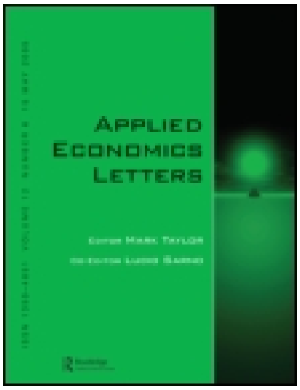

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Cumulative class attendance and exam performance

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Cumulative class attendance and exam performance

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This study considers the effect of cumulative class attendance while estimating the relationship between class attendance and students' exam performance, using an individual-level data. We find that, cumulative attendance has produced a positive and significant impact on students' exam performance. Attending lectures corresponds to a 4% improvement in exam performance, and the marginal impact of cumulative attendance on exam performance is also close to 4%. It is of note that the impact of attendance on exam performance is reduced about 0.4% after one controls for the cumulative attendance effect.

I. Introduction

The determinant of college students' academic performance is an important issue in higher education. Students' efforts, professors' teaching inputs, class size (Nelson and Hevert, 1992; Hanushek, 1999), exam time taken (Feinberg, 2004) and socio-demographic characteristics such as race and gender (Siegfried, 1979; Ferber *et al*., 1983; Watts and Lynch, 1989; Anderson *et al*., 1994; Borg and Stranahan, 2002) are all possible factors that could produce an impact on students' exam performance. Among all variables, whether or not students attend lectures and classroom discussions affect their exam performance has received considerable attention.

Lectures and classroom discussions are major means of instruction for most undergraduate courses. In light of the fact that absenteeism is rampant in undergraduate courses at major American universities, many researchers have investigated the relationship between class attendance and exam performance, using either a micro or a macro data approach (Anikeeff, 1954; Schmidt, 1983; Jones, 1984; Buckalew *et al*., 1986; Brocato, 1989; Park and Kerr, 1990; Van Blerkom, 1992; Romer, 1993; Gunn, 1993; Durden and Ellis, 1995; Devadoss and Foltz, 1996; Marburger, 2001; Bratti and Staffolani, 2002; Dolton *et al*., 2003; Kirby and McElroy, 2003; Rodgers, 2002; Rocca, 2003; Stanca, 2006; Chen, 2005).

Prior literature has found a strong statistical relationship between absenteeism and exam performance. On average, students who attend more classes perform better on their exams. However, none of the previous studies has considered the impact of past cumulative attendance on exam performance in addition to the attendance effect. The goal of this study is to explore the effect of cumulative attendance on students' exam performance, using an individual-level data set.

As is known, learning takes time; students may need several lectures to absorb materials taught by professors. In addition, concepts and models covered in earlier lectures may be used repeatedly later to analyse much more complicated issues. Therefore, one would expect that students' past cumulative attendance help them understand the subject better and enhance their grades. This is virtually true for

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most subjects including Economics. For example, students might feel confused about different shapes of indifference curves when they first learned this concept. After attending several classes, the repetitive use and the application of this concept should enable them to become familiar with this subject. Later, students would feel more comfortable analysing the maximization problem given their good understanding of indifference curves. Therefore, one would expect that students who missed fewer classes in the past might do better in their exams. As a result, it is important to incorporate this cumulative attendance effect when estimating the impact of attendance on exam performance.

In Section II, statistical models will be discussed. In Section III, the data used for this study will be examined. The estimation results are reported in Section IV, and the conclusion is summarized in Section V.

II. Statistical Models

This study employs micro level data to investigate the impact of cumulative attendance on exam performance. The following linear function is used to describe the relationship between exam performance and various input variables for learning.

$$y_{ij} = \beta x_{ij} + \alpha_i + \varepsilon_{ij}, \quad i = 1 \ldots N, j = 1 \ldots J \qquad (1)$$

N is the number of students and J is the number of exam questions. y_{ij} corresponds to student i's exam performance on question j; x_{ij} is student i's set of observable inputs in learning question j. β represents the estimated student input effect vector. α_i represents student i's time-invariant individual effect and ε_{ij} is the random disturbance term.

This study employs a linear probability model instead of a probit model when estimating the individual effect. The main reason for doing this is that concern is about the incidental parameters problem in a nonlinear panel model (Wooldridge, 2002; Greene, 2003). In addition, among panel linear probability models, the fixed effects model is better than the random effects model because one will need to assume that the individual effect is orthogonal to the disturbance term under the random effects specification. However, this assumption is less likely to be true in the present model. Hence, the discussion will be focused on the fixed effects model. The estimation results of the least squares model and the random effects model are also listed for the use of comparison.

III. Data

A survey was conducted of 129 students who attended the Public Finance course at Tamkang University in Taiwan in the Autumn of 2004. All students who major in Industrial Economics are required to take this course in their third-year of study. Attendance is taken at each meeting of the class during the sample semester. There are 13 two-hour class meetings in addition to two exams and one project presentation during the sample period.

Students' demographic variables are collected form the survey distributed in the very first class of the sample semester. They include students' school year, gender, average grades before taking this course, living arrangement and family economic condition. Also, two questions, hours students spent preparing for the exam and hours they spent studying every week, were asked when students took their two exams. Table 1 reports the summary statistics of students' characteristics.

