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Impact of Blended Course Selection System on Undergraduates' Learning Outcomes: A Logistic Model Approach

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ABSTRACT
The course selection system is fundamental to teaching management as well as students' learning outcome in colleges and universities. In this study, we examine the impact of a blended selection system on learning outcomes for undergraduates in both microeconomics and macroeconomics. Unlike the previous regime in which the course selection followed a rigid procedure, the newly blended regime allows undergraduates with dissimilar majors to choose whom (different lecturers in a course teaching team), when and where to take classes. As a key management system in higher education, does this course selection system make a difference in terms of course learning outcome? Taking the courses of economics which consist of microeconomics and macroeconomics as examples, using the grade cross-section data, we conduct a binary logistic regression and find out that the same selective system has dissimilar impacts on learning outcomes in different courses. Regarding microeconomics, the blended selection system has a higher probability of enhancing the students' scores of final exam, and the actual learning outcome is higher than expected. However, with respect to the macroeconomics, it is otherwise. Overall, the blended course selection system in our case has a mixed impact on the students' learning outcomes.
Keywords*: course selection, blended course selection system, microeconomics and macroeconomics, learning outcome, binary logistic regression, peer effects*

1. INTRODUCTION

Several factors may affect the learning outcome of university students. These factors encompass course selection system and credit system [1-3], teaching or/and learning approach [4-5], class attendance and performance, peer effects, to name only a few. In the literature, several studies examine the impacts of learning experience, learning environment and learning tools on students learning outcomes in universities and colleges since there is a likely causal link between them [6-8]. Much rigorous research on the assessment of the learning outcomes in economics courses has been conducted so far, in particular, the impact of class attendance [9], test scores and quizzes [10-12]on the learning outcomes. However, to the best of our knowledge, there exists little empirical research measuring the impact of course selection system on undergraduates' learning outcomes. This essay aims to investigate the relationship between selective system and the course learning effect on the basis of binary logistic model.

1.1. Our Contribution

This paper measures the impact of blended course system on course learning outcomes of undergraduates in a sample university in China. Using the courses cross-section data and the binary logistic model, we quantify the causal nexus between selective system and learning outcome. Intrusively speaking, the conclusions should be indifferent, however, we obtained dissimilar conclusions given the same analytical model. The findings suggest that the learning outcome of economics courses may be affected by other relevant factors such as peer effects, class attendance and teaching quality other than the blended course selection system. Overall, there exists no such course selection pattern that fits all. Our conclusion is with general significance and is also consistent with similar research [13].

1.2. Paper Structure

The rest of the paper is organized as follows. Section 2 introduces the background of the research. Section 3 offers the data sources and at presents a binary logistic model which is used to evaluate the effect of the blended course

selection system. Section 4 provides the discussion of the regression results and Section 5 concludes the paper.

2. BACKGROUND

In our case, both microeconomics and macroeconomics are under the rubrics of basic course for undergraduates majored in economics and management in the sample university. Given a four-year study period, students are provided with microeconomics in the second semester and macroeconomics in the third semester respectively. Prior to the fall semester of 2018, undergraduates of the sample university are not allowed to choose courses without restrictions, or rather they have to follow the required sequence when making course selection during the specific period. It is from the fall semester of 2018 that the sample university begin to implement the blended selective system, that is, students with different majors are allowed to choose their preferred courses and form the class within the limit of class size and finally take the courses provided by respective teacher matched to the above class accordingly. To be specific, in terms of macroeconomics with 2.5 credits and 42 credit hours, it has 6 professional teachers that forms a course group, using the same textbook, and gives lectures to the respectively matched class. Overall, there were 8 macroeconomics classes, 795 students enrolled in semester 1 of 2017, which covered approximately 20 majors such as engineering, materials, mathematics and physics. As to microeconomics with 3 credits and 48 credit hours, there were 7 professional teachers, also adopted the same microeconomics textbook and offered lectures to 758 students enrolled in semester 2 of 2018, which covered approximately 15 majors such as mathematics, mechanics and physics, to name just a few. At the end of the semester, both adopts the identical test paper, takes the uniform test. Finally, the papers are checked abiding by the same quality standard.

