Attendance Rates and Academic Achievement
Do Attendance Policies and Class Size Effects Impact Student Performance?

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ABSTRACT

This paper investigates the impact of a mandatory attendance policy on student grades. Data collected from 301 students in microeconomics principles classes taught by the same instructor are used to estimate performance. The empirical analysis controls for the endogeneity of attendance rates and class size. Results indicate that GPA prior to taking the course and SAT scores are consistent predictors of student performance, even after accounting for student withdrawals. In addition, attendance rates are not found to be significant indicators of exam grades after accounting for simultaneity. Since class size and the attendance policy do not appear to influence grades, it is suggested that instructors encourage, but not mandate attendance in both small and large lecture settings.

JEL classification: A2, A22

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Introduction

It is widely recognized that absenteeism can negatively impact grades in economics courses (Park and Kerr 1990, Romer 1993, Devadoss and Foltz 1996, Marburger 2001, forthcoming), and that high attendance rates can improve student performance in a variety of classroom settings (Sheets et al. 1995, Johnston and James 2000). However, it is difficult to determine whether attendance rates serve as indicators of inherent motivation and are endogenously determined with grades or if they can be treated as exogenous. If attendance rates are correlated with motivation, it is unlikely that instructors can improve student achievement by changing the course structure or establishing an attendance policy (c.f. Browne and Hoag 1995). Under this assumption, unmotivated students forced to attend lectures are unlikely to pay attention or participate and therefore gain minimally from a required attendance policy. However, if increased attendance translates into greater acquired knowledge, attendance policies may improve student performance.

Absenteeism, and related class disruptions (e.g. from students entering late and leaving early) can be a concern for educators because they create an unpleasant and unproductive atmosphere, reducing the ability to instructors to teach well and for students to learn. Understanding the severity of absenteeism in relation to student achievement can be important to instructors that wish to minimize such disruptions and increase incentives to attend class. Attendance rates are particularly important to track in large lectures because studies have found absences increase with class size (Romer 1993, Devadoss and Foltz 1996) and motivation and attention problems more likely to occur in larger classes (McConnell and Sosin 1984).

Attendance policies may therefore be more justifiable in large lectures, even for those strongly opposed for principled reasons (Browne and Hoag 1995, Devadoss and Foltz 1996).

This paper investigates the impact of a mandatory attendance policy on course grades in both small and large lectures through the estimation of the determinants of exam grades for classes with and without attendance policies while controlling for the endogeneity of attendance rates. It has been assumed in the literature that attendance rates are endogenous to grade determination (but often not corrected for), however it is possible that the attendance rates actually measure pre-determined motivation of students and can be treated as exogenous (as is common in time series analysis). This paper seeks to determine if a mandatory attendance policy impacts student grades and if attendance rates have a significant impact on student achievement. First, relevant literature is reviewed to provide the theoretical framework for the empirical analysis. The paper continues with the estimation of performance on exam grades to test the significance of the attendance policy and the impact of student absences on exam grades. Data collected for 301 students, including information on gender, GPA, SAT scores, major and scores on exams, are combined with a microeconomic approach to evaluating student achievement. Finally, the impact of the attendance policy on different student cohorts is investigated with a decomposition of the residual effects. The paper concludes with a discussion of the results and implications for teaching economics.

Class Performance and Attendance: Literature Review

The framework used to evaluate student performance in economics classes has often been derived from an educational production function in which the student is assumed to maximize course performance (or learning) subject to specific time constraints (Bonesronning 2003). From this model, it can be assumed that attendance will be higher when the perceived quality of instruction is greater to the student or when the returns to improved grades and/or learning are greatest. Instructors' efficacy can therefore play a large role in course attendance rates (Romer 1993). In addition, it has been hypothesized that students have a greater incentive to attend class if critical thinking is required on exams, if classes are offered during "prime times" (i.e. between 10 a.m. and 3 p.m.), and if there is an attendance policy (Devadoss and Foltz 1996). However, attendance rates are also expected to be influenced by difficult to measure student characteristics such as inherent motivation and other personal traits.

Although attendance is an important aspect of performance, studies have found cumulative GPA and SAT (or similar) scores to have greater impacts (Park and Kerr 1990, Devadoss and Foltz 2001) on course performance. A majority of the previous studies investigating class attendance have recognized that these rates can be endogenously determined with course grades. Romer (1993) controlled for endogeneity by only including highly motivated students (identified as the students that completed all of the assigned problems sets) in the analysis. He finds that simple ways of controlling for motivation and other omitted factors have only a moderate impact on the relation between absences and student performance. Park and Kerr (1990) control for the motivation of students by including the self reported study hours in their analysis. Devadoss and Foltz (1996) estimate class performance with a recursive model to correct for the endogeneity of class attendance. They estimate student drive with a student reported motivational level and use this in combination with prior GPA to predict absences. Their estimations suggest that motivation has a strong positive impact on attendance rates. Sheets et al. (1995) implement a two-step model including predicted values of attendance (based on student evaluations) to estimate class performance. Attendance rates are calculated from observations of one class period for each class using a survey containing a four-year time period. This may create potential problems associated with any bias related to the specific day that attendance was taken within a single semester (if the day was not representative of attendance the rates of the semester) and between semesters. Durden and Ellis (1995) use student reported attendance rates and find a threshold effect for absences. They find a nonlinear relationship inferring that a few absences do not impact grades, however more than the threshold level of four were found to negatively impact grades. They do not address endogeneity.

