Paper 4: Effects of Expanding Summer Credit Recovery in Algebra

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Background / Context:
As described in the background for Paper 1, the consequences of failing core academic courses during the first year are dire. In Chicago, over a quarter of students fail at least one semester of algebra in their ninth grade year, and only 13% of students who fail both semesters of Algebra I in ninth grade graduate in 4 years.

Offering credit recovery options is one strategy to deal with high failure rates. The primary goal of credit recovery programs is to give students an opportunity to retake classes that they failed in an effort to get them back on track and keep them in school (Watson & Gemin, 2008). It makes theoretical sense to try to get students to recover their algebra credits early, in the summer after ninth grade—before they take geometry or Algebra II and chemistry or physics, which may require mastery of Algebra content matter. Recovering credits earlier may also put students back on track towards accruing the credits necessary to progress to the next grade and ultimately graduate. However, offering summer classes takes resources—time, money, and coordination. Schools often concentrate their credit recovery efforts on students that are close to graduation, rather than ninth graders. In fact, there is little evidence about the extent to which getting students to recover credits early leads to substantive improvements in student progression and later outcomes. While it seems like a good idea, the pay-off may not actually be large for a number of reasons: few students who failed in the prior year may show up in the summer for credit recovery; few students may pass even if they do show up; and the gains of attending summer school for learning and for credit accumulation may be very small compared to students' initial deficits in skills or the number of total credits they eventually need to recover. Thus, schools might put in substantial effort to hire teachers and find facilities for credit recovery with little pay-off in terms of their schools' on-track rates, test scores, and later graduation rates.

Purpose / Objective / Research Question / Focus of Study:
This study examines the benefits of offering expanded credit recovery options for ninth grade algebra, relative to business as usual (i.e., the summer programming schools would offer in the absence of efforts to expand credit recovery). Evidence of the effects of credit recovery for getting students back on track for graduation is lacking, and this study presents the opportunity to generate such evidence.

Setting:
The setting will be neighborhood high schools in Chicago in 2009-2011. CPS is the third-largest U.S. district. The district is 87% low-income and 42% African American and 44% Latino. For this study, we include all neighborhood high schools (no charter or selective enrollment schools) that had incoming ninth grade cohorts for all four years, excluding a group of schools that were participating in another district-sponsored algebra program.

Population / Participants / Subjects:
The population consists of all first-time ninth grade students who entered regular neighborhood high schools between fall 2009 and fall 2011 who failed second semester algebra (Algebra IB). There were about 4,000 students in each cohort. All neighborhood high schools were included for analysis (76 schools).

Intervention / Program / Practice:
In this study, some high schools in CPS were given the resources to offer second-semester Algebra I credit recovery courses to as many ninth grade students as they could recruit. In addition, they received support for recruiting students who failed Algebra IB to come to summer school, as well as logistical support around finding qualified teachers. Schools received funding to implement at least two Algebra I credit recovery courses during the summer sessions of 2011 and 2012— at least one online and one face-to-face section; some schools offered four or six sections of algebra credit recovery, which were paid for by the program.

Not all schools were invited to participate in the study. Schools were invited to participate in the study based on two main criteria. The primary criterion was the number of students who failed second semester algebra in 2010. Researchers ranked schools by the number of students who failed in the year prior to the start of the study (2010) and considered those with the most failures eligible to be invited to participate. Those above the cut-off for eligibility were invited, if they met the other criterion, while those below the cut-off were not. Schools could have large numbers of algebra failures because they had high failure rates, or because they were large schools, or both. The second criterion was that they were not closed for construction over the summer, and could potentially offer summer school. Each summer, a number of schools were closed for construction. In addition, we excluded charter schools from consideration because their students' transcripts do not appear in the centralized data system. We also did not consider schools that were in one area of the district whose area chief had refused participation because of other algebra-related initiatives being implemented.

