Is There a Vantage Advantage?

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Abstract

We investigate the causal impact of seating location on academic achievement, by leveraging a unique natural experiment that changed seating assignment in core MBA classes at a large midwestern university from endogenous choice by students to exogenous assignment by administrative staff. We first document substantial correlations between seating choice and grades during the period in which students chose where they sit (Fall 2009 to Winter 2014), and show that self-selection drives a large portion of these findings. Using data from the exogenous seating assignment era (Fall 2014 to Winter 2019), we then provide evidence of a modest positive causal impact of sitting in the front row on academic achievement. This causal effect is mainly observed in more quantitative classes, is likely driven by improved learning, and does not vary by student gender.

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1 Introduction

As universities aim to standardize their educational practices and offer equitable learning opportunities for students, there is a natural interest in seating assignment policies. Whether such policies are needed and what type of policies might be beneficial depend crucially on (1) the causal impact of seating location on academic outcomes, and if there is a causal impact, (2) the mechanism through which it operates. Although many researchers have analyzed the impact of seating location on student achievement, the literature has relied mainly on correlational studies and / or small samples. The results from this literature largely suggest substantial positive effects of sitting towards the front and/or center of the classroom, although some fail to find any significant effects.[1]

We contribute to this literature by exploiting a novel, large-scale natural experiment, wherein a large MBA program switched the seating arrangements for all the core classes from endogenous choice by students to exogenous assignment by the administrative staff. We put together a novel dataset that codes the seating position of each student in a class and links seating locations with three other sources of data: (1) students' course grades, obtained from the registrar, (2) course grade components coded based on historical syllabi, obtained from the library, and (3) students' final test scores in a subset of the courses, obtained from the centralized course management platform used by the institution. The data span 11 cohorts of MBA students in 9 core curriculum courses that students are required to take in the first year of the program. Between Fall 2009 and Winter 2014 (endogenous era), the students pick their seats on the first day of each class and sat in that seat for the remainder of the course. Starting in Fall 2014 (exogenous era), students are exogenously assigned seats and assignments are shuffled for each course and term. Our setting and data allow us to obtain cross-sectional associations (paralleling most studies in the literature) and causal estimates in the same context.

We begin by using data from the endogenous choice era to explore cross-sectional associations, regressing the standardized final grade on seat location variables, demographic

[1]We identified 23 studies examining correlation of seating positions with student achievement (See Appendix table A1 for a summary). Twelve of these studies document a positive correlation for sitting in toward the front of the classroom, three find a positive correlation for measures of more central seating, while eight studies find no significant correlations.

controls, and course section-year fixed effects. We document that students who sit more centrally and in the front rows obtain higher average grades. Compared to those sitting in the center, those sitting half the way from the center to the side of the class have an 8.5% lower standardized final grade, and those sitting at the far edges (toward or outside the visual periphery of the professor) have an additional 5.5% lower standardized final grade. The distance from the front of the class (or depth) also matters, with the second row associated with the highest mean grade. Specifically, compared to those sitting in the fourth row (back), the standardized final grade is higher by 10% for those sitting in the third row, by 16% for those sitting in the second row, and by 9% for those sitting in the front row.

While these cross-sectional correlations are interesting, estimating the magnitude of a true *causal* effect of seating position on student achievement is a central challenge emphasized in the literature. In particular, there is likely to be selection bias from unobserved student heterogeneity that is correlated with the seating choice and with student achievement. For example, students with high academic aptitude may be more likely to choose centrally located seats. Indeed, we confirm a sorting pattern. We construct a "relative GPA in other core classes" (GPAO) variable as the standardized average grade in all other core classes excluding the focal class. We show that given an index course, students with higher GPAO are more likely to sit in the front rows rather than the back rows, and more centrally rather than in the right or left sides of the classroom in the index course. In the presence of such sorting effects, cross-sectional associations are likely to be misleading about the causal impact of seat location on academic performance.

Even with data from the endogenous era, our setting allows for empirical strategies that address certain forms of selection bias. Specifically, unlike most studies in the literature, we have multiple observations (across up to nine core courses) for each student in each cohort. This allows for two alternative ways to control for heterogeneity in student ability. First, we include GPAO as a control in the cross-sectional regression. Because the GPAO variable is likely to be highly correlated with student academic ability, it is arguably an effective proxy for the main source of selection bias. Second, we take advantage of the panel data availability and include student fixed effects in our analyses (i.e., with two-way fixed effects, for course-section-years and individuals) to flexibly control for student-level confounders. In this approach, we rely solely on within-student variation in chosen seat location across different classes. The results from both approaches significantly weaken the association between grades and seating locations documented by the cross-sectional analysis. The specifications with student fixed effects show that sitting half the way from the center to the side of the class is associated with a 3-4% lower (not consistently significant) standardized final grade, and sitting at the far edges does not have a statistically or economically significant effect. The distance from the front of the class continues to matter, but with a lower magnitude: Compared to sitting in the fourth row (back), the standardized final grade 4% higher for the third row, 9% higher for the second row, and 5% higher for the first row.

Although the panel nature of the data allows us to control for student-level unobserved heterogeneity more satisfactorily than most of the studies in the literature, potential selection concerns still remain. For example, student choice could vary systematically across classes. That is, students with high motivation and/or interest in a particular class may be more likely to sit in the front in that class than in their other classes. Indeed, we find that including course-type (more or less quantitative) student fixed effects materially affects the results. However, finer level of course-individual-specific selection can only be addressed with exogenous manipulation of seating locations, in which the assignment of seats is orthogonal to student-course specific unobservables.

Accordingly, to more rigorously investigate the causal impact of seating location on student academic outcomes, we exploit the exogenous seating assignment policy change that went into effect in the fall of 2014. Specifically, we examine regressions of standardized final grade on seating positions, including class (i.e., course-section-year) fixed effects as well as several different controls for student heterogeneity. These analyses confirm that sitting in a more central positions has no substantially or statistically significant causal impact on grades. However, sitting in the front row has a modest positive causal effect on academic achievement in the class: students who are assigned to sit in the 1st (front) row earn grades that are 6% of a standard deviation higher than the students who are assigned to sit in the 4th (back) row.

Previous work has documented a gender gap in academic achievement in business schools, with men (women) outperforming women (men) in quantitative (non-quantitative) courses

(Krishna and Orhun (2022)). This pattern parallels other work showing that female students earn lower grades in STEM courses (e.g. Koester et al., 2016) and are less likely to pursue higher education in STEM fields (e.g. Hill et al., 2010). Therefore, we investigate whether the causal effect of being assigned to sit in the front varies by student gender and course type. Following the literature and terminology among MBA students, we classify courses into "poet" and "quant" courses. In the core curriculum, there are three poet courses (strategy, marketing, and organizational behavior) and six quant courses (statistics, operations, accounting (1 and 2), finance, and economics). We find that the positive impact of sitting in the front is observed mainly in quant courses. However, we do not find any gender differences in the impact of seating location on grades, regardless of the course type.

Why does sitting in the front increase grades? Sitting in the front may help with learning. For example, research on learning and attention has argued that preferential seating in the front of the classroom can help students struggling with attention disorders by minimizing distractions (e.g., Clifton, 2007). It is possible that all students learn better when distractions are minimized. Alternatively, sitting in the front may increase student participation in the course or professor's familiarity with the student, increasing the student's grade on the engagement portion of the grade. We undertake two sets of analyses to provide additional insights on how seating location may affect final grades. First, we show that the impact of sitting in the front is not stronger in classes that put a higher weight on class participation. If the effect mainly operates through changing participation grades, we would expect the impact to be higher in classes where participation is a larger component of the final grade. Therefore, this finding does not support the hypothesis that sitting in the front mainly increases final grades by increasing engagement grades. Second, using data on final exam scores for a large subset of quantitative core courses from the centralized course management platform (Canvas), we find that students who are assigned to sit in the front score higher on the final exam. The effect sizes are similar to that for the standardized final course grade. This finding suggests that sitting in the front may be helping students learn better in quantitative courses.

Our work is most closely related to studies that report results from exogenous seating assignments in classrooms. This literature has produced mixed results. Earlier work compared two sections of the same course in a given term that are assigned to different seating policies. Examining grades in an educational psychology class, Wulf (1976) compares one section with endogenous seat selection (44 students), and another (37 students) where students are assigned seats on a reverse alphabetical basis. The author finds no effect of seat location on grades when seats are exogenously assigned, despite a positive correlation between front seats and higher grades when seats are chosen by students. Using a similar design involving two sections of a psychology class, Stires (1980) documents that regardless of whether the seat choice is left to the students or assigned alphabetically, students who sit in the center of the class have higher grades than students who sit at the sides, and students who sit in the front of the class have higher grades than those who sit in the back. More recent studies report outcomes from one course in which all students are exogenously assigned seats. Perkins and Wieman (2005) document that students assigned to sit in the front rows perform better compared to those assigned to sit in the back rows in an introductory physics class of 201 students. In contrast, Kalinowski and Taper (2007) and Parker et al. (2011) fail to find differences in academic achievements between students assigned to sit in the front versus the back in an introductory biology class of 43 students and in a 55-student senior nutritional biochemistry class, respectively. Studying 1,138 students enrolled in a capstone business course taught by the same instructor over 10 years, Meeks et al. (2013) find that neither seating location (front vs. back rows) nor seating type (traditional chairs vs. tables) have a significant impact on student performance. In all these studies, instructors are involved in experimental design, implementation and data collection, and the students are aware of the manipulation because they are not experiencing the same seating policy in their other courses.

