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Endogenous effects of midterm grades and evaluations: a simultaneous framework

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Abstract

In this paper, we estimated the link between overall evaluations and grades in a simultaneous framework. We adopted midterm grades rather than expected grades as a proxy for final grades, which is innovative in studies of this issue. In doing so, we found a positive and significant relationship between overall evaluations and midterm grades, which implies that students rate their professors primarily based on their midterm achievement.

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1. Introduction

Teacher performance is one of the primary factors determining student performance. Since the quality of teaching service cannot be easily monitored by a third party (including deans and department heads), universities and colleges have adopted student evaluations as a means of assessing faculty performance in the classroom. In other words, teacher performance is measured by students, but student performance is determined by teacher performance. If student performance and teacher performance are reflected in students' grades and student evaluations of teachers (SETs), respectively, then grades and SETs are simultaneously determined and endogenously correlated. For that reason, a simultaneous framework may be an appropriate method to use in estimating the link between SETs and grades.

The challenge in conducting this type of study is in the timing of the focal activity – that is, students' final grades are determined after students fill out the evaluation, which means that a proxy is needed for students' final grades. Indeed, a fair number of previous studies have empirically investigated the issue (e.g., Voeks and French, 1960; Kelly, 1972; Nichols and Soper, 1972; Soper, 1973; Mirus, 1973; Tuckman, 1975; Danielsen and White, 1976; Dilts, 1980; Marlin and Niss, 1980; Seiver, 1983; Nelson and Lynch, 1984; Aigner and Thum, 1986; Mason, Steagall, and Fabritius, 1995; Krautmann and Sander, 1997; Becker and Watts, 1999; Grimes, Millea, and Woodruff, 2004; Isely and Singh, 2005; McPherson, 2006). All of these studies used reported grade expectation as a proxy for students' final grades. In this paper, we adopt an alternative proxy – students' midterm grades – for students' final grades rather than reported grade expectation.

We conducted a survey in spring 2008 to learn more about students' final grade expectation. The survey was distributed and collected some time before the final exam and after the midterm exams. The questions were: "What grade for this class do you expect to receive? Why do you expect that grade? Express your reasons." We found that students' expected grades basically depended on their midterm grades, yet still differed. The difference between the expected final grade and midterm grades was based on the expectation of a grading curve, which, if available, would enable them to improve their grade on the final exam or at least do as well as on the midterm exams. Since expected grades and midterm grades are not actual final grades, both must have some bias. However, this is not our main concern. Our primary interest was in students' rating behavior. Students, as human beings, experience emotions. Since students fill out the evaluation after midterm exams have been completed and graded, those grades will likely and directly affect students' emotions and thus in turn influence their rating behavior. Both expected grades and final grades will not affect students' rating behavior because expected grades are not real grades (they are just expectations) and final grades are determined after students fill out the evaluation. The evidence for this statement was offered by Seiver (1983), who adopted a simultaneous framework in his study on this topic. His findings led him to suggest that students' expected grades do not relate to their overall evaluations of teachers. Certainly, some researchers, such as Krautmann and Sander (1999), have shown that expected grades and SETs are positively and significantly related. Nevertheless, if expected grades exert an impact on students' rating behavior, the effect may stem from midterm grades, because midterm grades are real grades and expected grades are mainly based upon midterm grades. Another issue is the possibility that students may not be able to forecast accurately. Therefore, in this case study we used the average of a student's grades on two midterm exams as a proxy, which is innovative and may be a better measure.

This paper is organized as follows. First, the basic framework and data measurement plan are presented. Second, econometric models and empirical results are reported. Third, a debatable argument is raised for discussion. The conclusion may be found in the final section.

