that the university-wide discussion of conversion to semesters is relevant and consequential. It is imperative that university leaders weigh the current administrative costs of conversion against the potential improvements to four-year graduation rates for undergraduates. The decision to operate under semesters is one that could align Cal Poly with the national calendar and provide students and faculty with the benefits currently enjoyed by semester schools within

the CSU and UC systems. Although the conversion process is often met with unfavorable perceptions, it is necessary to develop an educated consciousness of the potential advancement of student learning.

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