Our setting has several advantages that help us contribute to and extend this literature. First, as we describe in Section 2, the exogenous seating assignment policy is implemented by the school. Thus, the policy impacts all students in all core courses of a graduate degree program. In addition, the seat assignments are made by program staff, instructors are exogenously assigned to sections, and data is collected through centralized systems. Therefore, this setting provides higher data fidelity and a more generalizable context to study the potential impact of adopting an assigned seating policy on student outcomes. Second, our data span more than 20,000 student-class pairs during the exogenous era, and more than 13,000 student-class pairs during the endogenous era. The large sample size as well as variation in seating locations within students across classes affords us alternative strategies to address bias from potential correlation of student ability with seat choice. The large sample size also addresses a potential concern with many of the studies in the literature, that they may have been underpowered to detect causal effects, even if such effects existed. Third, and relatedly, the data span 281 section-course-term combinations in the exogenous assignment era, limiting the possibility that the causal estimates based on exogenous seating assignments are driven by sampling variation that produce unintended correlations between student aptitude and seating assignments. This is a potential concern in previous studies that examined the impact of seating location on grades in a few instances of exogenous assignment. Fourth, the richness of the data allows us to examine heterogeneous treatment effects across course types and student gender. Fifth, we are able to shed some light into the mechanism behind the causal effects we document by examining different grade components.

2 Data

2.1 Institutional Details

We utilize data from the full-time MBA program of a large Midwestern university. There are several administrative features of this MBA program that are relevant for this work. First, MBA students in the same cohort are assigned to sections upon arrival to the program. Cohorts are defined by graduation year (i.e., class of 2015). The program takes 2 years for most students, but can be longer (typically 3-years) for dual-degree students. The program office divides each cohort into sections, each having 70 - 75 students, and exogenously assigns students to sections conditional on the proportion of female students being comparable across sections.[2] Second, students take a set of required courses in the first-year with their section-mates. This curriculum is called the 'core' and consists of 9 courses in accounting, business

[2]Until Fall 2017, the MBA program offered core classes across 6 sections, and from Fall 2017 on, the MBA program shrank in size by one section.

economics, finance, marketing, operations, organizational behavior, statistics, and strategy.[3] Typically, each course is taught by 2 or 3 instructors in a given semester. Instructors and classrooms for a given course are exogenously assigned to sections by the program office.

Third, the core curriculum is coordinated, i.e., instructors are expected to use the same materials, grading rules, homeworks, and exams, to provide students in the same cohort with as comparable a core curriculum experience as possible across sections. In addition, classrooms are standardized across all core classes and accommodate 85 or 95 people. Figure 1 shows an example of a seating chart from one of these classrooms. The classrooms are tiered, the whiteboard and the drop-down screens are positioned in the front of the classroom on the wall behind the lectern. The instructor uses the lectern to project slides, control the screens, the classroom lighting and sound. The main entrances to the classrooms are on the two sides of the front wall.

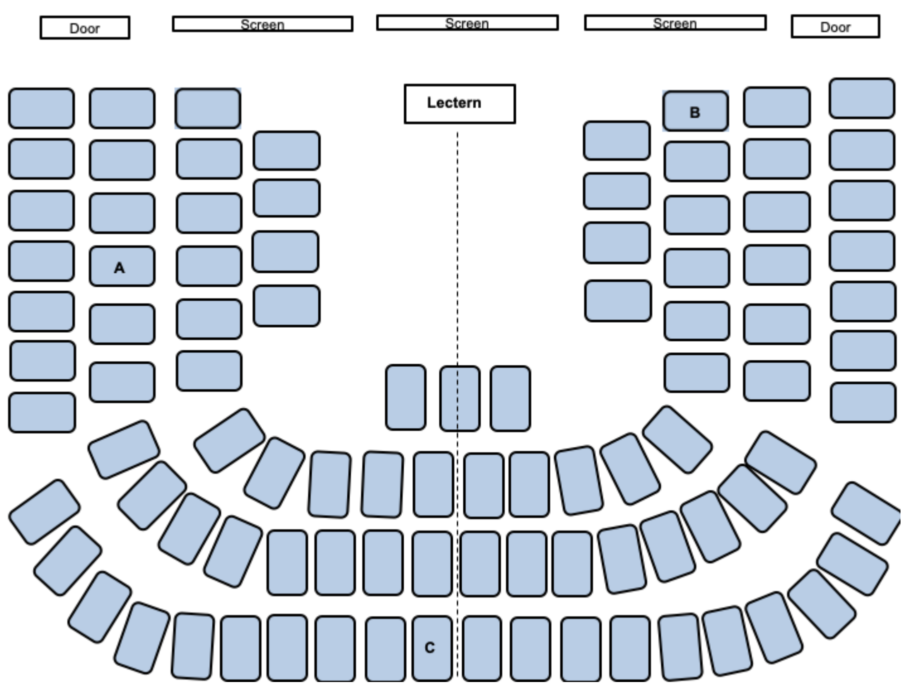

Figure 1: Layout of a Typical Core MBA Classroom

[3]There are three ways in which students may not be taking these courses with their section-mates. First, dual-degree students may take some core courses at a different time, since their time at the university is typically longer. Second, students can take exams to skip a core course and take electives instead. This is rare. Second, two courses offer additional flexibility: The finance course has a turbo version that students can self-select into, and in some years of the data period, the second of the two accounting courses could be taken either in the Fall or in the Winter semester.

Fourth, and crucial to the design of our study, where students sit in a core class is determined at the beginning of the semester and remains fixed over all class meetings that follow.[4] This is an established norm that students learn during their orientation program and adhere to in all core courses. The business school has changed its seat assignment policy over time, which we take advantage of in this study.

Until the Fall semester of 2014, the school implemented what we refer to in this paper as an "endogenous seating" policy. Under this policy, students entered the classroom on the first day of a class and chose a seat, knowing that they would sit in the same seat for the remainder of the term for that course. They were free to, and often did, choose different seats for different courses that they were taking. Seats were available on a first-come first-served basis. To indicate the seat they chose, the students wrote their name on the seat locations in an empty seating chart handed out by the instructor (the chart looked like Figure 1, but without colors or other indicators). Before the next class meeting, the administrative staff populated the seating charts by placing the pictures and names of the students on their chosen seats. The populated seating charts were made available electronically to the instructor and students.

Starting in Fall 2014, the program decided to exogenously assign students to seats in the core curriculum program. The seating charts were made by administrative support staff. Staff members had access to an online tool that populated the names and pictures (saved together as a thumbnail) of students registered for the class, and constructed seating charts by moving each thumbnail into a seat on the seating chart displayed by the online tool. The program office instructed the staff to balance gender and other dimensions of student identity on the seating chart, while being careful not to always place the same student in the same region of the classroom across the core courses they were taking.[5] The staff could only judge student identity dimensions that were discernible from student names and pictures. The seating charts were made available on the first day of class to all students, and the students sat in their assigned seats throughout the course.

[4]This policy is common practice at business schools and is thought to help instructors learn their students' names, and assist in accurately assigning class participation grades.

[5]Unless preferential seating was required by student accommodations.

2.2 Data Sources

We combine several administrative datasets to investigate the impact of seating location on academic performance. These datasets were made available by the university for research purposes. Our research purpose and methodology was approved by the university's IRB (HUM00242366).[6] We obtain the demographics and grades of about 5,800 MBA students who took core classes between Fall 2009 - Fall 2019 from the registrar. Demographic data include a binary definition of gender for all students, ethnicity indicators for most domestic students, and country of origin for international students. We use these demographics as controls for some of our analyses.[7] We obtain student seating locations from seating charts, which was carefully coded to include seating position features as described in more details below. We merge the seat location characteristics to students' grades and demographics using a cross-walk file between names and student identifiers in the registrar data. We supplement this data with grading components for each course-term instance, extracted from historical syllabi from the school's library. Finally, we collated students' final exam scores for a subset of courses for which the instructors reported these through the course management platform (Canvas).

The core curriculum program between Fall 2009 and Fall 2019 semesters offered 551 section-course-term combinations, which we refer to as *classes*. In the earlier years, each cohort had 6 sections. Starting in Fall 2016, cohorts comprised of 5 sections. A total of seven courses (Accounting 1, Economics, Finance, Statistics, Marketing, Org. Behavior and Strategy) are offered in the Fall semester, and in total for 62 term - section instances. The other two courses (Accounting 2 and Operations) are offered in the Winter semester, and in total for 57 term-section instances. In total, the program offered 551 core classes in our data period, and seating chart images were available from the program office for 457 of them.Across the classes for which we have seating charts, there are 33,865 grade observations (student-class level) in the registrar data. We are able to match 33,363 (98%) of these observations with the seating position of the student in a given class, which makes

[6]We abide by the requirements from IRB and Memorandum of Understanding (MOU) with the University to ensure data security and confidentiality.

[7]Appendix A details construction of the ethnicity and cultural background variables.

up our analysis sample. In the endogeous era 31.7% of the students in the sample are women, 9.5% are domestic under-represented minority students (URMs). In the exogenous era, 40% are women, 11.7% are URMs. Across both regimes, 30% of the student body are international and 12% are dual-degree students.

Grades In the MBA program, students can receive one of the following grades: Excellent (4.0), Good (3.0), Pass (2.0), Low Pass (1.0), and Fail (0). The school asks instructors in the core curriculum to abide by a grading curve such that a minimum of 5% of students receive a grade of Low Pass or below, no more than 25% of students to receive a grade of Excellent, and no more than 60% to receive a grade of Good or higher. The faculty mostly adhere to this policy: Overall, 25% of the students receive a grade of 4, 36% receive 3, 35% receive 2, 4% receive 1 or 0. Thus, the average GPA across the core courses is 2.83 and the median grade is 3.

Seating locations We obtained the filled seating charts as PDF files from the program office. For each seat in the classroom, we recorded whether it is empty or occupied, and if occupied, the name of the student sitting in the seat.[8] We also coded each seat's vertical distance and horizontal distance from the front center of the seating chart diagram. (Note that in terms of the physical space, vertical distance refers to distance from front of the classroom, and horizontal distance refers to the sideways distance from center of classroom.) The vertical distance was captured by row indicators (i.e., row 1 to row 4). Consider seats labeled A, B and C in Figure 1. Seat A is the third row of the right section, seat B is in the second row of the left section and seat C is in the fourth row of the center section. The horizontal distance of a seat was coded in relation to the classroom's virtual center, which is illustrated by the dashed line in Figure 1. In particular, for each seat, we recoded its section (left, center, right) and counted how many seats it was to the right or left of the virtual center of the classroom. For example, in Figure 1, seat C is 1 seat away from the virtual center, and seats A and B are both 11 seats away, in opposing directions. In our analyses, we care about the relative horizontal distance of a seat, because the tiered semi-circular seating

[8]The authors checked for errors and resolved any inconsistencies that arose across research assistants' efforts.

structure of the classrooms means that a back row seat that is 5 seats away from the center is still relatively central, while a front row seat that is 5 seats away from the center falls on the side. For example, in Figure 1, seat A's relative distance to center (*rdc*) is 79% because it is the 11th seat from the center to the right on a row that spans 14 seats in that direction. The *rdc* is 6% (1/17) for seat C and 79% (11/11) for seat B.