Most of these studies account for what Marburger (2001) classifies as macro approaches in which student level data obtained from various universities or courses is evaluated with information on attendance rates collected as class averages or over a sample period. Alternatively, Marburger (2001) uses detailed information on 60 students enrolled in a section of microeconomics principles over a single semester to investigate the impact of attendance on particular days on exam grades. In this study, the material covered by day is matched with respective multiple choices questions to determine if a student was more likely to miss a question related to material covered on the day of an absence. Based on Romer's (1993) suggestion to implement a controlled experiment to test whether an attendance policy impacts student grades, Marburger (forthcoming) recently updated the 2001 study with data from classes with and without attendance policies, however endogeneity is not addressed. He finds that a student that missed class was 9-14 percent more likely to respond incorrectly to a related exam question, but that the impact was found to decrease over the course of the semester. The percentage difference was 2 percent by the end of the semester when the gap in the absentee rate between the classes with attendance policies and those without was actually the greatest. This paper draws on Marburger's microeconomic approach utilizing more detailed information on a greater number of students to not only investigate the impact of absences on performance for preceding exams, but also to analyze the impact of a mandatory attendance policy on student achievement with a comparison of student performance on common questions in both large and small sections.

An important contribution of this paper is the identification and use of instruments to correct for the endogeneity of attendance rates. Several indicators such as high school GPA, the number of course hours taken in the freshman year, and the percentage of course hours completed relative to those enrolled, are used to identify general student motivation. They are tested as predictors of attendance rates and used in two-stage least squares and recursive model estimations of student performance. Another important contribution is the use of student level data to investigate the impact of absenteeism on specific exam grades. Previous studies have relied on student reported data and performance on the final exam to draw similar conclusions (with the exception of Marburger, forthcoming). This paper compares student performance for classes in the control group (with an attendance policy) to that of the experimental group (without an attendance policy) and traces exam performance throughout the semester to further investigate the impact of attendance on relevant exams.

Institutional and Course Setting

In the Fall 2001 semester, the Economics Department at Salisbury University, a regional university in the Maryland state system, created a large lecture format for microeconomics principles to reduce the use of adjunct professors. The same professor taught a large (capped at 120 students) and small (capped at 35 students) section in both the Fall 2001 and 2002 semesters. In these sections, class format was identical, and included a mixture of traditional lecture (chalk-and-talk), games, discussion, and in-class exercises. The level of participation was similar in all four sections. There were no attendance requirements in the two sections taught in Fall 2001, however an attendance policy was imposed in both sections taught in the Fall 2002 semester. An attendance policy was imposed after noting significantly lower grades in the large section on the final exam hypothesized to result from lower attendance rates and motivational issues (Caviglia-Harris 2004). The instructor decided to impose a strict attendance policy to address some of these problems. Students were permitted up to 4 absences. After the fourth absence, the final grade was to be reduced by one letter grade, and reduced an additional letter grade for every two absences after the fourth. Attendance was taken at the beginning, middle, and end of class by a student research assistant. Students were not aware that the policy was not used when assigning final grades.

Two exams, a cumulative final and the top four of six quizzes were averaged to evaluate student performance. Exams contained multiple-choice and essay questions (requiring students to provide graphs and/or numerical answers with explanations) that tested the same skills, topics and content for both classes. These exam questions were weighted 60 percent and 40 percent, respectively. The multiple-choice questions included on the final exam were developed by the author to evaluate student achievement in all principles courses taught at SU and to assess the program through yearly evaluation and statistical analyses. They were designed to vary in difficulty and to represent material covered in all microeconomics courses taught in the department.[1] These questions were evaluated by department faculty for content, design, and wording as well as to verify that they covered material appropriate to the department course objectives.

[1] The author designed the questions with feedback and input from other department faculty, making them similar in terms of rigor and content to the questions on exams administered previously in the semester.

The first and final exam contained identical multiple-choice questions for the classes taught in the Fall 2001 and 2002 semesters. The essay questions for these two exams were similar for the two sections taught in the same semester, but different by year. The second exam was different between years to reduce the transfer of information and answers between students on the exam day. Since questions on the first and cumulative final exams were identical for all four sections, data on these exams are used in the empirical analysis. In addition, multiple choice question results for the second exam are used in the analysis of grades in the Fall 2002 semester. Specific attention was made to ensure that questions were not copied or shared between students in different sections of the course. Each exam was assigned a number, which the student recorded on a separate answer sheet. Exams were handed in to the instructor while an assistant monitored the door. The instructor made sure that all parts of the exam were intact and that the assigned exam number matched the number the student recorded on the answer sheet.

Data Description

Data used in the analysis include 301 observations from students enrolled in four microeconomics principles courses taught by the same instructor in the Fall 2001 and 2002 semesters. Two of the courses were large sections (with an enrollment cap of 120 students) and two were smaller sections (with an enrollment cap of 35 students). These data include student characteristics, performance on exams, and for Fall 2002 semester (when an attendance policy was applied) number of days absent (see Tables 1-3).

To avoid any censoring that Becker and Powers (2001) report can occur due to student withdrawals, all enrolled students are included in the analysis. However, some observations are dropped from the estimations because of missing SAT scores, reducing the sample size from 301 to 267. (SAT scores are not available for all transfer students since the college entrance exam is not required for transfer admittance). To partially account for these missing data, a dummy variable is included in the analysis indicating student transfer status.