Fifteen schools participated in 2011; in total they offered 18 pairs of sections (36 total). Thirteen schools participated in 2012; in total they offered 20 pairs of sections (40 total) (see paper 1 for details). The participating schools were similar to other schools in CPS in most respects, with a few notable differences. They were larger schools than typical; they enrolled 1,785 students, on average, compared with an average enrollment of 729 students in high schools across CPS. This difference was expected because we could implement the study only in schools that were large enough to have sufficient students to fill at least two sections of second-semester algebra over the summer. The study schools also disproportionately served more Latino students and fewer African-American students than the district as a whole. This occurred because large schools are more likely to serve Latino students while small schools are more likely to serve African-American students.

The extra funding schools received as part of participating in this study increased their capacity to provide algebra credit recovery over the summer so that all ninth grade students who wanted to recover the credit over the summer could do so. To boost enrollments in summer algebra credit recovery, a set of outreach activities were implemented in each school to encourage ninth grade students who failed the second semester of Algebra I to attempt to recover the credit in the

summer. This included presentations to groups of failing students by study team members, calls to students' homes, and letters sent home about the importance of passing algebra and recovering credits. We define the presence of the funding for extra courses, plus the push to motivate students to enroll in credit recovery, as "expanded credit recovery options."

Research Design, Data Collection and Analysis:
This study conducts two types of analysis, using difference-in-difference approach where there are multiple embedded comparisons. We model outcome differences between two pre-intervention cohorts (2009 and 2010) and two post-intervention cohorts (2011 and 2012) in schools that were offered the opportunity to participate in expanded credit recovery and those that were not. The outcome variables include recovery rates in Algebra 1B, promotion to 10^{th} grade rates, 10^{th} grade PLAN scores on the Pre-Algebra/Algebra subtest, as well as course taking and course performance in the 10^{th} grade year.

We perform two school-level analyses and one student-level analysis. The first school-level analysis examines the intent-to-treat (ITT) effect--the effect of receiving an invitation to participate in expanded summer credit recovery. This analysis exploits the fact that invitation was determined rigidly by a known characteristic--the number of failures in 2010. We compare differences in student outcomes from pre- to post-intervention years within schools, and the size of these differences between schools eligible and not eligible for participation. We include failure rates and school size in the current year as control variables. Additional control variables include students' background characteristics--students' math scores on standardized tests at the end of eighth grade and beginning of ninth grade, number of semester courses failed in ninth grade, whether they failed 0, 1 or two semesters of algebra, race, gender, SES, year fixed effects and school fixed effects.

The second school-level analysis examines the treatment-on-the-treated (TOT) effect, that is, the effect of accepting an invitation to participate in expanded summer credit recovery. This analysis exploits the fact that invitation was determined by the number of failures in 2010 using an instrumental variables framework. We assume that, conditional on cohort size and failure rates in the current year, the number of failures in a past year is only related to our outcome of interest through participating in expanded credit recovery. Thus, we use eligibility status in a year to instrument for participation. We include failure rates and school size in the current year as control variables in both stages of the analysis. Additional control variables include students' background characteristics--students' math scores on standardized tests at the end of eighth grade and beginning of ninth grade, number of semester courses failed in ninth grade, whether they failed 0, 1 or two semesters of algebra, race, gender, SES, year fixed effects and school fixed effects.

The student-level analysis examines the effect of successfully recovering an algebra credit over the summer using an instrumental variables approach. Appealing to the same logic as above, we use school-by-year eligibility to participate in expanded credit recovery to estimate the compliers average treatment effects of recovering a credit. We take advantage of the two known exogenous sources of variation affecting attendance in Algebra IB in the summer. One source of variation was whether schools received an invitation to participate on the basis of the number of failures in 2010. A second source of variation was whether or not the school was under construction, which

was decided by the district independently from this study. We use additional control variables as described above.