Figure 1 depicts a lectern in the front and center of the classroom. Instructors rarely stay behind the lectern. Walking around when lecturing or leading a case discussion in the space that is between the lectern and the students is a common practice, which means that the students sitting in the edges closest to the screens often fall outside of the instructor's immediate visual perimeter. To indicate these seats, we denote any seat whose relative distance is 85% or larger as an *edge* seat. In Figure 1, this means the three seats on the two edges of rows 3 and 4, two seats on the edges of row 2 and the last seat on the edges of row 1 are considered edge seats.

Syllabi We consult library records of course syllabi to code the weight of different grade components, such as the percentage contribution of individual and group assignments, exams and class participation to the final grade. Because the core classes are coordinated, all instructors in the same course-term use the same materials, assignments, exams and have the same grade weights in their syllabi.

Appendix Table A2 documents the summary statistics of different grade components for the core courses. On average, 40.3% of the student's grade in a class is determined by the final. Except in the case of the Strategy course, the final is an individual (rather than group) exam/project. Another individual grade component is class participation. The average weight of participation is 19.3% across courses and years. The average weight of individual and group assignments are 20.1% and 20.3% respectively. The weight of these components vary widely across different courses in the core curriculum. For example, courses in organizational behavior, strategy and accounting courses put a higher weight on participation, assigning at least 20% (and up to 40%) of the grade to be determined by the variation in participation grades. In contrast, economics, finance, operations, and statistics allow at most 15% (and down to 0%) of the grade to depend on participation. Variation within course, over time, is less pronounced. Recall that sections within a course-term all have the same grading rules, therefore, variation in grading weights within a course is due to changes over academic years. In some courses, such as in Operations and Organizational Behavior, the grading component weights remain relatively constant over time. In others, such as in Accounting 2, Marketing and Strategy, component weights vary over time.

Final Exam Scores In addition to official grades data from the registrar, we also obtain final exam scores recorded on the learning management system used by instructors and students at the university (Canvas). The core curriculum instructors started using Canvas during Fall 2015. We focus on data from five core courses (accounting, finance, economics, statistics and operations management) systematically conducted final exams and reported the scores on Canvas. The analysis sample contains 7,730 final exam scores across these five courses offered from Fall 2015 to Winter 2019.[9] The advantage of analyzing exam scores in addition to final course grades is that the former are not affected by class participation, or group work, and therefore more closely reflect individual students learning outcomes.

3 Cross-sectional associations between grades and seat locations

We start by exploring the cross-sectional association between student grade and seating location in class in the endogenous era (Fall 2009-Winter 2014), i.e., the period where students select their seating position for the duration of each course. This analysis is informative for two reasons. One, for faculty members that teach individual classes, their perceptions about whether a seating position matters is likely to be driven by cross-sectional correlations in the data. Thus this analysis provides insight into what perceived effects of seating positions could be, in a regime where students self-select seating positions. Second, many studies in the literature that rely on data from limited number of courses explore cross-sectional correlations (though most authors are careful about highlighting the limitations of this ap-

[9]About 1% observations from the canvas data were not matched due to non-MBA enrollment and lack of seating location information and 0.1% of the student-course observations were not found in the Canvas data possibly due to students opting out of having their data used for research purposes.

proach). Hence this analysis provides a benchmark to compare against the literature and also to compare against results from later analysis that will try to carefully address potential bias due to a correlation between student ability and seat choice.

3.1 Baseline Specification

Our baseline specification exploring the cross-sectional correlation between student performance and seating location is as follows:

$$G_{ic(st)} = \beta L_{ic(st)} + \gamma X_i + \mu_{c(st)} + \varepsilon_{ic(st)} \tag{1}$$

where $c(st)$ indicates a class (i.e., an instance of course delivery experienced by section s in term t), $G_{ic(st)}$ is the standardized grade of student i in class $c(st)$, and $L_{ic(st)}$ are location characteristics of the student's seat in that class, X_i include indicators for i's gender and ethnicity/cultural background, and $\mu_{c(st)}$ indicate class fixed-effects. We cluster standard errors at the student level. The coefficient of interest β captures the association between the characteristics of the location of the seat and the grades. Location characteristics comprise metrics that capture the vertical distance of the seat with row indicators and horizontal distance to the center based either on discrete partitions of the classroom or with metrics that rely on the relative distance to the center (as discussed in Section 2.2 above).

We present results from the estimation of Equation 1 with three alternative definitions of horizontal distance in Panel A of Table 1. Column (1) presents estimates from a specification that includes relative distance from the center as a linear measure for horizontal placement of the seat. Results from this specification suggest that the grades of students sitting in the second row are predicted to be 15.9% of a standard deviation higher than those of the students sitting in the back row (baseline), and students sitting in the center (where *rdc* is 0) are predicted to receive grades that are 22.6% of a standard deviation higher than students who are sitting at the very edge (where *rdc* is 1). Column (2) presents estimates from a specification that includes the linear effect of relative distance as well as an indicator for a seat being on the edges, to capture the potential nonlinearity that may arise from sitting in seats that are outside of the instructor's immediate visual span. Recall that the edge seats are defined as those with *rdc* greater than 0.85. Column (3) presents estimates from an alternative specification that includes indicators for three horizontal partitions of the classroom: the center section, the edge seats and seats that are on the side sections but not on the edges (baseline). Regardless of the specification, we see that sitting centrally is associated with higher grades. For example, estimates in column (3) suggest that students who sit in the center section earn 5.6% of a standard deviation higher grades and students who sit at an edge seat earn 12.7% of a standard deviation lower grades in the course compared to those who sit in more central seats of the side section. Overall, the results suggest large positive associations between sitting centrally and earning high grades in a given class.

Of course, seat choice may be driven by factors that also influence grades in the class. For example, if students of high academic potential prefer more central seats, a positive association of sitting centrally and receiving higher grades would emerge. To provide an initial test for such a systematic sorting pattern, we calculate student i's GPA in other courses.[10] We then standardize this metric across all students taking class $c(st)$, denoted as $GPAO_{ic(st)}$, and use it to predict the student's seat choice. The results are presented in Panel A of Table A5. The results indicate a positive sorting pattern: Students with a relatively higher cumulative GPA in other courses are more likely to sit in the front rows rather than the back rows, and also more likely to sit centrally. We defer the discussion of students' seat choice patterns, including the role of demographics, to Appendix B. However, the fact that GPAO predicts seat choice in the endogenous era suggests strong caution in interpreting observational studies in this domain.

3.2 Accounting for student-level unobserved heterogeneity

As discussed earlier, a central challenge in the literature is addressing bias from correlation of unobserved student-level characteristics (e.g., interest or aptitude) with seating choice.

[10]The correlation between the standardized grade in class c and GPA in other core courses is 0.48. In a population similar to the students represented in these data, previous research (Huberth et al., 2015; Koester, Grom, and McKay, 2016) has shown this metric to exhibit the strongest correlation with course grades among several measures regularly collected in administrative databases (e.g., high school GPA and standardized test scores).

Table 1: Associations between Grades and Seat Choice (Endogenous Era)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	PANEL A: CLASS FE ONLY			PANEL B: CLASS FE + OTHER GPA			PANEL C: CLASS FE + INDVL FE			PANEL D: CLASS FE + INDVL-CTYPE FE		
Row 1	0.0770*	0.0780*	0.0941**	0.0438	0.0442	0.0522*	0.0455	0.0455	0.0500	0.0614	0.0609	0.0611
	(0.0450)	(0.0449)	(0.0453)	(0.0286)	(0.0286)	(0.0287)	(0.0422)	(0.0422)	(0.0423)	(0.0453)	(0.0453)	(0.0455)
Row 2	0.1591***	0.1613***	0.1592***	0.0971***	0.0980***	0.0966***	0.0929***	0.0932***	0.0917***	0.1114***	0.1122***	0.1110***
	(0.0281)	(0.0281)	(0.0282)	(0.0179)	(0.0179)	(0.0179)	(0.0288)	(0.0288)	(0.0288)	(0.0300)	(0.0300)	(0.0300)
Row 3	0.1007***	0.1028***	0.1019***	0.0512***	0.0520***	0.0515***	0.0422*	0.0425*	0.0419*	0.0384	0.0394	0.0390
	(0.0258)	(0.0258)	(0.0259)	(0.0173)	(0.0173)	(0.0173)	(0.0244)	(0.0244)	(0.0244)	(0.0259)	(0.0259)	(0.0259)
Rel. Distance to Center	-0.2257***	-0.1778***		-0.1134***	-0.0935***		-0.0661*	-0.0616		-0.0460	-0.0255	
	(0.0394)	(0.0468)		(0.0254)	(0.0317)		(0.0383)	(0.0451)		(0.0408)	(0.0486)	
Edges (Farend)		-0.0722**	-0.1266***		-0.0301	-0.0599**		-0.0062	-0.0246		-0.0285	-0.0389
		(0.0357)	(0.0318)		(0.0291)	(0.0258)		(0.0338)	(0.0302)		(0.0353)	(0.0313)
Center			0.0555**			0.0270*			0.0145			-0.0008
			(0.0230)			(0.0155)			(0.0222)			(0.0237)
Std. GPAO				0.4138***	0.4136***	0.4143***						
				(0.0086)	(0.0086)	(0.0086)						
Constant	0.2747***	0.2582***	0.1482***	0.1076***	0.1008***	0.0441***	-0.0083	-0.0099	-0.0448**	-0.0245	-0.0316	-0.0418*
	(0.0338)	(0.0351)	(0.0310)	(0.0179)	(0.0190)	(0.0163)	(0.0228)	(0.0240)	(0.0204)	(0.0241)	(0.0258)	(0.0216)
N	13068	13068	13068	13068	13068	13068	13068	13068	13068	12325	12325	12325
r2_a	0.036	0.036	0.035	0.192	0.192	0.192	0.295	0.295	0.295	0.389	0.389	0.389
Controls	Gender, Ethnicity & Region Dummies			Gender, Ethnicity & Region Dummies			NA			NA		
Fixed Effects	Class			Class			Class + Individual			Class + Individual-Course Type		
Sample	Endogenous (FA2009-WN2014)			Endogenous (FA2009-WN2014)			Endogenous (FA2009-WN2014)			Endogenous (FA2009-WN2014)		
Pvalue: Row 2 vs Row 3	0.025	0.025	0.028	0.015	0.015	0.017	0.048	0.048	0.052	0.007	0.007	0.007
Pvalue: Row 2 vs Row 1	0.065	0.061	0.143	0.078	0.075	0.140	0.253	0.250	0.311	0.250	0.238	0.251
Pvalue: Row 3 vs Row 1	0.590	0.573	0.859	0.797	0.785	0.981	0.935	0.941	0.843	0.598	0.624	0.616