Numerous studies have analyzed student performance in economics under a variety of contexts (Kennedy and Siegfried 1997, Saunders and Saunders 1999, Ziegert 2000, Becker and Powers 2001, Emerson and Taylor 2004) using data collected for the Test of Understanding in College Economics (TUCE), sponsored by Saunders (1994) for the National Council on Economic Education. Data used in these studies often include information on the type of institution, instructor, student reported characteristics as well as performance on multiple-choice questions administered before and after micro- and macroeconomics principle courses. Although the TUCE is widely recognized as an adequate measure of economic knowledge (Rothman and Scott 1973, Kennedy and Siegfried 1997, Saunders and Saunders 1999, Finegan and Siegfried 1999), several studies have questioned its validity as a measurement for understanding student learning in economics (Becker 1997). Swartz et al. (1980) note that the exclusive use of the TUCE to examine student ability provides a downward bias on estimates. By evaluating both the difficulty and discrimination indices for the TUCE and department developed questions, they find their own questions to improve discriminate ability and better predict student achievement. In addition, O'Neill (2001) finds that students that have been tested using essay questions throughout the semester do significantly worse on the TUCE than those that are tested using the multiple choice format. And finally, department chairs have found internally developed measurements of student achievement designed to fit existing curricula to be more useful when assessing economic programs and courses (McCoy et al. 1994). Another restriction of the TUCE data is that the questions are designed to test general economic understanding and acquired knowledge before and after taking principles of economics courses. The questions are therefore not designed to test the role of absenteeism on grades throughout the semester.

This paper uses student level data collected for one common course at the same institution. Such an approach has positive and negative aspects. On the positive side, data include student characteristics composed from university records, performance on all course exams, as well as attendance rates prior to each exam. Student reporting errors and the provision of falsified information are avoided by using university records (Maxwell and Lopus 1994, c.f. Emerson and Taylor 2004). Although such data reduces response errors, sample size is significantly smaller relative to some previous studies, reducing variability and degrees of freedom in the estimations. An overview of the data, including descriptive statistics, follows.

In Table 1, students are divided between the large and small course sections. There are a few significant differences that can be found between the means of these two groups. The larger sections contain a significantly higher number of students that are required to take micro and macro economic principles for their majors, lower GPAs (although this is significant only at the 10 percent level) and a lower number of course hours completed before taking the course. There are no significant differences between gender, number of transfer students, or the number prior economics courses taken between the classes. Student ability (as measured by SAT scores) and the withdrawal rates are also significantly similar. Student performance on the exams and in the class overall is significantly lower for the large sections suggesting that class size may impact student achievement. In addition, student attendance rates are significantly lower for the larger section providing some evidence of reduced student motivation in larger classes (McConnell and Sosin, 1984; Romer, 1993; Devadoss and Foltz, 1996) and subjective evidence that class size may indirectly impact class performance by reducing incentives to attend class (Caviglia-Harris 2004)

Table 2 suggests, anecdotally, that the attendance policy imposed on the Fall 2002 semester did not impact class performance. In this table students are divided between the two semesters included in the analysis. There are no significant differences between class composition, student characteristics, or student performance on exams.

And finally, Table 3 presents student characteristics and exam grades for those students with relatively high and low attendance rates (Fall 2002 only). Students are divided into these two groups according to the average number of days missed (1.9). Note that a majority of the students were not impacted by the attendance policy, since most missed significantly less than the number that would imposed a penalty (5 absences) on the course grade. Only 17.3 percent of students missed 4 or more class periods while only 6 percent missed 5 or more. Based on a comparison of the means, students with higher rates of absenteeism did significantly worse on the exams and the course overall. There were also significant differences between the number of withdrawn courses (more for those with low attendance rates), GPA (lower for those with low attendance rates), and the number of economics courses taken prior to microeconomics principles (lower for those with high attendance rates) between these two groups of students.

Absentee rates increased over the course of the semester, but declined at the end.[2] For the small class absentee rates were 5 percent in the first third, 9 percent in the second, and 8 percent in last third. In the large class rates increased from 5 percent in the first third, to 20 percent in the second third, and declined to 15 percent in the last third. These absentee rates were significantly lower than most of these found in the literature (Romer 1993, Marberger 2001,

[2] This finding is similar to the declining attendance rate trends found by Marburger (2001, forthcoming) over the course of the semester.

Sheets et al. 1995). The average student missed 1.9 of the 28 class days, or 7 percent of the classes. On a day of expected high absenteeism (a class at the end of the semester and after an exam) there was an attendance rate of 71 percent in the small class and 77 percent in the large class. Attendance rates were not taken on a regular basis in the Fall 2001 semester, but for a similar low attendance day, the attendance rate in the small class was 86 percent in the small class and 74 percent in the large class.

The impacts of class size, the attendance policy and absences on student achievement are tested in the empirical section of the paper and take into account differences in student characteristics and ability. The data presented in Tables 1-3 suggest that statistical differences may exist between exam performance and the large and small sections of the course, and that absences may impact grades, however it is possible that after accounting for other factors that these suggestions are not empirically supported.