2. Basic Framework and Data Measurement

Due to endogeneity, the professor's overall evaluation and the student's grade are jointly determined simultaneously. Hence, a simple simultaneous-equation model can be specified as follows:

Overall Evaluation = f (*Student's grade*, *Student's quality*, *Student's interest about the class*, *Student's marginal cost*, *Professor's communication skill*), and

Student's Grade = f (*Overall Evaluation*, *Student's quality*, *Student's interest about the class*, *Student's marginal cost*, *Professor's communication skill*).

To obtain the individual-micro data, a questionnaire was created at the end of the spring 2008 semester. Three *Principles of Microeconomics* classes taught by three different instructors were used as a case study. About one week before the final exam, a secretary handed out the questionnaires to each student in each of these three classes. The total effective number of participants was 99 students (A total of 23 surveys were not effective. The details are provided later.) Although 99 surveys may be a small number, they reflected the variation of the study for two reasons: (1) these 99 students were not just taught by one instructor; and (2) these 99 students were from a number of different majors on campus, such as business, economics, social sciences, humanities, engineering, education, and so on. Moreover, prior researchers, such as Howard and Maxwell (1982), only adopted 83 students in a sample to investigate the relationship between grades and student satisfaction. Therefore, the analysis should be believed in light of the sample size. In addition, responses were anonymous. In other words, the results of the final exam absolutely did not affect students' responses. Meanwhile, it is assumed that students responded to each question honestly. Table 1 reports means and standard deviations for the variables used.

The details of the questionnaire are as follows:

1. *Student's quality*. We used SAT scores to proxy this variable. Students were asked to write down their SAT scores. Note that some students could not remember their SAT score and thus did not answer. Those samples were excluded.
2. *Student's grade*. Since students' final grades were determined before they answered this questionnaire, we used midterm grade as a proxy for final grade expectation. There were two midterm exams and one final exam during the semester. Therefore, it was reasonable to use midterm grade as a proxy for final grade expectation. Students were asked to write down their scores on exam 1 and exam 2. We then calculated the average score for these two exams. Note that some students might have been concerned about being identified by their teachers so they may have elected not to respond to this question. Thus, those samples were excluded. In addition, since the midterm grade is self-reported, the same bias seen in self-reported expected grades may be possible. This argument could be partially true – we excluded those students who did not respond and/or did not write down a clear number (e.g., some students wrote 6? or 5?). Thus, even if there are some biases, they should not be significant. For example, the correct number might be 68 while the student might write down 67 or 69. Some students might not recall their scores correctly, but they may remember that their scores were around a certain number.