What is the real effect of the one-year implementation of the blended course selection system? So far the main problems associated with the blended selective system are listed below: firstly, it increases the frequency of both microeconomics and macroeconomics selection for students because the new system has broken the organization of the traditional major oriented teaching class, thus, a class reorganization is needed to facilitate the course teaching. The point is, this sort of class reorganization has to be done by respective lecturer which might to some extent affect teaching quality accordingly. Secondly, due to the limited teachers: 6 lecturers undertook 8 classes' macroeconomics teaching work in the fall semester of 2018; in contrast, in the spring semester of 2019, seven lecturers undertook 8 classes' macroeconomics teaching work. In either semester, someone in the teaching group must entail two classes' course teaching assignments in different time. Notice that in this circumstance, it is likely that class time may conflict with legal holiday such that affects the teaching scheduled plan, efficiency and the teaching quality as well. Finally, intuitively, the blended selection system might be not that conducive to regular management of class reorganization mostly because of less familiarity, less communication and thus poor peer effect among students. To delve into the effect of blended selection system on course learning outcome, this paper draws on the logistic model as well as the cross-section scores of undergraduates attributable to the aforementioned system to analyze whether and to what extend the blended selection system will influence the undergraduates' learning outcome.

3. DATA AND MODEL

3.1. Data Source

Our data is first-hand and is available from the economics teaching team of Business School of Qingdao University of Technology, for simplicity, we refer to the institution as the sample university. The grade dataset consists of the final exam of macroeconomics in the fall semester in 2018, namely the 795 score samples of eight teaching class, and the final exam of microeconomics in the spring semester in 2019, that is, the 758 score samples of eight teaching class.

Table 1. The statistical description of final exams of macroeconomics and microeconomics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Macroeconomics	795	72.46	13.83	11	97
Microeconomics	758	66.06	14.51	17	95

Table 1 showcases the corresponding statistical description of the final scores. At first glance, Table 1 indicates that the average grade of macroeconomics with the value being 72.46 is approximately 6.5 points bigger than that of microeconomics. However, there is no comparison between the two courses. On the one hand, from the fall semester in 2018, the sample university began to adopt the blended selective system for the first time, given the fact that a large number of students with science or engineering background choose to minor in macroeconomics, the course teaching team lowered the item difficulty and the degree of discrimination fell between interval of 0.65-0.75, thus the average grade was a little bit higher. Likewise, the blended selective system was also initially carried out in the spring semester in 2019. Nevertheless, given the experimental experience of macroeconomics, along with the goal of enhancing students' learning outcomes, the same teaching team raises the item difficulty and lowered

the degree of discrimination this time which led to the substantial decline of microeconomics average score.

Table 2. Statistical descriptions of macroeconomics and microeconomics

	Macroeconomics (N=795)				Microeconomics (N=758)			
Variables	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Final grade	0.48	0.50	0	1	0.50	0.50	0	1
Class performance	28.35	1.66	21	31	28.72	2.21	9	30
Selection system	0.90	2.98	0	1	0.91	0.29	0	1

Table 2 displays the statistical description of macroeconomics and microeconomics respectively. Among which the final grade and selection system are dummy variables by definition, with the values being 0 and 1. As for class performance, it is classified into a discrete variable. Notice that both data of macroeconomics and microeconomics accrue to cross-section data, and each of which is inclusive of class performance (accounting for 30% of the total points), final grade (accounting for 70% of the total points) and individual major information. Also note that here the class performance includes three parts: class attendance, assignment and quizzes. In order to remove the multicollinearity among explanatory variables, the final grade is taken the form of 100 points rather than total points that contain class performance. We then examine whether the blended selection system will affect the course learning outcome based on the above assumptions.

