Addressing the Needs of Underprepared Students in Higher Education

Does College Remediation Work?

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ABSTRACT

Each year, thousands graduate high school academically underprepared for college. Many must take remedial or developmental postsecondary coursework, and there is a growing debate about the effectiveness of such programs. This paper examines the effects of remediation using a unique data set of over 28,000 students. To account for selection biases, the paper implements an instrumental variables strategy based on variation in placement policies and the importance of proximity in college choice. The results suggest that students in remediation are more likely to persist in college in comparison to students with similar backgrounds who were not required to take the courses.

I. Introduction

Although approximately two-thirds of recent high school graduates enter college each year, many of these students are unprepared academically for college-level material (Greene and Foster 2003). In some cases, academic deficiencies are so severe that colleges choose to expel the students. For instance, during the fall of 2001, the California State University system "kicked out more than 2,200

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students—nearly 7 percent of the freshman class—for failing to master basic English and math skills'' (Trounson 2002). However, the most common response has been to place ill-prepared students in remedial courses.[1] Because the average college student attends an open-admissions, nonselective institution to which he or she is almost assured admission, the remediation placement exam taken when first arriving on campus has become the key academic gate-keeper to postsecondary study.[2] In 2001, colleges required nearly one-third of first-year students to take a remedial course in reading, writing, or mathematics (National Center for Education Statistics (NCES) 2003).

Remediation proponents suggest that the courses help underprepared students gain the skills necessary to excel in college and may serve as a tool to integrate students into the school population (Soliday 2002). In addition, many blame the pervasive need for college remediation on poor K-12 quality and lack of rigor. Lack of information is also a likely culprit as many studies suggest high school students understand little about the preparation necessary for college (Greene and Foster 2003; Secondary and Higher Education Remediation Advisory Commission (SHERAC) 1997), and high school graduation standards do not coincide with the competencies needed in college for the (McCabe 2001).[3] Remediation also may serve several institutional needs by providing a sorting mechanism that enables institutions to separate weaker students into less costly courses. By doing so, institutions can protect institutional selectivity, regulate entry to more expensive upper-level courses, and maintain the research functions of the university.[4] Remediation also may generate enrollment, particularly in the English and math departments that offer the remedial courses.

However, by increasing the number of requirements and extending the time to degree, remediation may negatively impact student outcomes such as persistence, major choice, and eventual labor market returns.[5] Moreover, the cost of remediation is significant. In Ohio, the focus of our study, public colleges spent approximately $15 million teaching 260,000 credit hours of high school-level courses to freshmen in 2000; another $8.4 million was spent on older students (Ohio Board of Regents 2001). In addition, the 20,000 freshmen in the courses paid $15 million in tuition

1. The literature defines ''remediation'' as coursework that is retaken while classes that focus on new material are termed ''developmental.'' In this paper, we will refer to both types of below-college-level courses as remedial. This also includes ''basic-skills training'' and ''nontraditional coursework'' but not ESL courses.

2. The bulk of remediation is provided by nonselective public institutions, the point of entry for 80 percent of four-year students and virtually all two-year students. Four-fifths of public four-year colleges and 98 percent of community colleges provide remedial courses.

3. For a short time, Minnesota allowed colleges to bill secondary schools for the cost of their graduates' remedial classes, and several secondary school districts in Virginia ''guarantee'' their diplomas by paying the remedial expenses of their former students (Wheat 1998).

4. Research suggests remedial courses are less costly than core academic programs. The Arkansas Department of Higher Education (1998) found that the direct and indirect costs per FTE were 37 percent less for remedial courses in comparison to core programs at four-year colleges. Additionally, Price Waterhouse found similar results examining expenditures within the City University of New York (CUNY) system (CUNY 1999).