Findings / Results:
We find that that offering resources to schools to expand credit recovery for ninth graders substantially increases their ninth grade recovery rates. The effect of being offered a chance to participate (ITT) increases recovery rates from 12% to 20% on average. The effect of implementing the expanded recovery options doubles recovery rates from 13% to 27%. While the recovery rate doubled, the percentage of students who recover is still low, largely because only a subset of students who fail show up for recovery, even when sufficient resources are available. In addition, many schools chose not to expand credit recovery, even though they would receive additional resources; approximately 55% of schools that were offered the opportunity to participate accepted. Despite these notable changes in recovery rates, preliminary models suggest that schools do not see a detectable benefit from participating in terms of test scores, course-taking, and course performance in students' second year of high school. However, while not statistically significant, there were differences by treatment in whether students' records in their second year of high school were observed, and final conclusions about second year outcomes will require missing data models that are currently being developed. In addition, the act of receiving credit itself may have contributed directly to students' probability of staying in school and graduating, which is an outcome that is not yet observable.

Preliminary analysis of the student-level models indicates that recovering credits over the summer impacts promotion to 10^{th} grade, whether or not a student takes the PLAN exam, and the level of difficulty of course selection in the next school year. By imputing student-level missing data (when missing due to not being promoted to 10^{th} grade etc.), we may be able to estimate the ways in which observable later outcomes are driven by sample selection due to credit recovery and produce reasonable estimates as to the true local effect of credit recovery. Should the data permit, we will also look for heterogeneous effects by the number of courses failed in 9^{th} grade. We will examine if pay-offs to credit recovery differ by the size of the initial credit deficit.

Conclusions:
While expanding credit recovery options may seem like an attractive strategy to improve future student outcomes and move students further on the path to graduation, the estimated pay-offs relative to the costs may imply that expanding summer credit recovery is not a prudent use of resources. While recovery rates increase with expanded recovery options, most students still do not recover, and schools do not see a definitive increase even in scale with the students who do recover. This study is not yet able to identify impacts on graduation (4-year graduation for students in the second cohort will take place June 2015), a key outcome of interest, and early credit recovery may be more likely to affect graduation than second year performance. Pending forthcoming results, we will discuss the possibility of heterogeneous effects by initial credit deficit.

Appendix A. References

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Appendix B. Tables and Figures

Figure 1. Theory of Action Behind Summer Online Algebra Credit Recovery

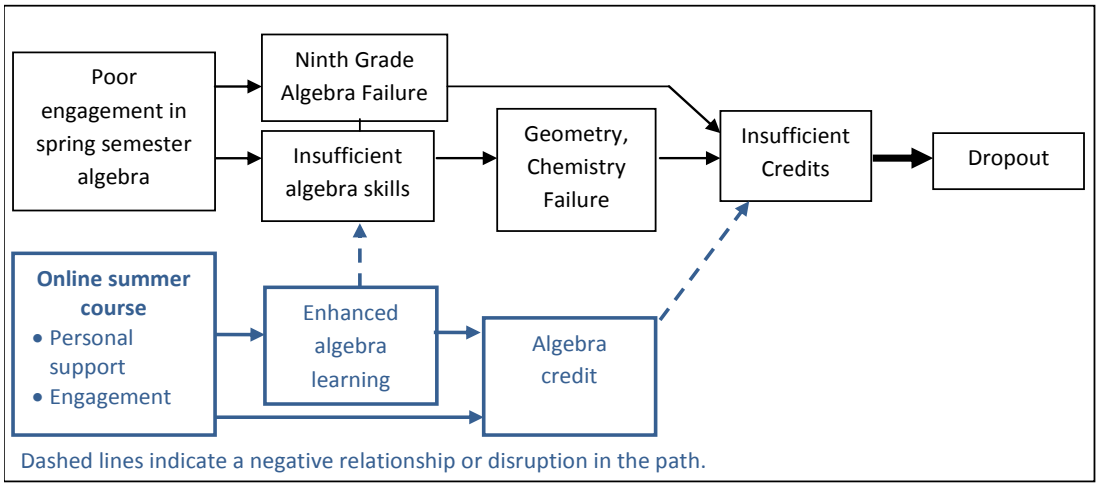

Table 1. Characteristics of CPS High Schools Participating in Credit Recovery Study in Summer 2011 and District High Schools Overall, as of 2010