3.2. Model Building

By processing the course data, we find out that the data is asymptomatically normally distributed. Furthermore, there are many extreme values. In this case, it is reasonable to draw on the logistic regression model to analyze the relationships among the dependent variable denoted by grade, explanatory variables namely the class performance denoted by *nfts* and course selection system denoted by *nccm*. In particular, the paper intends to investigate whether the blended selective system will affect students' final grade. The discrete choice model [14] is displayed below:

$$\ln\left(\frac{\hat{P}_i}{1-\hat{P}_i}\right) = X_i'\hat{\beta} \tag{1}$$

In Equation (1), where X_i represents the vector form of the explanatory variables, and $\hat{\beta}$ is the corresponding estimated parameters. Where $\hat{P}_1$ is the function of grade conditional on performance and system, i.e., $\hat{P}_i = \hat{P}\left(grade_i = 1 \middle| nfts_i, nccm_i\right)$. Notice that class performance and selection system are two dummy variables. We assume that grade variable takes 1 if the individual score exceeds the mean and 0 otherwise. Similarly, the dummy variable system takes 1 if the sample university adopts the blended system and 0 otherwise.

4. RESULTS AND DISCUSSION

4.1. Results

Using the previous courses cross-section data, the paper conducts the logistic regression on macroeconomics and microeconomics, respectively. Tables 3 and 4 display the respective results.

Table 3. Result of macroeconomics

	Macroeconomics [a] (N=795)			
	Coef.	St. Err.	z-value	p-value
Constant	-14.106	1.643	-8.59	0.000***
nfts	0.500	0.056	8.89	0.000***
nccm	-0.198	0.253	-0.78	0.435
LR-Statistic	103.794	0.000***	103.794	0.000***
Pseudo R^2	0.094			

[a] The dependent variable is students' final grade of macroeconomics.

*** p<0.01, ** p<0.05, and * p<0.1 denotes the 1%, 5% and 10% significant level, respectively.

Table 3 indicates, with respect to macroeconomics, the goodness-of-fit [13] is on the order of 0.1(Pseudo R^2=0.094). Given 1% significant level, the p value is 0.000, which implies that the choice model is significant on the whole. To be specific, because the coefficient of the variable of class performance (*nfts*) is positive(0.500), which means it may drive up the final exam significantly, in essence, the higher the grade of class performance, the

higher the final grade the student may obtain. By contrast, the coefficient of the variable of selection system (*nccm*) is negative (-0.198), which means the blended system is less likely to improve the final exam. Although the parameter of course selection system is insignificant (p=0.435), still it might affect the final outcome, there are several reasons for this: partly because there are teaching quality variations among different teachers in the course group, partly because of the poorer peer effects induced by the introduction of the blended system which is unobservable. Overall, the logistic model passed the significance test and makes sense from the perspective of economics. Thus, the vector form of the regression model of macroeconomics is:

$$\ln(\frac{\hat{P}_i}{1-\hat{P}_i}) = X_i'\hat{\beta} = -14.106 + 0.5nfts - 0.198nccm \quad (2)$$

Based on equation (2), we can further derive the respective marginal effect of class performance and selection system below:

$$\frac{\partial P\left(grade_i = 1 \middle| X_i\right)}{\partial nfts_i} = \frac{e^{X_i'\hat{\beta}}}{\left(1+e^{X_i'\hat{\beta}}\right)^2}\beta_2,$$

$$\frac{\partial P\left(grade_i = 1 \middle| X_i\right)}{\partial nccm_i} = \frac{e^{X_i'\hat{\beta}}}{\left(1+e^{X_i'\hat{\beta}}\right)^2}\beta_3 \quad (3)$$

Equation (2) and (3) indicate that the coefficient of class performance of macroeconomics is 0.5 which implies that the class performance can enhance final grade: ignoring the variable of course selection system, on average, with per point enhanced in class performance, it is found to enhance the final grade with a probability of 0.125. Whereas the coefficient of selection system of macroeconomics is -0.198 which means that the system has a negative impact on the learning outcome of macroeconomics: keeping class performance and other variables constant, on average, the blended selection system is found to lower students' final grade with a probability of 0.049. In a nutshell, the blended course selective system is not applicable to macroeconomics in terms of our model regression analysis.

Similarly, using the cross-section data of microeconomics as well as equation (1) and (3), we obtain the microeconomics result shown in table 4.