Even in the endogenous choice data period, we can control for student-level unobserved heterogeneity because we are able to observe students' academic achievement across a variety of courses. We take two approaches. First, we include $GPAO_{ic(st)}$ as an additional control variable in the estimation of Equation 1. Second, we repeat our analyses with student fixed-effects. The results are reported in Table 1, Panel B and Panel C, respectively.

Including $GPAO_{ic(st)}$ as a control or including student-fixed effects both weaken the association between grades and seating locations, as expected from a positive sorting pattern. Sitting half the way from the center to the side of the class is associated with a decrease by about 3-4% of a standard deviation, and sitting at the far edges does not have a statistically or economically significant effect on grades. The distance from the front continues to matter, but with a lower magnitude: Compared to sitting in the 4th row (back), sitting in the third row is associated with a 4% increase, in the second row is associated with a 9% increase, and sitting in the front row is associated with a 5% increase in the standardized final grades.

While controlling for student-level unobserved heterogeneity approach eliminates some of the confounding, selection concerns may remain. In particular, the seat preferences may not be stable for a student across different classes. For example, students with high motivation and/or interest in a particular class may be more likely to sit in the front in that class than in their other classes. In the context of the MBA programs, students typically think of themselves as poets or quants, reflecting different interests in career paths[11] The students also think of the curriculum in terms of poet courses (marketing, organizational behavior, strategy) and quant courses (economics, statistics, operations and accounting). To the extent that different career interests correlate with seating choices in core courses, we might expect within-student variation in seating preferences. To explore this possibility, we further extend the specification in Equation 1 by including course-type (poet or quant) X student fixed-effects. The results are reported in Panel D of Table 1. The results are materially different than those in Panel B, suggesting a systematic within-student heterogeneity in seat choices. In particular, once we control for student unobservables at the course-type level, horizontal distance from the center no longer predicts grades.

Although the rich panel nature of the data allows us to control for several dimensions of

[11] The main industry publication is aptly named Poets& Quants.

unobserved heterogeneity, these approaches suffer from two potential caveats. First, we may worry that after including individual and course-type specific fixed effects, the variation in seat locations may not rich enough to identify the influence sitting centrally. Although this is a general concern, we see that not only are the standard errors are large, but also the magnitude of coefficients are not economically meaningful. Second, and more importantly, the fixed-effects we are able to include may not resolve all selection concerns. In particular, we may worry that students' interest/motivation and other factors that lead to different seat choices may vary at the course level, rather than be the same for all poet or all quant courses. Such finer level of selection can only be addressed with exogenous manipulation of seating locations, in which the assignment of seats is orthogonal to student-course specific unobservables.

4 Causal Impact of Seat Location on Grades

4.1 Average Effects

Exogenous assignment of students into seats was afforded by the new policy starting in Fall 2014. The directive to the staff making the seat assignments was to balance gender and other dimensions of diversity, while being careful not to put the same student always in the same region of the classroom across the core courses. The staff could judge diversity based on observable cues from student names and pictures. Oftentimes, the staff used rules of thumb to achieve balance, such as alternating the assignment of men and women in seats. We conjecture that seat location is as good as random conditional on student observables, because (i) the staff did not have access to any other information about the students, and (ii) their directive was to balance observable diversity. In support of this conjecture, and in contrast to our findings in the endogenous seat selection period, $GPAO_{ic(st)}$ does not predict seat location after controlling for the impact of student observables on seat assignment (see Panel B of Table A5).

Therefore, we rely on the conditional independence of seat assignment to estimate the causal impact of where a student sits on their final grade. In particular, using the data from the exogenous seat assignment era, we estimate the same variations of the specification in Equation 1 as we did in Section 3. Panel A of Table 3, presents results from using three different definitions of horizontal distance, which are the same as before.

Regardless of how horizontal placement of the seat is measured, we find no causal impact of how centrally a student is placed on the student's final grade in the course. We find that only one feature of the seat location matters for students' academic performance: whether the student sits in the front row of the classroom. The causal effect of sitting in the front row is a 5% of a standard deviation increase in grades. Panel B reports results from a specification that includes student fixed-effects, and Panel C reports results from a specification that includes student-course-type fixed-effects. The results are largely unchanged: we see no causal impact of horizontal placement, and the causal effect of sitting in the front row is a 5% - 5.6% of a standard deviation increase in grades. To put the magnitude of this effect into context, we note that approximately 38% of the variation in standardized grades in the exogenous era is within student and course-type. Therefore, we conclude that sitting in the front row has a moderate positive effect on students' grades.

4.2 Heterogeneity by Gender and Course Type

Prior work has documented a gender gap in academic achievements in business schools, with men (women) outperforming women (men) in quantitative (non-quantitative) courses (e.g., Krishna and Orhun, 2022). Therefore, we investigate whether the causal effect of being assigned to sit in the front varies with student gender and course type. In examining both types of heterogeneity, we estimate the following main specification:

$$G_{ic(st)} = \alpha_{ig} + (\beta_0 + \beta_1 \cdot 1(g = 1))L_{ic(st)} + \mu_{c(st)} + \varepsilon_{ic(st)}, \tag{2}$$

where g is the placeholder variable for the binary group we are interested in (i.e., gender or course-type). When estimating heterogeneity with respect to course-type, α_{ig} captures student unobservables specific to course-type. In the case of gender heterogeneity, α_{ig} reduces to α_i. All other variables are as defined in Equation 1.

Table 3 reports the results from the estimation of Equation 3 exploring gender heterogene-

Table 2: Causal Impact of Seat Location on Grades (Exogenous Era)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	PANEL A: CLASS FE ONLY			PANEL B: CLASS FE + OTHER GPA			PANEL C: CLASS FE + INDVL FE			PANEL D: CLASS FE + INDVL-CTYPE FE		
Row 1	0.0509**	0.0510**	0.0501*	0.0554**	0.0555**	0.0561**	0.0562**	0.0563**	0.0571**	0.0522**	0.0525**	0.0519**
	(0.0252)	(0.0252)	(0.0256)	(0.0226)	(0.0226)	(0.0229)	(0.0229)	(0.0229)	(0.0232)	(0.0224)	(0.0224)	(0.0227)
Row 2	-0.0034	-0.0035	-0.0037	0.0136	0.0135	0.0135	0.0215	0.0214	0.0213	0.0218	0.0217	0.0216
	(0.0178)	(0.0178)	(0.0179)	(0.0163)	(0.0163)	(0.0164)	(0.0167)	(0.0167)	(0.0168)	(0.0163)	(0.0163)	(0.0164)
Row 3	-0.0123	-0.0125	-0.0126	-0.0099	-0.0101	-0.0101	-0.0073	-0.0076	-0.0076	-0.0089	-0.0093	-0.0093
	(0.0169)	(0.0169)	(0.0169)	(0.0151)	(0.0151)	(0.0151)	(0.0154)	(0.0154)	(0.0154)	(0.0154)	(0.0154)	(0.0154)
Rel. Distance to Center	0.0113	0.0051		0.0011	-0.0058		-0.0018	-0.0081		0.0185	0.0041	
	(0.0270)	(0.0304)		(0.0235)	(0.0269)		(0.0240)	(0.0272)		(0.0237)	(0.0272)	
Edges (Farend)		0.0122	0.0131		0.0135	0.0117		0.0127	0.0100		0.0292	0.0302
		(0.0294)	(0.0274)		(0.0265)	(0.0246)		(0.0272)	(0.0254)		(0.0264)	(0.0244)
Center			-0.0025			0.0016			0.0020			-0.0015
			(0.0149)			(0.0134)			(0.0136)			(0.0134)
Std. GPAO				0.4738***	0.4738***	0.4738***						
				(0.0052)	(0.0052)	(0.0052)						
Constant	0.2527***	0.2546***	0.2584***	0.0632***	0.0652***	0.0618***	-0.0075	-0.0056	-0.0102	-0.0164	-0.0121	-0.0093
	(0.0268)	(0.0271)	(0.0256)	(0.0153)	(0.0158)	(0.0141)	(0.0135)	(0.0141)	(0.0133)	(0.0135)	(0.0140)	(0.0131)
N	20295	20295	20295	20295	20295	20295	20295	20295	20295	20277	20277	20277
Adj. R-squared	0.040	0.040	0.040	0.239	0.239	0.239	0.313	0.313	0.313	0.422	0.422	0.422
Controls	Gender, Ethnicity & Region Dummies			Gender, Ethnicity & Region Dummies			NA			NA		
Fixed Effects	Class			Class			Class + Individual			Class + Individual-Course Type		
Sample	Exogenous (FA2014-FA2019)			Exogenous (FA2014-FA2019)			Exogenous (FA2014-FA2019)			Exogenous (FA2014-FA2019)		
Pvalue: Row 2 vs Row 3	0.623	0.619	0.625	0.150	0.148	0.149	0.083	0.081	0.082	0.061	0.059	0.060
Pvalue: Row 2 vs Row 1	0.034	0.033	0.035	0.068	0.066	0.062	0.138	0.136	0.125	0.186	0.181	0.188
Pvalue: Row 3 vs Row 1	0.013	0.013	0.014	0.004	0.003	0.003	0.005	0.005	0.005	0.007	0.006	0.007

ity in column 1 of Panel A and course-type heterogeneity in column 1 of Panel B. Columns 2 and 3 in both panels report results from estimating Equation 1 on subsamples defined by the binary variable (i.e., gender or course-type) of interest. The results in Panel A indicate that there are no significant differences in the impact of seating location on grades between men and women overall. The results in Panel B suggest that the positive impact of sitting in the front is observed only in quant courses. In poet courses, the causal impact of sitting in the front is substantively close to zero and statistically insignificant. In quant courses, sitting in the front row increases standardized grades by 8.24%. Considering that 35% of the variation in standardized grades in quant courses is within student, the fact that sitting in the front row has an 8% increase in standardized grades is meaningful. In Panel C, we explore whether there is a gender heterogeneity in the impact of sitting in the front row by course-type. We find that, regardless of student gender, sitting in the front row increases grades in quant courses, and there is no causal impact of seat location on grades in poet courses.[12]