3. *Student's interest in the class*. If a student is interested in the class, he/she will attend the class more often. Thus, we used student's attendance to proxy this variable. Students were asked: *how many times have you missed the class during the semester*? We then subtracted this number from the total number of meeting times in the semester.
4. *Student's marginal cost*. If a student works longer and/or is taking more credit hours in a semester, his/her marginal cost will be higher. Thus, we used total working hours per week and total credit hours per semester to proxy this variable. Students were asked to write down the total number of hours worked per week and total number of credit hours taken during the semester.
5. *Professor's communication skill*. Students were asked: *Do you agree that the instructor's speech and English are clear and understandable*? There were five choices for this question: *1* = No, I strongly disagree; *2* = No, I disagree but not strongly; *3* = I have no comments. *4* = Yes, I agree but not strongly; *5* = Yes, I strongly agree.
6. *Overall evaluation*. Students were asked: *Overall, I would rate the quality of this instructor as excellent*. There were five choices for this question: *1* = No, I strongly disagree; *2* = No, I disagree but not strongly; *3* = I have no comments. I think it is about average. *4* = Yes, I agree but not strongly; *5* = Yes, I strongly agree.
7. *Student's math background*. Students were asked whether or not they had finished college algebra and calculus classes. Set "yes" as 1 and "no" as 0. This variable is considered because a good math background (e.g., algebra and calculus) will benefit the learning of economics since economics is more mathematical than other business and social sciences classes.
8. *Depth of understanding of the lecture*. Students were asked: *how much do you usually understand the lecture in the class*? There were five choices for this question: *1* = Below 30%; *2* = 30 – 49%; *3* = 50 – 69%; *4* = 70 – 89%; *5* = Over 90%.
9. *Tests reflect the course content*. Students were asked: *Do you agree that tests reflect the course content*? There were five choices for this question: *1* = No, I strongly disagree; *2* = No, I disagree but not strongly; *3* = I have no comments. *4* = Yes, I agree but not strongly; *5* = Yes, I strongly agree.
10. *Professor's instruction skill*. Students were asked: *Do you agree that the instructor well organizes the lecture*? There were five choices for this question: *1* = No, I strongly disagree; *2* = No, I disagree but not strongly; *3* = I have no comments. *4* = Yes, I agree but not strongly; *5* = Yes, I strongly agree.
11. *Student's efforts*. Two variables indicated this factor: (1) Frequency of studying for this class. There were five choices for this question: *1* = I study only 1 day before the test; *2* = I study only 2 – 3 days before the test; *3* = I study only 4 – 5 days before the test; *4* = I study one week before the test; *5* = I study regularly right after the class. (2) Frequency of practicing the study-guide before the exam. On a weekly basis we provided students with a study-guide with answers. There were five choices for these two questions: *1* = I never use the study-guide; *2* = I practice only once before the exam; *3* = I practice 2 times before the exam; *4* = I practice 3 times before the exam; *5* = I practice more than 3 times before the exam.
12. *Professor's efforts*. Two questions were asked: (1) *Do you agree that the instructor is well prepared for the class*? (2) *Do you agree that the instructor is enthusiastic about teaching*? There were five choices for these two questions: *1* = No, I strongly disagree; *2*

= No, I disagree but not strongly; *3* = I have no comments. *4* = Yes, I agree but not strongly; *5* = Yes, I strongly agree.

The reason for omitting one variable, student age, should be noted since the information collected using this variable may offer insights into a student's maturity level that could be relevant for the analysis. It was omitted because some students did not respond to this survey question and student age is not the primary factor determining student rating and grades. In addition, several prior researchers, such as Nelson and Lynch (1984), Krautmann and Sander (1997), and McPherson (2006) did not adopt this variable. So as not to lose too many surveys, we decided not to adopt this variable.

3. Econometric Models and Empirical Results

(a) Econometric Models

To correct for simultaneous questions, the Two-Stage Least Squares (2SLS) procedure was used to obtain unique estimates that were consistent and asymptotically efficient. Therefore, in the first stage:

$$EVU = a_0 + a_1 WOR + a_2 WPR + a_3 ENU + a_4 DEP + \varepsilon_1 , \quad (1)$$

and

$$GAD = b_0 + b_1 TRC + b_2 ALG + b_3 CAL + b_4 FRS + b_5 FRP + \varepsilon_2 , \quad (2)$$

where *EVU* = overall evaluation; *WOR* = well organized the lecture; *WPR* = well prepared for the class; *ENU* = enthusiastic about teaching; *DEP* = depth of understanding of the lecture; *GAD* = student's grade; *TRC* = tests reflect the course content; *ALG* = finished college algebra class; *CAL* = finished calculus class; *FRS* = frequency of studying for the class; *FRP* = frequency of practicing study guide; and $\varepsilon_1, \varepsilon_2$ = stochastic disturbance with a mean 0 and a variance σ^2.

We save $E\hat{V}U$ and $G\hat{A}D$, the predicted values of *EVU* and *GAD* as obtained from the reduced form estimates. The results from Equations (1) and (2) are reported in Table 2. In the second stage, the professor's overall evaluation and student's grade can be modeled as two types of functions: (1) linear function; and (2) Cobb-Douglas function. These two econometric models can be expressed as follows.