4. Methods and Empirical Analysis

Estimations on the impact of absences and class size on achievement can be made using the standard reduced form production function (Raimondo et al. 1990, Bonesronning 2003):

$$A_{it} = \alpha_0 + \beta_1 A_{it-1} + \beta_2 I_i + \beta_3 C_t + \beta_3 M_t + e_{it} \tag{1}$$

where the dependent variable, A_{it} is achievement in the course (or exam grades) for student i at time t, and is dependent on achievement in the previous semester, $A_{it-1,}$ a vector of student characteristics, I_{it}, class size, C_t, student motivation and ability M_t, and a random error term, e_{it}. In the empirical estimation, achievement (A) is measured by performance on exams and by the class average. A_{t-1} is included as the GPA recorded one semester prior to taking the course. Student characteristics (I) include major, prior economics knowledge, college hours completed, transfer status, and gender. Class size (C) is included as a dummy variable and equal to one for those students enrolled in one of the large sections and zero otherwise. And finally prior GPA, combined SAT scores[3] and the number of absences represent student motivation and ability, M.

Estimation issues addressed include multicollinearity, survival bias and endogeneity. SAT verbal and math scores and combined SAT and GPA are found to be collinear, with correlation coefficients of 0.51 and 0.49, respectively. The verbal and math SAT scores are combined to eliminate collinearly, and since both GPA and SAT scores provide relative, but different information (performance in undergraduate courses, and ability prior to college), dropping one of them from the estimation is not preferred. To correct for potential multicollinearity problems, the portion of the variation in GPA that is not related to SAT score is identified with a regression. The residual from this regression serves as the independent variable in the empirical analysis (Park and Kerr 1990). And finally, the potential bias resulting from student self-selecting themselves from the sample by withdrawing, or dropping, the course is addressed with hurdle model (Becker and Powers 2001). A two-stage Heckman selection model is run to account for the survival rate of students. The results of both the OLS and Heckman selection estimation are provided in the result tables.

Previous attempts to correct for the possible endogeneity of attendance have been creative, including the use of proxies to estimate student motivation in estimations such as student-reported levels of studying (Park and Kerr 1990), teaching evaluations, (Sheets et al. 1995), and student-reported motivation levels (Devadoss and Foltz 1996), as well as dropping observations thought to bias results (Romer 1993), however the ideal method would be to run a simultaneous system of equations. The problem with such estimation is that it is difficult to

[3] The verbal and mathematical SAT scores are found to be highly correlated so the scores are combined in the analysis.

identify and measure instrumental variables for attendance. Becker and Salemi (1977) find that the common use of pre-course TUCE score to proxy student motivation to result in biased estimates and instead use aptitude and school setting as instruments. This paper uses detailed information on student achievement prior to taking the class to estimate student motivation, predict absences and identify instruments to be used in a simultaneous system of equations to estimate the impact of absence on student achievement.

To investigate the implications of class size, a mandatory attendance policy and attendance rates on student achievement, a series of estimations are performed. First, performance on common multiple-choice questions administered in all four sections of microeconomic principles taught by the same instructor over two semesters is investigated. Second, the influence of attendance rates on respective exams is investigated for students enrolled in the course in the Fall 2002 semester, when attendance rates were recorded by student. Lastly, Blinder-Oaxaca style decompositions of the residual effects are estimated to investigate whether the attendance policy and individual attendance rates on are different for students in the large and small lectures.

4.1 Estimation of Student Performance on Exams

The first series of estimations, student performance on the first exam and final exam (both with identical questions between sections and years) are investigated with OLS and Heckman selection models (Table 4). Results from the regression analysis indicate that the most significant and consistent indicators of performance are GPA prior to taking the class, prior economics knowledge, and SAT score. These findings are consistent with previous studies that find GPA and college entrance exams scores to be key determinates while other factors such as attendance rates and perceived value of the course to be minor determinants, if indicators at all (Park and Kerr 1990, Anderson et al. 1994, Kennedy and Siegfried 1997, Marburger forthcoming).

Class size is not a significant determinant of performance in any of the estimations, with the exception of when achievement is estimated with data only from the Fall 2001 semester, the semester in which no attendance policy was incorporated into the course design. In comparison, when only using data for the Fall 2002 semester the impact of class size becomes insignificant. In addition, Heckman models[4] are used to estimate the final exam score to account for censoring of the data occurring when students self select themselves from the sample by withdrawing or dropping the course (Becker and Powers 2001). The Heckman selection criteria are determined by the estimation of the probability of remaining in the course (or of not withdrawing). In this estimation, the only significant identifier is performance on the first exam. Also tested are GPA, class size and major. It was expected that poorer students (as indicated by cumulative GPA) or students not enrolled in a major requiring microeconomic principles would be more likely to drop the course. However, the results do not indicate that any particular student attribute can predict withdrawals accurately, with the exception of performance on the first exam. All of the students that withdrew failed the first exam. Including other student characteristics and motivation factors, such as major and prior GPA do not improve the predictability of the estimation so the reduced form is used. After accounting the selection bias, the impact of class size remains the same in each of the estimations. The sign and significance of the coefficients do not change, however the size of the coefficients are reduced in all but one case. This finding is

[4] The two-equation procedure involves the estimation of a probit model of the adoption decision, calculation of the sample selection control function and incorporation of that control function (the inverse Mills ratio or lambda, λ) into the model of effort that is estimated with ordinary least squares (OLS). The inverse Mills ratio, sometimes referred to as the hazard rate, is based on the probability density function of the censored error term, and is used to normalize the mean of the error terms to zero. Consistent estimators are then calculated for α and β (Maddala 1983).

opposed the conclusions of Becker and Powers (2001). They suggest that previous studies have underestimated the negative impact of class size on grades due to the selection sample.

Finally, it should be noted that the Fall 2002 dummy variable is insignificant in the estimations of both exam scores including the full set of observations. This suggests that the attendance policy (and any omitted differences between semesters) do not significantly impact student grades. This result is counter to a simple comparison of the separate regressions using the independent data from each semester, and warrants further investigation.