4.3 Potential Mechanism: Evidence from Final Exam Scores and Participation Weights

Why does sitting in the front increase grades in quantitative courses? Sitting in the front may increase student participation in the course or professor's familiarity with the student, impacting the student's grade on the engagement portion of the grade. Alternatively, sitting in the front may help with learning, for example by minimizing distractions. Overall, the quant courses put lower weight on participation, therefore the first explanation seems unlikely, but to shed empirical light onto the participation-based versus the learning-based explanation, we conduct two subsequent analyses.

First, we examine the causal impact of seat location on final exam scores. Examining the impact on final exam scores instead of the final course grade allows us to abstract away from variations in student performance in class participation and group work to focus on an academic performance metric that most closely measures content knowledge. This analysis

[12]Results from a fully-interacted model also support this conclusion and are available upon request.

Table 3: Causal Impact of Seat Location: Heterogeneity By Gender and Course Type

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	PANEL A: GENDER			PANEL B: COURSE TYPE			PANEL C: GENDER AND COURSE TYPE		
Sample	All	Female Only	Male Only	All	Quant Only	Poet Only	All	Quant Only	Poet Only
Row 1=1	0.0581**	0.0662*	0.0581**	-0.0019	0.0805***	-0.0019	-0.0006	0.0665**	-0.0006
	(0.0292)	(0.0360)	(0.0291)	(0.0412)	(0.0264)	(0.0411)	(0.0517)	(0.0333)	(0.0517)
Row 2=1	0.0125	0.0369	0.0125	0.0075	0.0305	0.0075	-0.0218	0.0358	-0.0218
	(0.0213)	(0.0259)	(0.0213)	(0.0306)	(0.0191)	(0.0306)	(0.0398)	(0.0251)	(0.0398)
Row 3=1	-0.0155	0.0014	-0.0155	-0.0259	0.0005	-0.0259	-0.0311	-0.0169	-0.0311
	(0.0202)	(0.0236)	(0.0201)	(0.0289)	(0.0181)	(0.0288)	(0.0370)	(0.0235)	(0.0370)
Rel. Distance to Center	-0.0004	0.0191	-0.0004	0.0432	0.0047	0.0432	0.0712	-0.0025	0.0712
	(0.0306)	(0.0376)	(0.0305)	(0.0441)	(0.0276)	(0.0441)	(0.0553)	(0.0353)	(0.0553)
Female # Rel. Distance to Center	0.0195						-0.0518	0.0219	-0.0518
	(0.0483)						(0.0906)	(0.0567)	(0.0906)
Row 1=1 # Female	0.0082						0.0181	0.0423	0.0181
	(0.0463)						(0.0846)	(0.0544)	(0.0845)
Row 2=1 # Female	0.0244						0.0774	-0.0061	0.0774
	(0.0335)						(0.0620)	(0.0387)	(0.0619)
Row 3=1 # Female	0.0169						0.0201	0.0429	0.0201
	(0.0310)						(0.0586)	(0.0367)	(0.0585)
Row 1=1 # Quant=1				0.0824*			0.0671		
				(0.0483)			(0.0601)		
Row 2=1 # Quant=1				0.0230			0.0576		
				(0.0355)			(0.0467)		
Row 3=1 # Quant=1				0.0264			0.0141		
				(0.0342)			(0.0433)		
Quant=1 # Rel. Distance to Center				-0.0385			-0.0737		
				(0.0516)			(0.0642)		
Row 1=1 # Female # Quant=1							0.0243		
							(0.0991)		
Row 2=1 # Female # Quant=1							-0.0835		
							(0.0718)		
Row 3=1 # Female # Quant=1							0.0228		
							(0.0694)		
Female # Quant=1 # Rel. Distance to Center							0.0737		
							(0.1071)		
Constant	-0.0119	-0.1351***	0.0702***	-0.0167	-0.0183	-0.0139	-0.0200	-0.0200	-0.0200
	(0.0134)	(0.0210)	(0.0174)	(0.0137)	(0.0157)	(0.0254)	(0.0137)	(0.0157)	(0.0254)
N	20295	8115	12180	20277	12788	7489	20277	12788	7489
Adj. R-squared	0.331	0.313	0.333	0.422	0.474	0.315	0.427	0.477	0.324
Fixed Effects	Class-Gender & Indvdl			Class & Indvdl-Coursetype			Class-Gender & Indvdl-Coursetype		

relies on five of the six quant courses (Accounting 2, Finance, Economics, Statistics, and Operations) that use an individual final exam, and for which these grades are available on Canvas for the period inclusive of Fall 2015 to Winter 2019). The results are presented in Table 4. The first six columns replicate the baseline analysis in Table 2, for the Canvas data subsample.[13] The results show that there is indeed a large row 1 effect, amounting to about 8.3% of standardized final grade (Column 6). This is comparable to the estimate of 8.1% in column 5 of Table 3 that estimated the effect for all six quant courses. The next six columns of Table 4 replicate our main approach using standardized final exam score obtained from Canvas as the dependent variable instead of the standardized course grade. The causal impact of seating location on final exam performance is qualitatively very similar to the impact on the course grade: how centrally the student is placed in the classroom has no effect on final exam score, and being assigned a seat in the front row causes final exam scores to increase by 6.29% of a standard deviation compared to being assigned to sit in the back row. The magnitude of the effect on the standardized seating score suggests that three quarters of the grade effect (6.29% / 8.29%) is due to a material change in the score on an exam that evaluates individual learning. This finding rules out student participation as a primary driver of the impact of sitting in the front row has on grades, and instead is consistent with sitting in the front helping students learn the course content better.

Second, we evaluate whether the impact of sitting in the front is stronger in classes that put a higher weight on participation. We estimate the specification in Equation 3, where Z is the percentage of the grade that the course syllabus specified to be determined by participation. The estimates, reported in Table A3, show that the impact of sitting in the front row is not larger in classes that put a higher weight on participation, regardless of whether we use a continuous (Panel A) or discrete (Panel B) characterization of class participation weight, and whether we use variation across all courses (first column), or only within quant or poet courses (second and third columns, respectively). These results provide additional evidence that the impact of sitting in the front row is unlikely to be operating through participation. Therefore, we conclude that sitting in the front row in quant classes

[13] Due to space considerations, we only report results from a specification that includes student demographics and student fixed effects (i.e., corresponding to Panels A and C of earlier tables), but results are not materially affected if we use specifications as in Panels B and D of the earlier tables.

is impacts course grades through increased performance on exams and assignments.[14]

5 Conclusion

It can be concerning to observe students sitting in the back and toward the edges of the classroom earning systematically lower grades. Indeed, based on observations of such associations, some faculty members teaching in the core curriculum of the program we examine advocated for assigned seating policies to help provide equitable learning opportunities to students. The program office introduced exogenous seating assignment policy to address these concerns. Years later, owing to this policy change, we are able to shed light onto whether concerns regarding the impact of seating location on academic achievement were well-founded.

The main message of this paper is that causal effects of seat location on academic performance are modest and limited to the front row when they exist, although a number of prior studies as well as cross-sectional analyses we conducted reveal substantial associations. Our results underscore student self-selection as a driver for a large portion of the relationship between grades and classroom seating. We provide direct and indirect evidence that students with high academic potential (and interest in a given area) are more likely to sit toward the front and center of the classroom. In Appendix B, we also document systematic differences in student seat preferences as a function of student gender, ethnicity, and regional background. To the extent that these demographics predict grade differences in a course or a program, demographic differences in student seat preferences can also contaminate inference in cross-sectional approaches. Therefore, as our paper clearly demonstrates within the same educational context, associations between seating locations and grades can be misleading.

Although we find modest effects that are limited to the front row, our work can help design more equitable student learning experiences in two ways. Most directly, our results suggest

[14] It is not immediately clear why the positive effect of sitting in the front row is only observed in quant courses. It could be that these courses require a more sustained degree of attention, and therefore sitting in the front makes a larger difference. It could also be that because poet courses typically place a higher weight on group projects and participation, and therefore modest improvements in individual learning, if any, do not necessarily translate to increases in course grades. Because we lack data on final exam grades for poet courses, we are unable to evaluate whether sitting in the front row has a causal effect on final exam scores in poet courses.