Model 1:

$$EVU = \alpha_0 + \alpha_1 G\hat{A}D + \alpha_2 SAT + \alpha_3 WHR + \alpha_4 CRD + \alpha_5 ATD + \alpha_6 SPH + u_1 , \quad (3)$$

and

$$GAD = \beta_0 + \beta_1 E\hat{V}U + \beta_2 SAT + \beta_3 WHR + \beta_4 CRD + \beta_5 ATD + \beta_6 SPH + u_2 . \quad (4)$$

Model 2:

$$EVU = C_0 \left(G\hat{A}D\right)^{\gamma_1} (SAT)^{\gamma_2} (WHR)^{\gamma_3} (CRD)^{\gamma_4} (ATD)^{\gamma_5} (SPH)^{\gamma_6} , \quad (5)$$

and

$$GAD = D_0 \left(E\hat{V}U\right)^{\delta_1} (SAT)^{\delta_2} (WHR)^{\delta_3} (CRD)^{\delta_4} (ATD)^{\delta_5} (SPH)^{\delta_6} . \quad (6)$$

Taking natural logarithms of both sides of Equations (3) and (4), the professor's overall evaluation (*EVU*) and student's grade (*GAD*) functions become linear. Hence, the econometric models can be created as follows.

$$\ln EVU = \gamma_0 + \gamma_1 \ln G\hat{A}D + \gamma_2 \ln SAT + \gamma_3 \ln WHR + \gamma_4 \ln CRD + \gamma_5 \ln ATD + \gamma_6 \ln SPH + v_1 , \quad (7)$$

and

$$\ln GAD = \delta_0 + \delta_1 \ln E\hat{V}U + \delta_2 \ln SAT + \delta_3 \ln WHR + \delta_4 \ln CRD + \delta_5 \ln ATD + \delta_6 \ln SPH + v_2 , \quad (8)$$

where $\gamma_0 = \ln C_0$; $\delta_0 = \ln D_0$; *SAT* = total SAT scores; *WHR* = total working hours; *CRD* = total credit hours taken during the semester; *ATD* = total number of attended classes; *SPH* = speech and English are clear and understandable; and u_1, u_2, v_1, v_2 = stochastic disturbance with a mean 0 and a variance σ^2.

(b) Empirical Results

Determinants of Overall Evaluation

The results from Equations (3) and (7) are presented in Columns (1) and (2) of Table 3. As that table shows, student's grade (midterm average grade) exerts a positive and significant effect on overall evaluation at the 5% level, meaning that student's grade is one of the primary factors that will impact students' rating behavior. One possible reason for the positive and significant effect is that students' grades (especially midterm grades) directly affect students' emotional feelings, leading some (or many) students to use student evaluations of teaching to reward or exact revenge on their professors. Another possible reason is contamination of SETs by grades. That is, easy graders may receive better evaluations than hard graders due to their grading more easily. Student's quality (indicated by SAT scores) exerts a positive and significant effect on overall evaluation at the 1% level, implying that higher-quality students may do well on exams and are thus more likely to give their professors higher ratings.

In addition, as expected, student's marginal costs (indicated by working hours per week and credit hours taken per semester) provide negative and significant effects on overall evaluation at the 1% level, meaning that the higher the marginal cost of taking the class, the lower the student will rate the professor. Moreover, student's interest (indicated by attendance) and professor's communication skill (indicated by clear and understandable speech) exert positive and significant effects on overall evaluation at the 1% level. These results imply that: (1) a student who is interested in the class will be more willing to learn and hence will give his/her professors better evaluations; and (2) a clearer and more understandable speech pattern will enable students to understand the class more easily and help them to do better, such that students then will be willing to give their professors better evaluations.

Additionally, the R-square has proximately 59.6–63.5% explanatory power for the independent variables. The equality of all means was tested. According to the *F*-statistics, the null hypothesis that all means are equal is rejected.