4.2 Estimation of the Impact of Attendance Rates on Student Performance

The second series of estimations to be analyzed include the determinants of the three exams administered in class during the Fall 2002 semester (Table 5). Individual student absences included in the estimations are those recorded prior to each exam to determine if material missed prior to an exam impacted the number of correct responses. These estimations are performed using ordinary least squares, two-stage least squares and a recursive model. A Hausman test is first performed to test for the simultaneity of absences. Results of this test indicate that in all three exam estimations, absences prior to the exam are endogenous and therefore that the OLS estimations will result in biased and inefficient estimates (although they are included for comparison). Instrumental variables are used to control for student motivation and the simultaneity of attendance rates. Good instruments can be defined as variables not included in the intended estimation, uncorrelated with the disturbance term, and correlated with the endogenous variables included in the estimation (Gujarati 1995). Possible instruments for class attendance include those proxies that can identify student motivation and performance in the classroom prior to taking the course and may be dependent upon attendance rates in other courses. Those variables considered are high school GPA, the number of courses failed the first year at college, the number of courses students withdrew from at SU, and the number of courses completed relative to those enrolled. The number of course withdrawals best predicts absences of these choice variables and is correlated to absences, suggesting that this variable serves as a "good" instrument. One reason why this variable serves as a good indicator of student motivation is because SU students may withdraw from a course until one week after mid-semester, giving students the opportunity to withdraw if failure is expected.

Estimation results reveal that on all three exams, SAT scores and student GPA continue to be the most significant and consistent predictors of performance. Note that the OLS estimates indicate that absences prior to taking the exam are significant determinants of exam grades, however, when the endogeneity of absentee rates is accounted for in the 2SLS and recursive regressions, absences are found to be insignificant determinants of exam scores. The 2SLS estimation uses student withdrawals to instrument for absences. A second method for correcting endogeneity is to run a recursive system where the endogenous variable (absences) is estimated sequentially (Devadoss and Foltz 1996). The results of these estimations are also presented in Table 5 and are consistent with those of the 2SLS estimations. These results suggest that academically successful students, are more highly motivated, attend classes more frequently, and as a result may perform better in economics and their classes overall (also see Devadoss and Foltz 1996).

4.3 Decomposition of the Residual Effects of an Attendance Policy

To further examine the possible impacts of imposing a mandatory attendance policy, Blinder-Oaxaca style decompositions (Blinder 1973, Oaxaca 1973) of the residual effects are performed on the final exam scores based on the framework presented in Jackson and Lindley (1989). Regression results do not indicate any significant difference between performances on exams between years or class sizes. However, it is possible that the mandatory attendance policy impacted different student cohorts to varied extents. And, since much of the previous literature has found attendance rates to have significantly impacts on economic achievement, additional inquiry into this issue can provide additional support of the results. This decomposition allows for a more detailed comparison of differences between the control and experimental groups in relation to the impact of attendance rates.

Essentially, attendance policy impacts are decomposed into the endowment and residual effects, and the residual effects are divided into the constant and coefficient effects. This method allows for the partial isolation of the sources of disparity with a joint testing of the significance of the two components of the residual effects, and a more complete and accurate interpretation of group differences (Jackson and Lindley 1989). The endowment effect measures differences in exogenous variables such as intelligence and prior economics knowledge. If this value is negative and large, this implies that differences in exam performance by students in the control group can be attributed to lower initial endowments of those variables impacting exam grades. The constant effect is that portion of the total difference between group means that cannot be attributed to the endowment effect or those differential responses due to different initial characteristics. We would expect the constant effect to be positive and significant if there is a clear impact of the attendance policy on final exam performance. The coefficient effect measures differences between group responses in the dependent variable due to changes in the independent variables. If the coefficient effect is positive, this supports the supposition that students in the control group perform relatively better on exams due to attendance policy effects or different individual choices resulting from the policy.

In the analysis of the endowment and residual effects of the attendance policy between control and experimental groups, results reveal that the endowment effect is 0.059, and the constant and coefficient effects are 1.196 and -1.189, respectively (Table 6). All tests for the significance of these effects indicate no significant difference, and therefore provide further evidence that the attendance policy did not impact grades. Moreover, the mandatory attendance policy did not positively impact grades for any group of students in the study, including those in the large class, those with lower grades or those with significantly less prior knowledge of economics.

5. Discussion and Conclusions

This paper addresses two issues related to student performance in economics classes: the impact of attendance rates and a mandatory attendance policy on exam grades. Student level information collected from 301 students enrolled in microeconomics principles classes taught by the same instructor is used to estimate the impact of class size, a mandatory attendance policy, and absentee rates on performance. Two of the four course sections included in the analysis serve as the experimental group, and were not required to attend class, while the remaining two sections served as the control group, and were required to adhere to a strict attendance policy. While the attendance policy reduced absences and disturbances in the large class, similar to Chan et al. (1997) empirical results indicate that the policy did not impact grades. These estimations are found to be robust to corrections for endogeneity, sample selection and censoring. Students in the large class were more likely to be absent even with the attendance policy (when compared to students in the smaller section with an attendance policy), however, they did not perform significantly better or worse after accounting for student characteristics and other factors. It appears that the large class design can increase the incentive to miss class, however this is just one marginal factor determining the student's decision to attend. Instead, motivational factors appear to influence attendance rates to a greater extent.