Table 2 reports the means and standard deviations of students' attendance, cumulative average attendance, and exam performance by demographic variables. The average absenteeism rate is about 8% in the sample; this number is lower than that in some previous studies (Romer, 1993; Marburger, 2001). However, it is worth noting that Public Finance is a required course for the third year students. As pointed out by Rocca (2003), when students are in their junior and senior years, they are more likely to come to classes. Thus, an 8% absenteeism rate seems reasonable.

In this study, the dependent variable is a binary variable indicating students' exam performance. Fifty multiple choice questions are asked in the midterm exam while 70 are asked in the final exam. Among the 70 final exam questions, 20 questions are exactly from the midterm exam questions. If students answer the exam question correctly 1 is assigned to the binary variable; otherwise the binary variable is 0.

Two main independent variables are attendance and cumulative attendance. It is argued that, in addition to attendance, materials and concepts that students have learned from previous lectures should also produce some effects on their exam performance. Therefore, one should take into account the cumulative attendance effect when estimating the impact of attendance on exam performance. The effect of cumulative attendance on exam performance has never been explored in prior empirical literature in this area.

The binary variable, *Attendance*, is coded as 1 if students have attended the lecture in which the class material covered that day was relevant to the

Table 1. Summary statistics.

	Sample size	%	Mean	Standard deviation
All students	129	1.000		
Year of Study				
Sophomore	1	0.780		
Junior	115	89.14		
Senior	13	10.07		
Gender				
Female	67	51.94	0.5194	0.5016
Male	62	48.06	0.4806	0.5016
Average grade before entering the course			70.337	8.7436
above 90	9	6.980		
80–90	51	39.53		
70–80	45	34.88		
60–70	24	18.60		
below 60	0	0.000		
Housing				
Live with relatives	51	39.53	0.3953	0.4908
Not live with relatives	78	60.47	0.6047	0.4908
Family economic condition				
Poor	7	5.430		
Below average	16	12.40		
Average	96	74.42		
Above average	9	6.980		
Wealthy	1	0.780		
Hours studied before the exam			8.8780	6.7571
Above 15 hours	12	9.300		
10–15 hours	19	14.73		
5–10 hours	76	58.91		
Below 5 hours	22	17.05		
Hours studied every week			1.4770	1.8597
Above 2 hours	26	20.16		
1–2 hours	62	48.06		
Below 1 hours	41	31.78		

corresponding exam question; *Attendance* is coded as 0 if students miss the class that day. The cumulative attendance variable is constructed as follows: the percentage of classes which the student has shown up before certain date. For instance, at the tenth lecture, if a student missed three classes in the past, then the cumulative attendance is coded as 0.7.

IV. Estimation Results

Table 3 reports the estimation results. The first panel presents the estimation results of the least squares method, the second panel presents the estimation results of the fixed effects method, and the third panel presents the estimation results of the random effects method. Within each method, four different models are estimated. Model 1 is the benchmark model. Model 3 differs from model 1 in that it incorporates the effects of preparation before the exam on exam performance. Also, models 1 and 3 do not take into account the effect of cumulative attendance on students' exam performance while models 2 and 4 do.

From the first panel (i.e. the least squares results), it is found that, on average, class attendance produces a positive and significant impact on exam performance. On average, students are more likely to answer exam questions correctly if they choose to attend lectures. Attending lecture corresponds to a 7.8% improvement in exam performance. However, the least square estimates could be biased in that it fails to consider the unobserved individual characteristics like motivation. We remedy this potential problem by using the panel estimator.

From panel two (i.e. the fixed effects results), it is found that attending lectures corresponds to a 4% improvement in exam performance after incorporating the time-invariant individual heterogeneity. This suggests that the least squares result might overestimate the impact of attendance on exam performance. This finding is consistent with

Table 2. Attendance, Cumulative Attendance, and Exam Performance

	Attendance		Cumulative Attendance		Exam Performance	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
All students	0.9219	0.0098	0.6767	0.0354	65.52	0.8232
Year of study						
Sophomore	1.0000		0.7083		34.05	
Junior	0.9344	0.0080	0.6785	0.0355	66.12	0.7814
Senior	0.8047	0.0167	0.6567	0.0329	62.06	0.8218
Gender						
Female	0.9334	0.0078	0.6790	0.0356	66.29	0.8537
Male	0.9094	0.0115	0.6742	0.0351	64.66	0.7880
Average grade before entering the course						
above 90	0.9744	0.0038	0.6332	0.0329	74.87	0.4936
80–90	0.9316	0.0073	0.6708	0.0349	66.16	0.8320
70–80	0.9095	0.0098	0.6775	0.0342	61.74	0.6469
60–70	0.8034	0.0198	0.6962	0.0382	56.87	0.6139
below 60						
Housing						
Live with relatives	0.9110	0.0127	0.6716	0.0361	66.88	0.7234
Not live with relatives	0.9290	0.0072	0.6801	0.0349	64.64	0.8778
Family economic condition						
Poor	0.9121	0.0082	0.6671	0.0347	63.98	0.5453
Below average	0.9471	0.0077	0.6872	0.0368	66.21	0.6132
Average	0.9295	0.0082	0.6780	0.0354	65.44	0.8818
Above average	0.8803	0.0084	0.6633	0.0314	66.43	0.7419
Wealthy	0.2308		0.4250		48.00	
Hours studied before the exam						
Above 15 hours	0.9487	0.0053	0.6491	0.0363	59.92	0.0059
10–15 hours	0.9271	0.0066	0.6850	0.0352	66.50	0.0094
5–10 hours	0.9200	0.0091	0.7018	0.0348	65.28	0.0085
Below 5 hours	0.9091	0.0150	0.6358	0.0354	68.86	0.0059
Hours studied every week						
Above 2 hours	0.9172	0.0071	0.6892	0.0378	65.61	0.0087
1–2 hours	0.9194	0.0070	0.6653	0.0349	65.22	0.0088
Below 1 hours	0.9287	0.0141	0.6842	0.0338	65.93	0.0070