Determinants of Student's Grade

The results from Equations (4) and (8) are reported in Columns (3) and (4) of Table 3. As that table shows, overall evaluation exerts a positive and significant effect on student's grade at the 10% level. One possible reason for the positive and significant effect is that better teachers are enthusiastic about teaching and make more efforts to prepare and organize the lectures, which improves student performance. In addition, student quality exerts a positive and significant effect on student's grade at the 1% level, implying that student quality is one of the primary factors determining student achievement.

Although working hours per week has a negative effect on student's grade, the effect is not significant at any level. Student's working hours reflects a student's marginal cost of efforts. If a student is working 40 or more hours a week while enrolled as a full-time student, the student may skip the class quite often and never study/review after class. Hence, the student may reduce class-related efforts and thus he/she will not understand the professor in class and will not do well on the exam. Moreover, as expected, student's interest (as indicated by attendance) exerts a positive and significant effect on student's grade at the 1% level, meaning that the greater the student's interest in the class, the more likely it is that the student will attend the class more often and thus do better on exams. Further, the professor's communication skill has a positive and significant effect on student's grade at the 10% level (see Column 4). This result implies that a professor who has a clearer and more understandable speech pattern enables students to understand the class more easily and thus helps them to do better on exams.

Finally, the R-square has approximately 47.3–47.9% explanatory power for the independent variables. The equality of all means was tested. Based upon the *F*-statistics, the null hypothesis that all means are equal is rejected.

4. Discussion

In this paper, we adopt midterm grades rather than expected grades as a proxy for final grades. However, one may argue that the adoption of midterm grades rather than expected grades as a proxy for final grades makes the model easier to use but eliminates an important source of dynamism in student behavior; that is, using midterm grades as a proxy implies that students will not adjust their learning according to their midterm grades, which is not the case. First-year students who did poorly on the midterm(s) would be more interested in improving their final grades than punishing their teachers on the SETs so it is even possible that these students will rate their professors higher on the SETs after working more closely with them to improve their knowledge and grades.

We do not totally agree with that argument – it is debatable. Our reasons can be expressed as follows. First, there is no empirical evidence to support the belief that learning adjustment and student rating behavior are positively and significantly correlated. It is possible that students who did poorly on the midterm(s) may try to study harder to adjust their learning and improve their final grades. However, this does not mean that these students will not punish their teachers on the SETs. Second, the main purpose of this study was to test the hypothesis that midterm grades will impact students' emotions and thus in turn influence their rating behavior. If that argument is completely true, midterm grades and SETs should be negatively and significantly correlated, but why are they positively and significantly correlated according to our empirical evidence? The result is the opposite, implying that the argument may not exactly be true. Certainly, it is likely that some students who did poorly on the midterms would be more interested in improving their final grades than punishing their teachers on the SETs and thus will rate their teachers higher in the SETs. Nevertheless, the percentage of these students may be small. Hence, the effect of these students may be dominated by the effect of other students who use SETs to exact revenge on professors.

5. Conclusion

The most important contribution in this paper is the adoption of midterm grades rather than expected grades as a proxy for final grades. We believe that midterm grades may be a better measure than expected grades because midterm grades more directly affect students' feelings and in turn influence their rating behavior. Neither expected grades nor final grades affect students' rating behavior since expected grades are not real grades (they are just an expectation) and final grades are determined after students fill out the evaluation. Therefore, due to endogeneity, the link between overall evaluation and grade is estimated in a simultaneous framework. The evidence reveals a positive and significant relationship between overall evaluations and midterm grades, implying that students rate their professors primarily according to their midterm achievement. Consequently, the results show that the hypothesis is accepted.