Estimations are first run to determine impact of student characteristics, class size and the attendance policy on grades. Results indicate that GPA prior to taking the course and SAT scores are consistent predictors of student performance, even after accounting for student withdrawals from the course. And, according to these estimates, class size and the attendance policy do not appear to influence grades. Estimations are also made to test the influence of the number of student absences on exam grades. While these estimations indicate that attendance rates can impact grades, once simultaneity is addressed, attendance rates are found to be insignificant. This result suggests that student motivation, captured by attendance rates, actually impact grades. This is an important finding since much of the previous research that does not account for simultaneity has found "clear links" between attendance rates and student achievement (Romer 1993, Marburger forthcoming, 2001). Instead, as it is widely recognized, prior economics knowledge and other indicators of academic knowledge are better predictors of exam performance (Devadoss and Foltz 1996, Marburger forthcoming).

In summary, these results suggest that course design may be important to class atmosphere (the mandatory attendance policy reduce disruptions in the large class), however, attendance policy and class size have minimal impacts on student achievement. Much of the debate on attendance policies seen in current literature stems from Romer's (1993) call for experimenting with mandatory attendance, following his conclusion that there is a strong statistical relationship between attendance and classroom performance. The debate continued with comments in the 1994 Summer edition of the *Journal of Economic Perspectives* (pages 205-215), a statistical study from Neil and Hoag (1995) and a recent update of Marburger's (forthcoming) study on the influence of a mandatory attendance policy on student grades (Marburger 2001). This study contributes to this line of research by using more detailed student level data and by correcting for student survival rates, collinearly, and endogeneity in the empirical analysis. As a result, the implications of the study are consistent with previous research however key differences are also identified. One important finding is that after accounting for student motivation, the number of absences does not impact exam grades, confirming a point that most instructors recognize: better students attend lectures more frequently on average (Deere 1994), and due to this inherent motivation receive higher grades. Including the number of absences in the estimation of student achievement can overestimate or bias the impact of absences on grades since motivation and attendance rates are difficult to separate. Another important finding of this study is that the mandatory attendance policy did not impact overall grades for students. This suggests that the advice that instructors encourage, but not mandate attendance (Chan et al. 1997, Devadoss and Foltz 1996) continues to be appropriate. Instructors should also avoid evaluating teaching and learning solely by student grades or increases in the number of correct answers. The inherent motivation to learn and do well in class is not something that instructors can easily influence, and should not be our teaching goal. Rather motivating students to find the subject interesting and evaluate situations critically should be something that we instill in all students, independent of course grade.

Table 1 – Variable Definitions and Student Characteristics by Class Size

		Small Sections (Enrollment Cap of 35)			Large Sections (Enrollment Cap of 120)			
Variable Name	Definition	Mean	Standard Deviation	Number of Obs.	Mean	Standard Deviation	Number of Obs.	t-stat
Large Class	= 1 if enrolled in large section	0	NA	71	1	NA	230	NA
Major	=1 for majors that require micro and macro principles	0.606	0.492	71	0.739	0.440	230	2.172**
Gender	= 1 for females	0.380	0.489	71	0.409	0.493	230	0.426
Cumulative Hours	number of course hours completed before taking principles of microeconomics	45.620	20.187	71	37.816	14.628	228	-3.564***
Econ Prior	number of economics courses completed prior to taking principles of microeconomics	0.183	0.425	71	0.122	.365	230	-1.189
No. Withdrawn	number of courses withdrawn from prior to taking principles of microeconomics	0.521	0.954	71	0.426	0.794	230	-0.893
Transfer	= 1 for transfer students	0.197	0.401	71	0.209	0.407	230	0.209
SAT	SAT combined verbal and math SAT score	1110.66	105.576	61	1101.75	105.691	206	-0.754
GPA	cumulative GPA before taking the course	3.00	0.637	71	2.87	0.551	228	-1.645*
Exam1	grade out of 100 (multiple choice questions)	82.465	12.244	71	78.152	15.104	230	-2.193**
Final	grade out of 100 (multiple choice questions)	74.040	11.847	66	69.178	12.784	216	-2.788***
Class Average	grade out of 100	76.653	9.463	66	73.428	10.656	216	-2.206**
Absences	total number of days absent	1.579	1.445	38	2.125	1.720	112	1.757*
Abs1	number of days absent before first exam	0.395	0.638	38	0.482	0.697	112	.682
Abs2	number of days absent before second exam	0.842	0.916	38	1.348	1.228	112	2.328**
Abs3	number of days absent before final exam	0.342	0.481	38	0.295	0.548	112	-.476
Withdraw	= 1 for students that dropped the course	0.070	0.258	71	0.065	0.247	230	0.288
Fall 2002	= 1 for students in Fall 2002 course; =0 for students in Fall 2001 course	0.577	0.497	71	0.513	0.501	230	-0.949
RGPA	(GPA corrected for collinearity; residual from estimation of student achievement prior to taking micro principles)	NA	NA	NA	NA	NA	NA	NA

*, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively

Table 2 – Student Characteristics By Year of Course

	Fall 2001			Fall 2002			
	Mean	Standard Deviation	Number of Obs.	Mean	Standard Deviation	Number of Obs.	t-stat
Large Class	0.789	0.410	142	0.742	0.439	159	-0.949
Major	0.711	0.455	142	0.704	0.458	159	-0.130
Gender	0.359	0.481	142	0.440	0.498	159	1.433
Cumulative Hours	40.25	15.938	142	39.140	16.890	157	-0.585
Econ Prior	0.113	0.359	142	0.157	0.398	159	1.014
No. Withdrawn	0.408	0.791	142	0.484	0.870	159	0.787
Transfer	0.169	0.376	142	0.239	0.428	159	1.499
SAT	1105.810	90.195	124	1102.030	117.513	143	-0.291
GPA	2.891	0.563	142	2.910	0.570	156	0.269
Exam1	78.803	14.500	142	79.497	14.682	159	0.412
Final	69.975	12.771	132	70.511	12.743	150	0.352
Class Average	74.822	10.308	132	73.620	10.599	150	-0.963
Absences	NA	NA	NA	1.987	1.667	150	NA
Withdraw	0.077	0.268	142	0.057	0.232	159	-0.491

*, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively

Table 3 –Characteristics of Students with Relatively High and Low Attendance Rates

	Students with High Attendance Rates (missed≤2)			Students with Low Attendance Rates (missed>2)			
	Mean	Standard Deviation	Number of Obs.	Mean	Standard Deviation	Number of Obs.	t-stat
Large Class	0.681	0.469	94	0.831	0.378	65	-1.43
Major	0.755	0.432	94	0.631	0.486	65	1.54
Gender	0.500	0.503	94	0.354	0.482	65	0.892
Cumulative Hours	38.702	16.000	94	39.793	18.250	65	-0.068
Econ Prior	0.117	0.323	94	0.215	0.484	65	-1.903*
No. Withdrawn	0.340	0.665	94	0.692	1.074	65	-2.691***
Transfer	0.277	0.450	94	0.185	0.391	65	0.48
SAT	1100.120	115.806	82	1104.590	120.687	61	-0.068
GPA	3.071	0.508	93	2.662	0.570	63	3.845***
Exam1	82.766	12.478	94	74.769	16.356	65	2.779***
Final	72.128	11.358	94	67.798	14.485	56	1.664*
Class Average[5]	75.173	9.455	94	71.013	11.922	56	2.557***
Absences	0.923	0.858	94	4.631	2.781	65	-12.123***

*, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively

[5] Class average is not reflective of the attendance policy. Grades were not reduced for students missing 4 or more classes, as indicated in the syllabus.

Table 4 – Estimation of Student Performance on Exams (Number of Correct Answers on Multiple Choice Questions)

	Exam 1 (n=264)	**Final Exam** (n=252)	**Final Exam With Selection Bias Correction** (n=252)	**Final Exam Fall 2001 No Attendance Policy** (n=118)	**Final Exam Fall 2001 With Selection Bias Correction** (n=118)	**Final Exam Fall 2002 Attendance Policy Used** (n=134)	**Final Exam Fall 2002 With Selection Bias Correction** (n=134)
Constant	3.312*	2.977	5.611**	1.782	1.840	2.795	5.937
	(1.747)	(2.543)	(2.604)	(3.712)	(3.751)	(3.542)	(3.828)
Large Class	-0.523	-0.729	-0.615	-1.455**	-1.250*	0.016	0.034
	(0.353)	(0.510)	(0.515)	(0.716)	(0.728)	(0.735)	(0.717)
Major	-0.378	0.385	0.507	1.113*	1.031	-0.695	-0.502
	(0.331)	(0.478)	(0.478)	(0.663)	(0.654)	(0.691)	(0.688)
Gender	0.737**	-0.340	-0.428	-0.848	-1.044*	-0.084	-0.158
	(0.303)	(0.433)	(0.433)	(0.628)	(0.635)	(0.613)	(0.596)
Cumulative	-0.009	0.014	0.016	0.031	0.030	0.003	0.006
Hours	(0.010)	(0.014)	(0.014)	(0.021)	(0.021)	(0.019)	(0.018)
Econ Prior	1.108***	1.313**	1.421**	1.565**	1.361*	1.123*	1.353*
	(0.387)	(0.558)	(0.587)	(0.794)	(0.831)	(0.779)	(0.784)
Transfer	0.594	0.357	0.400	-0.617	-0.743	1.024	1.030
	(0.475)	(0.690)	(0.677)	(1.122)	(1.118)	(0.887)	(0.846)
SAT	0.012***	0.016***	0.014***	0.017***	0.017***	0.017***	0.014***
	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
RGPA	1.834***	2.071***	1.642***	2.996***	2.444***	1.463***	1.152*
	(0.309)	(0.442)	(0.460)	(0.636)	(0.670)	(0.622)	(0.623)
Fall 2002	-0.108	0.138	0.188				
	(0.292)	(0.419)	(0.416)				
Lambda			-4.192***		-4.774***		-3.646*
			(1.287)		(1.705)		(2.066)
R-squared	0.34	0.28	0.31	0.37	0.41	0.28	0.30
Adj. R-squared	0.32	0.26	0.29	0.32	0.36	0.23	0.24

Notes: standard errors in parenthesis; *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively

Table 5 – Estimation of Student Performance on Exams Including Attendance Rates (Number of Correct Answers on Multiple Choice Questions)