	2011 Study Schools		All CPS high schools
Characteristics	**Average Number**	**Average Percent**	**Average Percent**
Female	906	50.7%	49.6%
Race/Ethnicity			
White	136	6.0%	4.7%
African American	628	42.4%	59.4%
Hispanic	957	48.0%	32.5%
Asian	4	0.2%	0.2%
Native American	8	0.4%	0.2%
Other Race	17	0.9%	1.2%
Eligible for free or reduced-price lunch	1468	91.5%	91.3%
Home language not English	975	48.3%	31.2%
Eligible for special education services	269	15.4%	18.9%

Number of study schools is 15. Averages are calculated from all students in grades 9-12 active during the fall semester, 2010. District averages include all schools with students in grades 9-12 (total school N=150).

Table 2. Characteristics of CPS High Schools Participating in Credit Recovery Study During Summer 2012 and District High Schools Overall, as of 2011

	2012 Study Schools		All CPS high schools
Characteristics	**Average Number**	**Average Percent**	**Average Percent**
Female	907	49.6%	49.4%
Race/Ethnicity			
White	179	8.2%	4.7%
African American	497	33.3%	58.4%
Hispanic	1076	54.5%	33.1%
Asian	2	0.1%	0.2%
Native American	8	0.4%	0.2%
Other Race	22	1.4%	1.3%
Eligible for free or reduced-price lunch	1572	91.0%	91.6%
Home language not English	1074	53.4%	31.4%
Eligible for special education services	287	16.0%	19.2%

Number of study schools is 13. Averages are calculated from all students in grades 9-12 active during the fall semester, 2011. District averages include all schools with students in grades 9-12 (total school N=150).

Table 3. Number and Percentage of Students Per Condition by Block, Summer 2011

		Passed Algebra IA		Failed Algebra IA		Algebra IA Status Unknown		Total
Condition	Gender	Number	Percent of Students by Condition	Number	Percent of Students by Condition	Number	Percent of Students by Condition	
F2F	Female	44	15%	28	10%	31	11%	103
	Male	70	24%	58	20%	59	20%	187
	Total	*114*	*39%*	*86*	*30%*	*90*	*31%*	*290*
Online	Female	45	15%	37	12%	35	11%	117
	Male	73	24%	60	20%	56	18%	189
	Total	*118*	*39%*	*97*	*32%*	*91*	*30%*	*306*

Table 4. Number and Percentage of Students Per Condition by Block, Summer 2012

		Passed Algebra IA		Failed Algebra IA		Algebra IA Status Unknown		Total
Condition	Gender	Number	Percent of Students by Condition	Number	Percent of Students by Condition	Number	Percent of Students by Condition	
F2F	Female	56	14%	52	13%	41	10%	149
	Male	83	21%	95	24%	70	18%	248
	Total	*139*	*35%*	*147*	*37%*	*111*	28%	*397*
Online	Female	53	13%	55	14%	44	11%	152
	Male	81	21%	93	24%	69	17%	243
	Total	*134*	*34%*	*148*	*37%*	*113*	*29%*	*395*

Table 5. Baseline Characteristics of Cohort 1 (Summer 2011)