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Table 1: Means and standard deviations of variables used

Variables	Mean	Standard Deviation
Overall evaluation	3.60606	1.30006
Midterm average grade (scores)	73.6591	13.8846
Total working hours	28.5960	15.3057
Total credit hours taken in a semester	11.6970	3.27780
Finished college algebra class	0.737374	0.442301
Finished calculus class	0.333333	0.473804
Total SAT scores	1084.49	159.464
Depth of understanding of the lecture	3.69697	1.12495
Number of attending the class during the semester	27.2828	3.32290
Frequency of studying for the class	2.60606	1.22739
Frequency of practicing the study guide before the exam	3.69697	1.17330
Tests reflect the course content	4.21212	0.906583
Well organized the lecture	4.29293	1.03266
Speech clear and understandable	3.56566	1.16200
Well prepared for the class	4.57576	0.729704
Enthusiastic about teaching	4.42424	0.904534

Table 2: Estimates of *EVU* and *GAD* in the First Stage

Explanatory Variables	**OLS** Explained Variable: *EVU*	**OLS** Explained Variable: *GAD*
Constant	-2.014*** (-4.60)	42.698*** (6.15)
WOR	0.162 (1.42)	
WPR	0.2233 (1.39)	
ENU	0.38793*** (4.43)	
DEP	0.64049*** (9.61)	
TRC		5.130*** (3.55)
ALG		-0.336 (-0.11)
CAL		6.967** (2.54)
FRS		1.243 (1.10)
FRP		1.092 (0.92)
R^2	0.777	0.213
$\bar{R}^2$	0.767	0.171
F-Statistics	81.77	5.05
Sample Size	99	99

(*t*-value) *** Denote statistical significance of the *t*-statistic at the 0.01 level; ** denote statistical significance of the *t*-statistic at the 0.05 level. *EVU* = overall evaluation; *GAD* = midterm average grade; *WOR* = well organized the lecture; *WPR* = well prepared for the class; *ENU* = enthusiastic about teaching; *DEP* = depth of understanding of the lecture; *TRC* = tests reflect the course content; *ALG* = finished college algebra class; *CAL* = finished calculus class; *FRS* = frequency of studying for the class; *FRP* = frequency of practicing study guides.

Table 3: Estimates of *EVU*, ln(*EVU*), *MGD*, and ln(*MGD*) in the Second Stage

Explanatory Variables	**2SLS** (1)	(2)	**2SLS** (3)	(4)
	Explained Variable: *EVU*	Explained Variable: ln(*EVU*)	Explained Variable: *GAD*	Explained Variable: ln(*GAD*)
Constant	-3.585*** (-2.95)	-12.390*** (-6.14)	-2.27 (-0.19)	-0.6379 (-0.7)
$\hat{GAD}$	0.03235** (2.26)			
ln($\hat{GAD}$)		2.0402** (2.21)		
$\hat{EVU}$			2.458* (1.74)	
ln($\hat{EVU}$)				0.1915* (1.65)
SAT	0.002805*** (4.85)		0.029404*** (3.63)	
ln(*SAT*)		2.6075*** (4.67)		1.1558*** (4.01)
WHR	-0.01819*** (-3.02)		-0.08053 (-1.02)	
ln(*WHR*)		-0.14203** (-2.34)		-0.0157 (-0.52)
CRD	-0.08657*** (-3.14)		0.3464 (0.95)	
ln(*CRD*)		-0.6063*** (-2.68)		0.1352 (1.10)
ATD	0.07224*** (2.66)		1.0944*** (3.20)	
ln(*ATD*)		1.5649*** (2.67)		0.7673*** (2.73)
SPH	0.37782*** (4.98)		1.024 (0.91)	
ln(*SPH*)		0.3714*** (4.54)		0.07765* (1.74)
R^2	0.635	0.596	0.479	0.473
$\bar{R}^2$	0.612	0.570	0.445	0.438
F-Statistics	26.72	22.63	14.12	13.59
Sample Size	99	99	99	99

(t-value) *** Denote statistical significance of the *t*-statistic at the 0.01 level; ** denote statistical significance of the t-statistic at the 0.05 level; * denote statistical significance of the t-statistic at the 0.1 level. *SAT* = total SAT scores; *WHR* = total working hours per week; *CRD* = total credit hours taken in a semester; *ATD* = total number of attendances; *SPH* = speech clear and understandable.