Table 4. Result of microeconomics

Microeconomics [a] (N=758)				
	Coef.	St. Err.	z-value	p-value
Constant	-12.758	1.726	-7.39	0.000***
nfts	0.437	0.058	7.52	0.000***
nccm	0.139	0.256	0.54	0.587
LR-Statistic	85.263			0.000***
Pseudo R^2	0.081			

[a] The dependent variable is students' final grade of microeconomics.

*** p<0.01, ** p<0.05, and * p<0.1 denotes the 1%, 5% and 10% significant level, respectively.

Table 4 shows that, regarding microeconomics, the goodness-of-fit [15] is on the order of 0.09(Pseudo R^2=0.081). Given 1% significant level, the p value is 0.000, which implies that the choice model is significant on the whole. To be specific, since the coefficient of the variable of class performance (*nfts*) is positive(0.437), which means it has a significant positive impact on the final exam, in essence, the higher the grade of class performance, the higher the final grade the student may obtain. More importantly, unlike the negative coefficient of selection system of macroeconomics, the coefficient of selection system (*nccm*) of microeconomics is also positive (0.139), which means the blended system is conducive to improve the final exam. Again, even though the parameter of course selection system is insignificant (p=0.587), it might affect the final outcome as well, there are several reasons for this: partly because there are teaching quality variations among different teachers in the course group, partly because of the poorer peer effects induced by the introduction of the blended system which are unobservable. As mentioned above, the logistic model passed the significance test and makes sense from the perspective of economics. Thus, the vector form of regression model of microeconomics is:

$$\ln(\frac{\hat{P}_i}{1-\hat{P}_i}) = X_i'\hat{\beta} = -12.758 + 0.437nfts + 0.139nccm \quad (4)$$

According to Equation (4) and the corresponding marginal effect of class performance and selection system, we get the coefficient of class performance of microeconomics is 0.437 which implies that the class performance can enhance final grade: controlling the variable of course selection system, on average, with per point enhanced in class performance, it is found to enhance the final grade with a probability of 0.11. And the coefficient of selection system of macroeconomics is 0.139 which means that the system variable also has a positive impact on the learning outcome of microeconomics: keeping class performance and other variables constant, on average, the blended selection system is found to enhance students' final grade with a probability of 0.034. In a nutshell, according to model (3), there does have a causal relationship among class performance, blended course selective system and the final exam grade. Thus, it is safe to say that microeconomics is quite applicable to adopt the blended selection system.

4.2. Discussion

Given the same selection pattern and the same teaching group, why does the blended selection system have a dissimilar impact on the learning outcome of macroeconomics and microeconomics? There are three possible reasons: in the first place, because microeconomics is mostly opened during the second semester, which is the first time for most students to get to know the course and they are less restricted by advanced courses other than some students of liberal arts. In the second place, since macroeconomics is the follow-up course of microeconomics, it is reasonable that the previous perceptions of microeconomics may have a direct effect on students' interest and outcome in learning macroeconomics. Finally, due to the fact that the sample university did not carry out the blended course selection system until the fall semester of 2018 for the first time, while the students registered for macroeconomics were the ones that using the previous selection system that was registered on the basis of traditional major oriented teaching class, hence, under the newly blended selective system, coupled with the lack of peer effects which were caused by different majors and microeconomics basis, all of which led to the less desirable learning outcome compared to that of microeconomics.

5. CONCLUSION

Using the course data of microeconomics and macroeconomics and along with logistic regression, we find out that selection system does matter since it may affect students' learning outcomes. That is, even if the same selective system is used, it still makes a difference in terms of the variations of the learning outcome of the undergraduates. The main results are:
(1) The blended selection approach is not applicable to macroeconomics. According to model estimation, the parameter of selection system (*nccm*) is negative (-0.198), which indicates that the blended selective system may lower the final score with the probability of 0.049.
(2) In contrast, the blended selection approach is quite applicable to microeconomics. Based on model estimation, the parameter of selection system is positive (0.139), which indicates that the blended selective system may enhance the final score with the probability of 0.034.
(3) No matter with microeconomics or macroeconomics, the class attendance, performance in class, quizzes and assignment rather than course selection system contribute substantially to the final grades.

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