	Exam 1 (n=140) OLS Estimation	**Exam 1** (n=140) 2SLS Estimation	**Exam 1** (n=140) Recursive Model Estimation	**Exam 2** (n=134) OLS Estimation	**Exam 2** (n=134) 2SLS Estimation	**Exam 2** (n=134) Recursive Model Estimation	**Final** (n=134) OLS Estimation	**Final** (n=134) 2SLS Estimation	**Final** (n=134) Recursive Model Estimation
Constant	1.371	1.447	1.483	7.718	6.480	17.545	2.984	2.963	0.473
	(2.257)	(2.220)	(2.332)	(11.338)	(11.404)	(14.019)	(3.504)	(4.237)	(3.900)
Large Class	-0.190	-0.202	-0.172	-1.543	-0.727	-2.256	0.123	-0.322	0.027
	(0.477)	(0.466)	(0.483)	(2.400)	(2.709)	(2.421)	(0.728)	(0.918)	(0.731)
Major	-0.870**	-0.896**	-0.850*	-5.067**	-5.442**	-5.065**	-0.831	-0.265	-0.568
	(0.440)	(0.445)	(0.447)	(2.254)	(2.311)	(2.303)	(0.686)	(0.894)	(0.693)
Gender	0.776*	0.789**	0.755*	0.488	0.294	0.579	-0.143	0.104	-0.064
	(0.401)	(0.395)	(0.406)	(1.967)	(1.973)	(1.998)	(0.606)	(0.747)	(0.610)
Cumulative	-0.012	-0.009	1.235**	-0.072	-0.076	2.499	0.007	-0.009	0.794
Hours	(0.012)	(0.019)	(0.522)	(0.061)	(0.061)	(2.632)	(0.019)	(0.024)	(0.805)
Econ Prior	1.145**	1.124**	-0.015	2.040	2.355	-0.065	1.172	0.968	0.002
	(0.501)	(0.497)	(0.012)	(2.510)	(2.537)	(0.062)	(0.770)	(0.939)	(0.019)
Transfer	0.570	0.555	0.581	5.832	5.339*	6.129**	0.827	1.651	1.052
	(0.561)	(0.549)	(0.568)	(2.830)	(2.911)	(2.872)	(0.881)	(1.170)	(0.883)
SAT	0.014***	0.014***	0.014***	0.067***	0.070***	0.063***	0.017***	0.014***	0.016***
	(0.002)	(0.002)	(0.002)	(0.009)	(0.011)	(0.009)	(0.003)	(0.004)	(0.003)
RGPA	1.681***	1.521*	1.882***	7.002***	5.244	8.160***	0.891	3.276**	1.572***
	(0.424)	(0.883)	(0.415)	(2.086)	(3.479)	(2.038)	(0.675)	(1.621)	(0.623)
Abs1	-0.555*	-0.944	-0.586						
	(0.296)	(1.920)	(1.244)						
Abs2				-2.025**	-4.438	-5.571			
				(0.880)	(3.938)	(5.071)			
Absences							-0.420**	1.331	1.059
							(0.206)	(1.058)	(0.702)
R-squared	0.46	0.45	0.44	0.43	0.40	0.42	0.30	0.05	0.29
F-test	12.08***	11.73***	11.43***	10.59***	9.19***	9.82***	5.97***	0.76	5.96***

Notes: standard errors in parenthesis; *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively

Table 6 – Estimation of Student Performance on the Final Exam and Decomposition of the Residual Effects

	Control Group (Classes with Attendance Policy) (n=134)	**Pooled Sample with Control and Experimental Groups** (no year dummy) (n=252)	**Sample with Control and Experimental Groups** (with year dummy) (n=252)	**Sample with Control and Experimental Groups** (with class size dummy and interaction terms) (n=252)
Constant	2.795	3.019	2.977	1.782
	(3.542)	(2.535)	(2.543)	(3.857)
Large Class	0.016	-0.734	-0.729	-1.455**
	(0.735)	(0.509)	(0.510)	(0.744)
Major	-0.695	0.379	0.385	1.113
	(0.691)	(0.477)	(0.478)	(0.689)
Gender	-0.084	-0.325	-0.340	-0.848
	(0.613)	(0.430)	(0.433)	(0.653)
Cumulative Hours	0.003	1.315	0.014	1.565
	(0.019)	(0.557)	(0.014)	(0.825)
Econ Prior	1.123*	0.014**	1.313**	0.031**
	(0.779)	(0.014)	(0.558)	(0.022)
Transfer	1.024	0.388	0.357	-0.617
	(0.887)	(0.682)	(0.690)	(1.166)
SAT	0.017***	0.016***	0.016***	0.017***
	(0.003)	(0.002)	(0.002)	(0.003)
RGPA	1.463***	2.063***	2.071***	2.996***
	(0.622)	(0.441)	(0.442)	(0.661)
Large Class * Fall 2002				1.471
				(1.030)
Major * Fall 2002				-1.808*
				(0.961)
Gender * Fall 2002				0.765
				(0.882)
Cumulative Hours * Fall 2002				-0.028
				(0.029)
Econ Prior * Fall 2002				-0.442
				(1.118)
Transfer * Fall 2002				1.641
				(1.448)
SAT * Fall 2002				0.000
				(0.004)
RGPA * Fall 2002				-1.533*
				(0.895)
Fall 2002			0.138	1.196
			(0.419)	(5.168)
Residual Sum of Squares	1395.182	2580.767	2579.619	2454.035
R-squared	0.28	0.28	0.28	0.32

Mean of the Dependent (Control group) = 21.201
Mean of the Dependent (Control group, no attendance policy effects) = 21.142
Mean of the Dependent (Experimental group) = 21.127

Constant effect = 1.196 (coefficient of interactive model) F* for residual effect = 1.34
Coefficient effect = -1.181 (Residual-Constant) F* for coefficient effect = 1.50

Notes: standard errors in parenthesis; *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively

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