Table 4: Causal Impact of Seat Location: Analysis Using Final Exam Score Data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Stdzd Final Grade						Std. Canvas final exam score					
Row 1	0.0763*	0.0764*	0.0724*	0.0820**	0.0824**	0.0829**	0.0645*	0.0644*	0.0651	0.0628*	0.0625*	0.0629*
	(0.0402)	(0.0402)	(0.0408)	(0.0348)	(0.0348)	(0.0354)	(0.0389)	(0.0389)	(0.0397)	(0.0323)	(0.0323)	(0.0331)
Row 2	0.0149	0.0150	0.0138	0.0332	0.0334	0.0342	-0.0102	-0.0102	-0.0098	0.0121	0.0119	0.0133
	(0.0290)	(0.0290)	(0.0292)	(0.0256)	(0.0256)	(0.0258)	(0.0286)	(0.0287)	(0.0289)	(0.0239)	(0.0239)	(0.0242)
Row 3	-0.0002	-0.0004	-0.0008	-0.0014	-0.0017	-0.0013	0.0066	0.0067	0.0068	0.0180	0.0182	0.0188
	(0.0274)	(0.0273)	(0.0274)	(0.0235)	(0.0235)	(0.0235)	(0.0260)	(0.0260)	(0.0260)	(0.0217)	(0.0217)	(0.0217)
Rel. Distance to Center	0.0255	0.0190		0.0214	0.0075		-0.0026	0.0007		0.0066	0.0173	
	(0.0426)	(0.0489)		(0.0354)	(0.0408)		(0.0420)	(0.0484)		(0.0329)	(0.0386)	
Edges (Farend)		0.0128	0.0151		0.0265	0.0314		-0.0065	-0.0049		-0.0203	-0.0107
		(0.0468)	(0.0432)		(0.0388)	(0.0359)		(0.0440)	(0.0408)		(0.0352)	(0.0324)
Center			-0.0111			0.0021			0.0020			0.0023
			(0.0240)			(0.0200)			(0.0242)			(0.0189)
Constant	0.2185***	0.2204***	0.2360***	-0.0290	-0.0248	-0.0234	0.2221***	0.2211***	0.2200***	-0.0205	-0.0237	-0.0185
	(0.0407)	(0.0412)	(0.0392)	(0.0211)	(0.0219)	(0.0202)	(0.0401)	(0.0405)	(0.0387)	(0.0195)	(0.0204)	(0.0190)
N	7730	7730	7730	7730	7730	7730	7730	7730	7730	7730	7730	7730
Ajusted R-squared	0.086	0.086	0.086	0.510	0.510	0.510	0.120	0.120	0.120	0.573	0.573	0.573
Controls	Gender, Ethnicity & Region Dummies			NA			Gender, Ethnicity & Region Dummies			NA		
Fixed Effects	Class			Class + Individual			Class			Class + Individual		
Sample	Exogenous (FA2014-FA2019)			Exogenous (FA2014-FA2019)			Exogenous (FA2014-FA2019)			Exogenous (FA2014-FA2019)		
Pvalue: Row 2 vs Row 3	0.597	0.593	0.612	0.167	0.162	0.157	0.556	0.554	0.562	0.803	0.792	0.817
Pvalue: Row 2 vs Row 1	0.129	0.128	0.145	0.161	0.159	0.162	0.058	0.058	0.057	0.129	0.129	0.140
Pvalue: Row 3 vs Row 1	0.058	0.057	0.070	0.015	0.014	0.015	0.132	0.133	0.136	0.155	0.159	0.171

that opportunities to sit in the front row should be equitably distributed among students. However, we also recognize that in many settings only a small proportion of the student body can be placed in the front row. Therefore, it is important to consider why sitting in the front is helpful. Our results suggest that the positive effect of sitting in the very front row is likely to operate through improved learning. Potential reasons for improved learning may include being better able to see or hear the professor, a feeling of hyper-visibility which helps with class preparation, and increased eye-contact and feeling of connection with the professor, which may increase motivation or interest in the class. Another reason may be that sitting in the very front minimizes distractions that interfere with paying attention (e.g., Clifton, 2007). Indeed, in the MBA program we study, students have reported being distracted by what is on the laptop screens of their classmates sitting in front of them. If increased attention is the main reason why sitting in the front row improves grades, other policies to curb distractions could be effective, potentially improving the learning experience of all students in the class regardless of their seat locations. We are in the process of collecting survey data to gain additional insights into these potential channels. We must recognize that even though our scope of our data is unprecedented and the exogenous assigned seating across multiple courses and instructors is novel to the literature, our insights remain specific to one business graduate program. We hope that our work encourages further research into whether and why sitting in the front row leads to better academic performance.

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Appendices

Table A1: Summary of Related Literature

N	Study	Sample size	Randomization	Key Findings
Panel A: Papers finding positive effects of front seating				
1	Becker et al. (1973)	282	No	Students in the front rows perform better, report liking the teacher more; this matched students perceptions.
2	Holliman and Anderson (1986)	141	No	Students seated in the front performed better than those in the back. Centrality, student density, and aisle seating were not related to grades.
3	Benedict and Hoag (2004)	198	No	Students who chose to sit in the front performed better than those in the back. Students forced forward tend to receive higher grades.
4	Perkins and Wieman (2005)	201	Yes	Students seated in the front rows had higher achievement levels.
5	Gossard et al. (2006)	88	No	Students seated in the front and middle performed better.
6	Parker et al. (2011)	55	Yes	Students sitting in the front in the stay group made more comments. The move group showed higher overall participation with no significant difference between the front and back.
7	Schee (2011)	373	No	Students in the front row performed better than those in the back half.
8	Pichierri and Guido (2016)	232	No	Students who occupy the highest (back) rows perform worse. High shyness may decrease the benefits from sitting in front.
9	Shernoff et al. (2017)	407	No	Students who preferred to sit in the back rows were less likely to be engaged and motivated, and obtained lower grades.
10	Bergtold et al. (2019)	347	No	Students who sit in the back of the class perform worse. Peer effect measures did not have a statistically significant impact on performance.
11	Will et al. (2020)	1364	No	Sitting in the back and using a computer in class negatively impacted grades. Negative effect of computer is independent of seating position.
12	Wasendorf et al. (2023)	386	No	Students who chose to sit at the back perform worse than those who sat in the middle and front, and attended less often.
Panel B: Papers finding positive effects of central seating				
13	Weinstein (1981)	NA (Lit. rev.)	NA	Concludes that "a front-center seat facilitates achievement, positive attitudes, and participation...The mechanisms...not yet been identified...hypothesize that teachers attend more to students in the front and center."
14	Marshall and Losonczy-Marshall (2010)	1829	No	Students sitting in the more central parts had higher percentage grades and attended classes more frequently.
15	Stires (1980)	279	Yes	Students seated in the middle (i.e., center) of the room got higher grades, liked the course better, and liked the instructors.
Panel C: Papers finding no significant effects of seating positions				
16	Wulf (1976)	81	Yes	No significant performance effects in class where seats were assigned; higher performers prefer front and middle seats.
17	Montello (1988)	NA (Lit. rev.)	NA	Concludes that: "[Seating location]..does not affect college course grades."
18	Kalinowski and Taper (2007)	45	Yes	No relationship between random seat assignments and student outcomes.
19	Armstrong and Chang (2007)	5814	Yes	No evidence that seat location affects student achievement even when students sit a considerable distance from the instructor in very large classes.
20	Meeks et al. (2013)	1138	No	No significant alteration in student performance due to assigned seating location over a 10-year period
21	Hirano et al. (2017)	500	No	Students with poor grades sat in low interactions seats (back rows, and sides of back rows). Students with good grades choose medium interaction seats. Students academic ability hard to predict from seat location.
22	Jover and Ramírez (2018)	49	No	Students are reluctant to sit in the first row; the most punctual students chose first rows, although this had no impact on academic performance.
23	Chan et al. (2022)	182	No	Those who sat at the front performed better for soft fields; no correlation of performance with seating location for hard fields.

Table A2: Course Grading Weights

	Course Name	Partici-pation %	Final Exam %	Individual, Other %	Group, Other %
Quant Courses	Accounting 1	28.64	35.45	35.91	0.00
	N=44	(2.25)	(5.04)	(4.21)	(0.00)
	Accounting 2	25.46	46.30	10.64	17.60
	N=50	(4.04)	(9.14)	(12.51)	(6.57)
	Economics	8.55	51.45	15.00	25.00
	N=62	(2.29)	(4.99)	(0.00)	(3.14)
	Finance	13.17	44.30	22.16	20.37
	N=41	(4.15)	(3.28)	(9.29)	(6.56)
	Statistics	14.18	57.82	15.82	12.18
	N=44	(1.35)	(1.35)	(11.51)	(11.51)
	Operations	15.00	33.46	21.54	30
	N=39	(0.00)	(2.34)	(2.34)	(0.00)
Poet Courses	Marketing	18.39	26.61	16.29	38.71
	N=62	(4.51)	(18.57)	(21.95)	(5.43)
	Org. Behavior	20.00	35.00	15.00	30.00
	N=53	(0.00)	(0.00)	(0.00)	(0.00)
	Strategy	28.95	35.32	30.56	5.16
	N=62	(5.21)	(11.01)	(12.58)	(5.04)
	Total	19.27	40.32	20.10	20.31
	N=457	7.72	13.00	13.58	13.25

For each core course, this table reports the number of class instances observed in our analyses sample, the average weight of each grading component (and the standard deviation, in parentheses) in terms of percentage of the course grade across all the term-section instances between Fall 2009 and Fall 2019 semesters. Individual, Other refers to the weight of individual assignments and exams during the term, excluding the final exam. Group, Other refers to the weight of group assignments and projects during the term.

