

Does a Semester of Precalculus Help Students Succeed in Calculus?

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Research Question

This study used a decade of enrollment data (2009-2018) at a medium-sized four-year institution to address the question: does a three credit-hour precalculus class have a measurable effect on student achievement in a subsequent calculus course?

The Problems with PreCalculus

Precalculus has a **high DFW rate**. In our sample of 1215 students who took a 3 credit hour precalculus course over the study time period, 45.2% of the students withdrew or earned a grade below C. This is consistent with national findings by Bressoud et al. (2014) and Sonnert & Sadler (2014).

The course is discouraging. Many students have seen the material before, and nationally only 30–40% continue on to calculus. Our results are consistent, with 34% of 1215 precalculus students eventually enrolling in calculus during the study.

Precalculus may not prepare students for calculus. In a national survey of over 10,000 students at 134 institutions, Sonnert & Sadler (2014) found that no group in their analysis benefited from precalculus, and it was detrimental for some groups.

Experimental Design

The study population consists of all students who enrolled in Calculus I on campus between 2009 and 2018. We considered two student pathways:

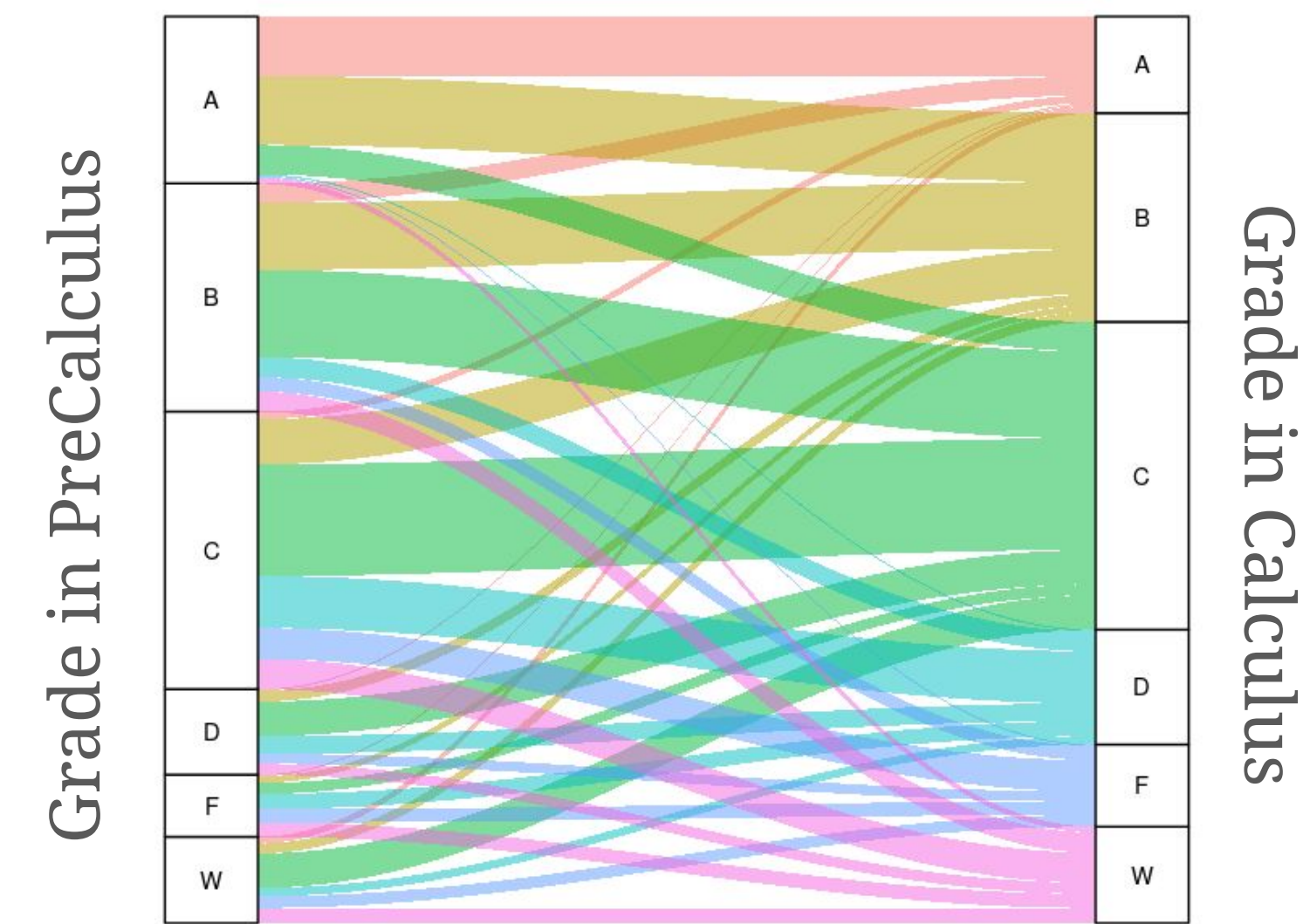
- Enroll in Precalculus before taking Calculus I ($n=383$)
- Enrolled directly into Calculus I ($n=1090$)

Effective Math SAT scores were calculated for each student by converting pre-2016 SAT and ACT MATH scores to the new SAT scale. The largest score was used if there were multiple. Discarding students without an Effective SAT leaves 383 students who took precalculus and then enrolled in calculus, and 1090 students who enrolled directly in calculus. Effective SAT scores were used to group equivalently prepared students and compare their achievements in calculus.