Characteristic	**Online**	**F2F**	***p-value***
Mean spring 2010 Explore math scaled score	13.45 (2.92)	13.25 (2.96)	0.193
Mean concentrated poverty (2009 ACS) [a]	0.13 (0.75)	0.12 (0.74)	0.912
Mean social status (2009 ACS) [b]	-0.57 (0.87)	-0.54 (0.85)	0.743
Mean number of unexcused absences (2010-2011school year)	32.05 (23.48)	30.49 (23.32)	0.289
Percent first-time freshman	88	91	0.194
Percent special education	10	7	0.216
Percent African American	38	35	0.226
Percent Latino	56	59	0.253
Percent Other Race (non-Latino, non-African American)	6	6	0.821
Percent Suspended (2010-2011 school year)	46	46	0.830
Percent Moved Schools (2010-2011 school year)	5	5	0.801
Percent Female (blocking variable)	38	36	0.629
Percent Passed Algebra 1A (blocking variable)	39	40	0.574
Percent Failed Algebra 1A (blocking variable)	32	30	0.575
Percent Unknown Pass/Fail in Algebra 1A (blocking variable)	30	30	0.989

Note: Sample includes 15 schools; 591 students (304 Online, 287 F2F). Values represent unadjusted means. Differences in characteristics by condition were tested using a model that modeled schools and summer school session as fixed effect to account for the clustering of students within schools and summer school session. Figures in parentheses are standard deviations.
a. Concentration of poverty is a standardized measure of poverty for the census block group in which the student lives. A large positive number indicates a high level of poverty concentration; a large negative numbers indicates a low level of poverty concentration. This measure is calculated from Census data (the percent of adult males employed and the percent of families with incomes above the poverty line), and is standardized such that a "0" value is the mean value for census block groups in Chicago.
b. Social status is a standardized measure of educational attainment/employment status for the census block group in which the student lives. A large positive number indicates a high social status; a large negative numbers indicates a low social status. This measure is calculated from Census data (mean level of education of adults and the percentage of employed persons who

work as managers or professionals), and is standardized such that a "0" value is the mean value for census block groups in Chicago.
Source: Chicago Public Schools (CPS) Administrative Data

Table 6. Baseline Characteristics of Cohort 2 (Summer 2012)

Characteristic	Online	F2F	*p-value*
Mean spring 2011 Explore math scaled score	13.64 (2.83)	13.78 (2.88)	0.354
Mean concentrated poverty (2009 ACS) [a]	-0.03 (0.79)	0.01 (0.76)	0.574
Mean social status (2009 ACS) [b]	-0.40 (0.86)	-0.45 (0.87)	0.475
Mean number of unexcused absences (2011-2012 school year)	24.03 (20.85)	25.86 (21.51)	0.246
Percent first-time freshman	87	88	0.586
Percent special education	9	10	0.521
Percent African American	31	28	0.107
Percent Latino	58	59	0.533
Percent Other Race (non-Latino, non-African American)	12	13	0.511
Percent Suspended (2011-2012 school year)	34	37	0.391
Percent Moved Schools (2011-2012 school year)	5	6	0.437
Percent Female (blocking variable)	39	38	0.740
Percent Passed Algebra 1A (blocking variable)	34	35	0.688
Percent Failed Algebra 1A (blocking variable)	38	37	0.790
Percent Unknown Pass/Fail in Algebra 1A (blocking variable)	29	28	0.868

Note: Sample includes 13 schools; 792 students (395 Online, 397 F2F). Values represent unadjusted means. Differences in characteristics by condition were tested using a model that modeled schools and summer school session as fixed effect to account for the clustering of students within schools and summer school session. Figures in parentheses are standard deviations.
a. Concentration of poverty is a standardized measure of poverty for the census block group in which the student lives. A large positive number indicates a high level of poverty concentration; a large negative numbers indicates a low level of poverty concentration. This measure is calculated from Census data (the percent of adult males employed and the percent of families with incomes above the poverty line), and is standardized such that a "0" value is the mean value for census block groups in Chicago.
b. Social status is a standardized measure of educational attainment/employment status for the census block group in which the student lives. A large positive number indicates a high social status; a large negative numbers indicates a low social status. This measure is calculated from Census data (mean level of education of adults and the percentage of employed persons who work as managers or professionals), and is standardized such that a "0" value is the mean value for census block groups in Chicago.
Source: Chicago Public Schools (CPS) Administrative Data