Table A3: Causal Impact of Seating Location: Heterogeneity by Weightage for Class Participation

	Panel A: Continuous Participation Points (demeaned)			Panel B: Dummy High Participation (> 19 points)		
Sample	All	Quant Only	Poet Only	All	Quant Courses	Poet Courses
Row 1=1	0.0583**	0.0907***	-0.0042	0.0531*	0.0671**	-0.0353
	(0.0230)	(0.0283)	(0.0422)	(0.0299)	(0.0302)	(0.0739)
Row 2=1	0.0222	0.0345*	0.0148	0.0204	0.0303	0.0456
	(0.0167)	(0.0199)	(0.0311)	(0.0222)	(0.0223)	(0.0543)
Row 3=1	-0.0063	0.0051	-0.0292	-0.0046	-0.0066	-0.0155
	(0.0154)	(0.0190)	(0.0290)	(0.0206)	(0.0210)	(0.0494)
Rel. Distance to Center	0.0004	0.0078	0.0228	-0.0086	0.0069	-0.0402
	(0.0240)	(0.0289)	(0.0446)	(0.0316)	(0.0322)	(0.0765)
Row 1=1 # Ptcp (Demeaned)	0.0035	0.0059	0.0010			
	(0.0035)	(0.0042)	(0.0080)			
Row 2=1 # Ptcp (Demeaned)	0.0009	0.0023	-0.0079			
	(0.0026)	(0.0030)	(0.0064)			
Row 3=1 # Ptcp (Demeaned)	0.0017	0.0029	0.0031			
	(0.0024)	(0.0028)	(0.0059)			
Row 1=1 # D_High_Ptcp				0.0070	0.0451	0.0484
				(0.0458)	(0.0608)	(0.0901)
Row 2=1 # D_High_Ptcp				0.0026	0.0021	-0.0560
				(0.0332)	(0.0436)	(0.0673)
Row 3=1 # D_High_Ptcp				-0.0061	0.0230	-0.0146
				(0.0309)	(0.0403)	(0.0609)
Rel. Distance to Center # Ptcp (Demeaned)	0.0040	0.0019	0.0195**			
	(0.0037)	(0.0044)	(0.0084)			
Rel. Distance to Center # D_High_Ptcp				0.0151	-0.0071	0.1215
				(0.0477)	(0.0621)	(0.0910)
Constant	-0.0077	-0.0191	-0.0135	-0.0075	-0.0186	-0.0138
	(0.0135)	(0.0158)	(0.0254)	(0.0135)	(0.0158)	(0.0254)
N	20295	12788	7489	20295	12788	7489
Adjusted R-squared	0.313	0.474	0.316	0.313	0.474	0.315
Fixed Effects	Class & Individual					

A Ethnic and Regional Backgrounds

In most of our analysis (except when including student fixed effects, which absorbs student characteristics) we include dummies using a "Region & Ethnicity" categorical variable. This variable takes on eight values, as summarized in Table A4. The first five categories correspond to grouping of US domestic students based on ethnicity. The next three categories correspond to grouping of international students by regions.

Table A4: Proportions of Ethnic and Regional Backgrounds

Ethnicity & Region	Category	Domestic	International	Total
1	US White	57.45	0.00	40.14
2	US Black	8.57	0.00	5.99
3	US Hisp+	6.25	0.00	4.36
4	US Asian	19.27	0.00	13.46
5	US NA	8.46	0.00	5.91
6	Other Intl	0.00	36.58	11.02
7	E Asian	0.00	32.03	9.65
8	S Asian	0.00	31.39	9.46
Total		100.00	100.00	100.00

Overall, about 70% of the student body comprises of domestic students. The ethnic background of the students is available for domestic students who chose to report it. The shares by the four major ethnic groups (White, Black, Hispanic and Asian) are reported in the table. The 8.46% share of "US NA" correspond to those that did not this information (about 6%) plus those reporting other or two or more ethnic backgrounds (less than 3%). International students are not asked to report their ethnicity, however the data indicates their country of origin. Among the international students, about 32% are from East Asia (China, Korea, Taiwan, Japan, etc.), about 31% are from South Asia (India, Thailand, etc.), and the rest from other regions. While we do not further categories the other regions, about 20% are from Latin America (Brazil, Mexico, Peru, Colombia, etc.), 12% are from Europe, Australasia, or Canada, and about 5% are from Africa or MENA (Israel, Turkey and Nigeria, etc).

B Predicting Chosen and Assigned Seat Location

In this section we undertake an analysis of the seating locations selections, both in the endogenous regime (FA2009 to WN2014) where students self-selected their seats, as well as exogenous (FA2014 to FA2019) regime where administrative staff assigned seats to the students. We consider three types of positional selections separately: (i) choice of row (1, 2, 3, or 4); (ii) Choice of centrality (0, 1, or 2), with all seats in the center section defined as 2, seats in the side section other than edge seats defined as 1, and edge seats (i.e., those with relative distance to the center 85% or larger) defined as 0; (iii) relative distance to the center as defined in section 2, which takes continuous values between 0 and 1. The results are presented in Table A5, with Panel A (Cols 1 to 3) examining the self-selection by the students in the endogenous choice regime, and Panel B (Cols 4 to 6) examining assignment by administrative staff in the endogenous assignment era. We use an ordered probit to examine selection between rows 1 to 4 (Col 1 and Col 4) and to analyze selection of centrality (Col 2 and 5). The choice of the relative distance to the center is examined using an OLS specification.

All models include a gender dummy as well as the eight dummy variables capturing ethnicity for domestic students and region for international students (see Appendix A.) The main goal of this analysis is to examine whether seat choice probabilities are correlated with student ability proxied by the $GPAO_{ic(st)}$ (which is the student i's GPA in other courses standardized across all students taking class $c(st)$), conditional on the observable demographic characteristics (gender, ethnicity and region).

The coefficient estimates on the $GPAO_{ic(st)}$ variables is significant in all 3 columns of Panel A, suggesting that in the self-selection regime, student choices of where to sit relate to their academic ability. In particular, students with higher ability avoid the back rows (negative and significant coefficient on $GPAO_{ic(st)}$ in Col 1), and prefer more central seats (positive coefficient in Col 2, and negative in Col 3). Importantly, the results in Panel B confirm that there is no statistically significant correlation between ability and seat assignment (conditional on demographic controls). The point estimates are close to zero and the standard errors are tight enough that we can rule any large correlations, suggesting that the seat assignments conditional on demographics were orthogonal to student ability.[15]

There are interesting correlations of demographic characteristics and seat selection, both in the endogenous and exogenous assignment regimes (relative to the omitted category of white male students). Female students appear to prefer more central seats, and it appears that administrative staff assign women more central seats as well. In the endogenous regime, women have a significant preference to sit in the front, whereas the administrative staff did not systematically allocate women to front seats. In the endogenous regime, US Black students seem to prefer front seats which assigners also preferentially allocated. While international students generally strongly preferred front seats in the endogenous regime, the assigners did not preferentially assign front seats for any of the international student categories. Relative to omitted white male group, foreign students preferred more central seating in the endogenous regime, and assigners also allocated likewise in the exogenous regime. US Hispanics and US Blacks show an aversion to central location during the self-selection period, whereas administrative staff preferentially allocated central seats to these groups. Overall, the assignment seems to allocate more central seats to women, minorities and international students (relative to white male omitted group), and showed some preferential allocation towards front rows for US Blacks and Hispanics.

[15] We undertook two sets of alternative analysis. First, we defined a categorical position variable with 12 levels that combined the row and centrality measures (4 rows x 3 centrality), and analyzed the choice into one of these 12 categories using a multinomial logit model. Second, we analyzed each of the row and centrality choices using separate linear regression models. Overall, these yielded the same qualitative conclusion that seat assignment in the exogenous regime, contrary to results for the endogenous regime, is largely independent of $GPAO_{ic(st)}$, conditional on demographic controls. (Results are available on request.)

Table A5: Analysis of Seat Selection (Endogenous Regime) and Assignment (Exogenous Regime)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Row (1/2/3/4)	Centrality (0/1/2)	Rel. Distance to Center	Row (1/2/3/4)	Centrality (0/1/2)	Rel. Distance to Center
Model	Ordered Probit	Ordered Probit	OLS	Ordered Probit	Ordered Probit	OLS
	Panel A: Endogenous Sample (FA2009-WN2014)			Panel B: Exogenous Sample (FA2014-WN2019)		
Std. GPAO	-0.0549***	0.0785***	-0.0208***	0.0112	-0.0037	0.0015
	(0.0101)	(0.0108)	(0.0025)	(0.0082)	(0.0089)	(0.0020)
Female	-0.1265***	0.0603***	-0.0150***	-0.0098	0.1130***	-0.0261***
	(0.0206)	(0.0221)	(0.0052)	(0.0157)	(0.0172)	(0.0039)
US Black	-0.1370***	-0.0883*	0.0144	-0.0864***	0.1295***	-0.0340***
	(0.0456)	(0.0484)	(0.0115)	(0.0331)	(0.0367)	(0.0082)
US Hisp+	-0.0303	-0.1084**	0.0290**	-0.0700*	0.1398***	-0.0325***
	(0.0523)	(0.0544)	(0.0131)	(0.0368)	(0.0409)	(0.0091)
US Asian	0.0207	0.0107	-0.0034	0.0134	0.0791***	-0.0208***
	(0.0287)	(0.0303)	(0.0072)	(0.0252)	(0.0274)	(0.0062)
US NA	0.0681	0.1557***	-0.0355***	0.0232	0.0693*	-0.0187**
	(0.0422)	(0.0451)	(0.0105)	(0.0337)	(0.0367)	(0.0082)
Other Intl	-0.2991***	0.1615***	-0.0490***	-0.0167	0.0955***	-0.0253***
	(0.0325)	(0.0353)	(0.0082)	(0.0262)	(0.0286)	(0.0064)
E Asian	-0.2857***	0.0488	-0.0068	0.0063	0.0542*	-0.0112
	(0.0343)	(0.0367)	(0.0087)	(0.0279)	(0.0304)	(0.0068)
S Asian	-0.1798***	0.3056***	-0.0840***	0.0054	0.1148***	-0.0278***
	(0.0352)	(0.0392)	(0.0089)	(0.0270)	(0.0296)	(0.0066)
Constant			0.5001***			0.4809***
			(0.0043)			(0.0034)
cut1	-1.5863***	-1.1325***		-1.2919***	-1.3005***	
	(0.0220)	(0.0206)		(0.0167)	(0.0176)	
cut2	-0.5919***	-0.0120		-0.3969***	-0.0491***	
	(0.0184)	(0.0186)		(0.0147)	(0.0153)	
cut3	0.2454***			0.4375***		
	(0.0180)			(0.0147)		
N	13068	13068	13068	20295	20295	20295
Adjusted R-squared			0.016			0.004

C Seating-Performance Relationship: Cross-Sectional Endogenous versus Within-Student Exogenous

In this section, we present a comparison of seating position effects in the endogenous regime compared to the exogenous regimes. Specifically, we contrast what may be the perception of an instructor when seat choice is endogenous (which is the typical arrangement in academic settings with assigned seating), with the causal effects implied by our analysis of the data from the exogenous seating regime. We separately investigate the horizontal position (i.e. distance from the center) and the vertical position (i.e. row effect), using the same specification as in 1.