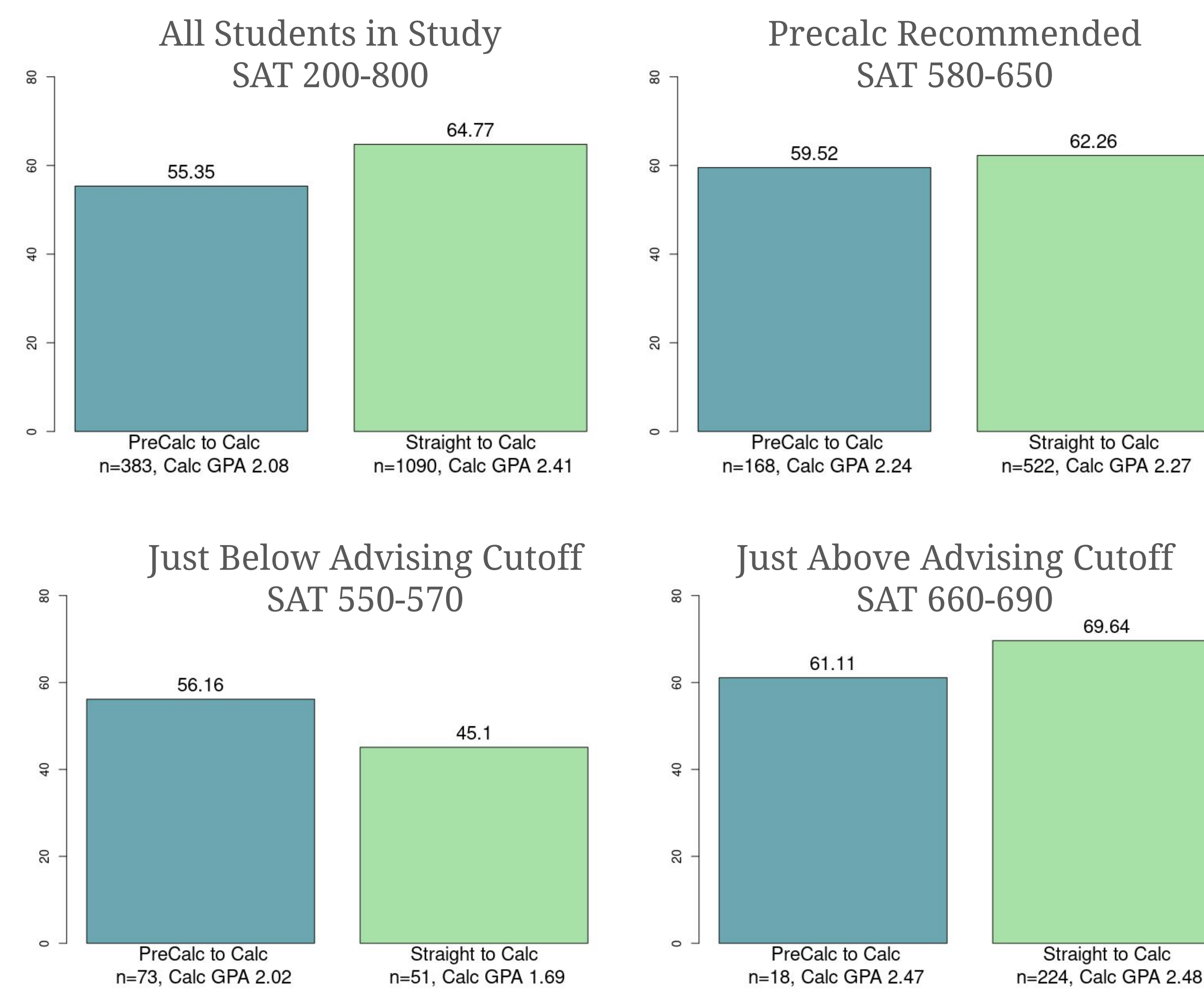
Students are advised into precalculus within the SAT range 580 to 650; above that they are advised to take calculus, and for SATs below 580 the recommendation is College Algebra or remedial offerings.