the prediction. Also, the results in the random effects specification are similar to that in the fixed effects specification.

As discussed earlier, in addition to the attendance effect, cumulative attendance could also produce some impact on exam performance. As expected, students with higher previous class attendance perform better in the exam. Cumulative attendance has a positive and significant impact on exam performance in all models. On average, the marginal impact of cumulative attendance on exam performance is also close to 4%. It is of note that the impact of attendance on exam performance is reduced about 0.4% after we control for the cumulative attendance effect.

Generally, the estimation results are comparable to prior studies. For instance, Stanca (2006) finds that the OLS estimates overestimate the impact of attendance on exam performance. In addition, Marburger (2001) and Stanca (2006) find that lecture attendance corresponds to a 2% to 4% improvement in exam performance. However, none of the previous literature has discussed this cumulative attendance effect which also yields a positive and significant impact on exam performance in the model.

V. Conclusion

This study considers the effect of cumulative class attendance while estimating the relationship between class attendance and students' exam performance in a panel setting. This cumulative attendance effect has long been neglected in prior research. It is found that, in addition to attendance, cumulative attendance is a strong predictor on students' exam performance. The empirical result shows that attending lecture corresponds to a 4% improvement in exam performance. Cumulative attendance has produced a positive and

Table 3. Estimation results

	Panel Linear Probability Model											
	Least Squares Method				Fixed Effects Model				Random Effects Model			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Dependent variable	Answer the Question Correctly (yes = 1, no = 0)											
Independent variable												
Attendance	0.0778**	0.0723**	0.0783**	0.0730**	0.0404**	0.0372**	0.0404**	0.0373**	0.0490**	0.0453**	0.0494**	0.0457**
	(0.0149)	(0.0151)	(0.0149)	(0.0151)	(0.0161)	(0.0162)	(0.0161)	(0.0162)	(0.0155)	(0.0155)	(0.0155)	(0.0155)
Cumulative attendance	NO	0.0428**	NO	0.0419**	NO	0.0391**	NO	0.0382**	NO	0.0402**	NO	0.0392**
		(0.0188)		(0.0187)		(0.0185)		(0.0188)		(0.0185)		(0.0185)
Old exam question	0.3038**	0.3038	0.3061**	0.3062**	0.3026**	0.3027**	0.3037**	0.3039**	0.3030**	0.3031**	0.3044**	0.3045**
	(0.0127)	(0.0127)	(0.0128)	(0.0128)	(0.0124)	(0.0124)	(0.0125)	(0.0125)	(0.0118)	(0.0117)	(0.0118)	(0.0118)
Hours studied before the exam	NO	NO	−0.0019**	−0.0019**	NO	NO	−0.0004	−0.0004	NO	NO	−0.0012	−0.0012
			(0.0004)	(0.0004)			(0.0010)	(0.0010)			(0.0008)	(0.0007)
Hours studied every week	NO	NO	−0.0025**	−0.0024**	NO	NO	0.0003	0.0003	NO	NO	−0.0006	−0.0006
			(0.0013)	(0.0013)			(0.0020)	(0.0020)			(0.0018)	(0.0017)
Exam question dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-squares	0.2172	0.2175	0.2184	0.2186	0.2566	0.2569	0.2565	0.2567				
F-value or X^2 value[A]	66.59**	66.23**	65.51**	65.15**	63.34**	62.92**	61.76**	61.36**	4392.13**	4398.09**	4369.75**	4375.41**
Sample size	15,340	15,340	15,340	15,340	15,340	15,340	15,340	15,340	15,340	15,340	15,340	15,340

Note: ** is at 5% significant level and * is at 10% significant level. White (1980) robust standard errors are in parentheses. YES means that the variable is included in the regresion model, and NO means that the variable is not included in the regression model.

[A]: the F-values are reported in the Least Squares and Fixed Effects models; the X^2-values are reported in the Random Effects models.

significant impact on students' exam performance; the marginal impact of cumulative attendance on exam performance is also close to 4%. Moreover, the impact of attendance on exam performance is reduced about 0.4% after one controls for the cumulative attendance effect.

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