Figure A1 presents the results from regressing the standardized course grade on dummy variables for each of the positions from the center of classroom, with the positive (negative) numbers denoting distances to the right (left) of the instructor.[16] The sub-figure on the left shows a clear and significant weakening of grades towards the sides of the class room, with this effect being largely symmetric. Because instructors are likely to form inferences based on such cross-sectional comparisons, it is likely that this represents the perceived effect of seating position on performance in classes where students choose their seats.

Figure A1: Relation of Distance to Center with Standardized Course Grade

In contrast, the sub-figure on the right, which uses data from the exogenous seating assignment regime and includes individual fixed effects that control for unobserved general

[16] While some classrooms have width greater than $+/-15$, we round positions outside the range to 15 as these are sparsely populated and yield noisy estimates.

ability, shows that there is very little *causal* relationship between distance to the center and student performance.

Figure A2 presents a comparison of results for row effects (with row 4 as the reference). The cross-sectional comparison in an endogenous selection regime (sub-figure on the left) suggests that row 2 and row 3 are associated with positive and significant learning effects, with row 1 showing positive but insignificant difference relative to row 4. However, the sub-figure on the right (from analysis with data from an exogenous assignment regime using individual fixed effects) suggests that there is a significant positive effect (at about 5% of the SD of the course grade) only for the first row, and no significant effects for rows 2 and 3. Thus, this analysis also confirms that what an instructor's perception from cross-sectional comparison in an endogenous selection regime systematically differs from the actual causal effects.

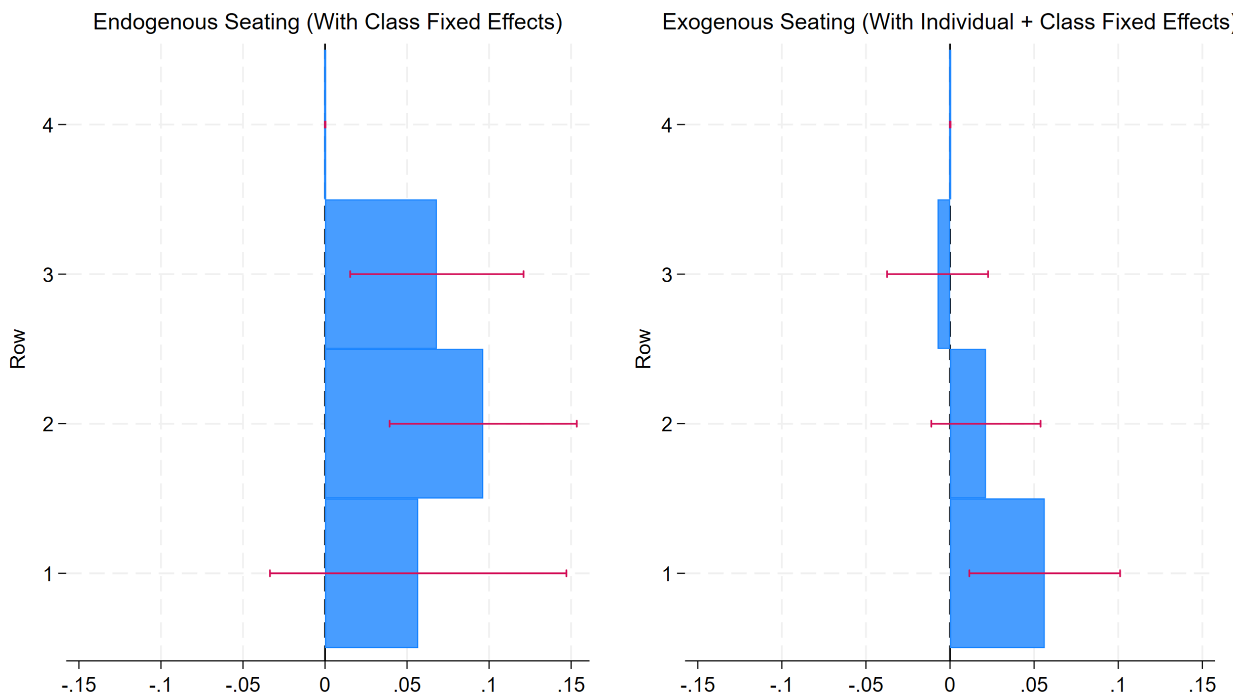

Figure A2: Relation of Seating Row with Standardized Course Grade

D Causal Effects of Seating Position: Heterogeneity by Ethnicity and Region

To examine whether the causal impact of seating position on student performance varies across ethnic groups and regions, we adopt the same specification as we used when analyzing heterogeneity by gender.

$$G_{ic(st)} = \alpha_i + \left(\beta_0 + \sum_{k=1}^{8} \beta_k \cdot E_k\right) L_{ic(st)} + \mu_{c(st)} + \varepsilon_{ic(st)}, \quad (3)$$

where E_k is one of eight dummy variables, five relating to ethnicity if the student is domestic, and three denoting region if the student is international (see discussion in Appendix A). All other variables are as defined in Equation 1. We include individual (α_i) and class ($\mu_{c(st)}$) fixed effects.

The eight ethnicity and region interactions with the four seating position variables (Row 2, Row 3, Row 4 and distance to the center; Row 1 is the omitted reference group) yield 32 total estimates. To simplify comparisons across groups and seating positions, we present the coefficient estimates in bar chart form in Figure A3. (Each coefficient estimate here adds on the estimate for the reference group (US White), so the bars represent the gross effect for each group, relative to the common reference point of Row 4 for US White. E.g., the bar plot for US Black, Row 1 is 0.0379, which is 0.0096 (coefficient on US Black × Row 1) + .0283 (coefficient on Row 1, which represents the effect for US White).)

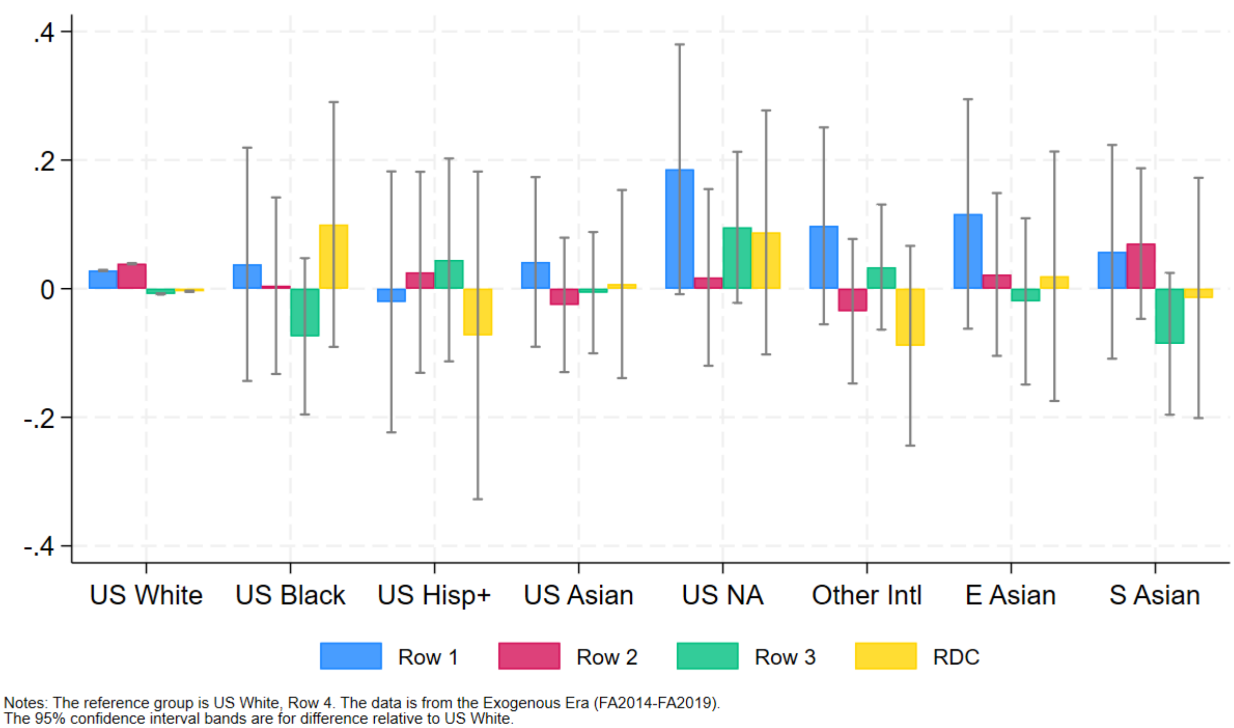

Figure A3: Causal Effect of Seating Positions: Heterogeneity by Ethnicity and Region

As the figure illustrates, we do not find any statistically significant variation in the causal effect of seating position, across different ethnicity or regional backgrounds. The front row effect is positive for all groups except "US Hispanics", but more pronounced for the US NA group, and for the "E Asian" and "Other International" categories. Seat locations away from the center appear beneficial for "US Black" and "US NA" categories, but more central locations seem to benefit “US Hispanics” and “Other International student groups. Row 2 and Row 3 effects are mixed across the groups.

If there was significant heterogeneity in learning effects across groups, e.g.,if some position X had a positive effect on Group A, and a negative effect on Group B, that would suggest a potential for allocation strategies that could increase Pareto efficiency in terms of total learning of all students. E.g., students from Group B in position X could be swapped with students from Group A. One caution in thinking about such re-allocations is that the dependent variable we use (GPA) is awarded in conformance to a strict curve, so Pareto improving reallocation to increase overall average GPA is not feasible in our setting. Even assuming that the effects we detect relate to actual learning, the results we get do not suggest room for significant efficiency gains from re-allocations. There is some possibility of reducing US Hispanic share of Row 1 seats (as US Hispanics have a small negative effect of Row 1), which could be reallocated to US NA or East Asian groups (which have the largest positive effects from Row 1). The re-allocations could aim to swap the US Hispanics with row 3 of E Asian (as Row 3 effect is negative for E.Asians) or with Row 2 of US NA (as Row 2 effect seems larger for US Hispanics).