Exploring the Data

Student Grades from PreCalculus to Calculus



Student Success Rates in Calculus by Pathway



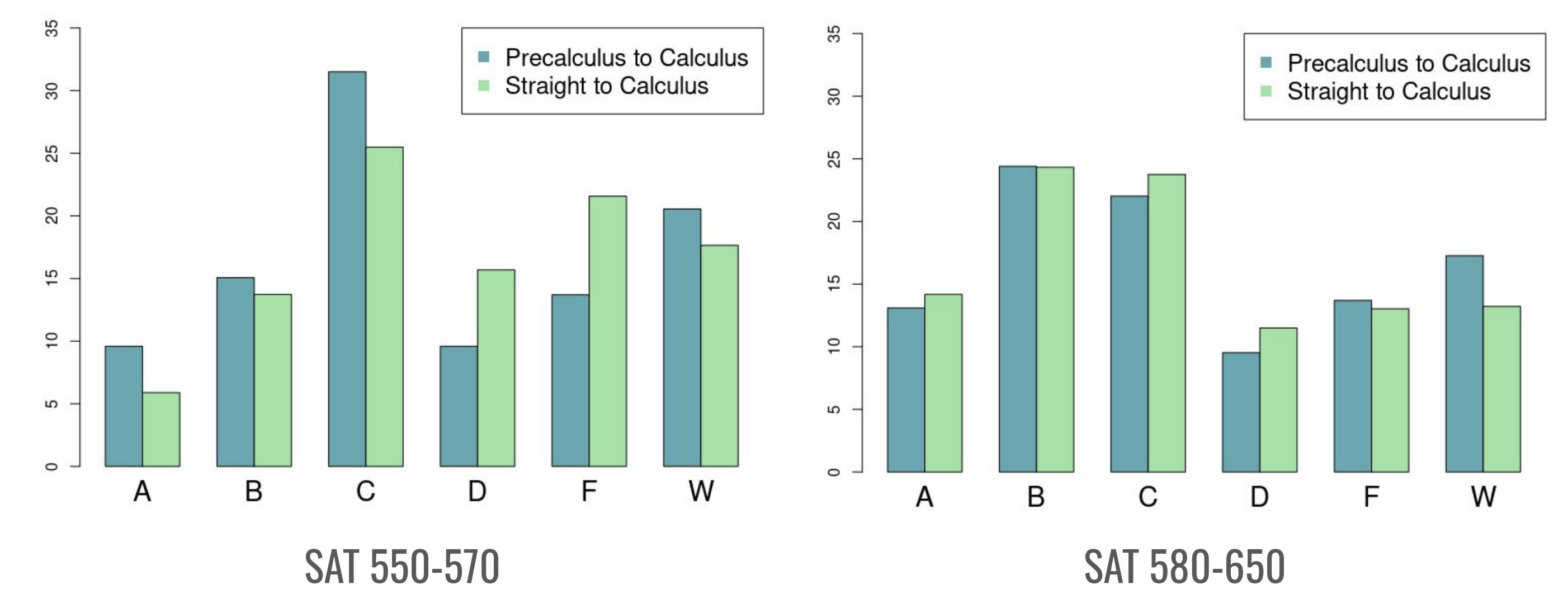
SAT	PreCalc to Calc			Straight to Calc		
	Success Rate	Calc GPA	n	Success Rate	Calc GPA	n
500 - 530	52.38	1.72	63	45.16	1.69	31
540 - 570	53.54	1.94	99	46.88	1.74	64
580 - 610	60.71	2.22	112	68.47	2.34	203
620 - 650	57.14	2.28	56	58.31	2.22	319
660 - 690	61.11	2.47	18	69.64	2.48	224
500 - 570	53.09	1.85	162	46.32	1.72	95
580 - 650	59.52	2.24	168	62.26	2.27	522
200 - 800	55.35	2.08	383	64.77	2.41	1090

Table 1: Success rates (C or better) by effective SAT range for students who proceed directly to calculus, or take a semester of precalculus first.

The Least Prepared Students See Some Benefit

We observe little difference in student achievement in calculus regardless of the pathway for students with SAT scores above 570. Students who enroll directly in calculus succeed at similar - or even slightly higher - rates and achieve a similar average calculus GPA to students who take a semester of precalculus. This includes the entire SAT range in which students are currently advised into precalculus.

Performance in Calculus by Pathway



Conversely, students with an SAT in the range 500 to 570 show a consistent benefit from precalculus. These students are more likely to succeed in calculus with a C or higher (53.1%) compared to equivalently prepared students who enroll directly in calculus (46.3%). They also have a higher average GPA in their calculus class. Students immediately *below* the current advising cut-off for precalculus (SAT 550-570) have higher grades in calculus by almost a third of a letter grade if they first take a semester of precalculus.

Conclusions and Further Questions

All students who are currently being advised into precalculus (SAT 580-650) may be better served by moving directly into calculus, while students with SAT 500-570 who are currently being advised into classes below precalculus appear to benefit from precalculus.

There are several confounding factors in our analysis, including that we do not capture previous precalculus (or calculus) courses taken at other institutions or in high school. Pass rates in precalculus are also an issue, so providing students with precalculus support while enrolled in calculus may be more effective than requiring a full precalculus course, even for SAT scores below 570 where we observe positive outcomes.

(references available on request)