5. Nationally and in Ohio, most colleges offer general institutional credit for remedial courses but this credit often does not count towards a degree. Additionally, over four-fifths of campuses restrict enrollment in at least some college-level classes until remediation is complete (NCES 2003; LOEO 1995). These requirements may restrict students' course schedules and impede the ability to major in certain areas.

for their remediation as well as used financial aid resources and sacrificed foregone wages. With a conservative estimated annual cost of over $1 billion nationally at public colleges (Breneman and Haarlow 1997), many states question whether and, if so, how remediation should be offered. Remedial courses are ‘‘not allowed’’ at public institutions in two states, and at least eight states restrict remediation to two-year colleges. Other states have imposed or are considering limits on the government funding of remedial coursework (Long 2008).[6] Finally, critics question whether the courses remove the incentive for students to adequately prepare while in high school.

Despite the extensive use of remedial courses to address academic deficiencies, little is known about their effects on subsequent student performance in college. Who should be placed in remediation, and how does it affect their educational progress? Most states and colleges do not have exit standards for remedial courses and do not perform systematic evaluation of their programs (Crowe 1998; Weissman, Bulakowski, and Jumisko 1997). There also are no current benchmarks by which to judge the success of higher education’s remediation efforts (Ohio Board of Regents 2001). Moreover, two reviews of the literature on remedial and developmental education found the bulk of studies to be seriously flawed methodologically (O’Hear and MacDonald 1995; Boylan and Saxon 1999). A simple comparison of students placed in remediation to those who are not is inherently flawed due to differences between the students. For example, NCES (1996) suggests that freshmen enrolled in remedial classes are less likely to persist into their second year, but this evidence does not control for student ability or possible movement across colleges. By design, lower-ability, less-prepared students are more likely to be placed into remediation, and so this group, even in the absence of remediation, is less likely to persist and complete a degree. The few papers that attempt to provide causal estimates of the impact of remediation tend to focus on a very small group of students at a single institution and do not examine outcomes beyond the first year (for example, see Aiken *et al.* 1998). As noted by Phipps (1998), ‘‘Conjecture and criticism have filled the void created by the lack of basic information.’’

This paper addresses this major hole in the literature. Using data from the Ohio Board of Regents (OBR), we track over 28,000 full-time, traditional-age freshmen at public colleges over six years to investigate the impact of remediation on college performance and persistence. To avoid the inherent biases in comparisons of students in and out of remediation, we use an instrumental variables strategy that exploits the facts that students tend to attend the closest campus to their home and that remedial placement policies vary across institutions. Together, these two sources of variation provide an exogenous predictor of the likelihood of remediation. In essence, we compare observationally alike students who attend different colleges, due to proximity, and therefore, have varying experiences with remediation. We also present evidence and discussion on the validity of this identification strategy.

6. For example, Florida and Illinois restrict remediation to two-year colleges, and the CUNY system came under fire in 1998 for implementing a similar restriction. The California State University system imposes a one-year limit on remedial work, while Texas, Tennessee, and Utah have or are considering similar restrictions.

Because our estimation strategy relies upon students for whom placement in remediation varies depending on which college they attend, we focus only on these marginal students in our analysis. The results therefore reflect the effect of remedial courses on the marginal student. Our estimates suggest that remediation has a positive impact on the college outcomes of underprepared students. Students placed in remediation are more likely to persist in college in comparison to students with similar test scores and backgrounds who were not required to take the courses. They also are less likely to transfer to a lower-level or less selective college and more likely to complete a four-year degree.[7]

II. The Supply and Demand of Remediation

A. The Economics of Remediation

Remedial classes are designed to address academic deficiencies and prepare students for subsequent college success. By teaching students the material they have not yet mastered, the courses may help underprepared students gain skills necessary to excel in college. Also, by grouping students with similar needs, remediation is similar to tracking in primary and secondary schools, which could enable instructors to better tailor their teaching to the needs of students and provide other kinds of support, such as tutoring.

On the other hand, grouping lower-ability students in remedial courses may produce negative peer effects. First, students who interact with peers who are higher achievers than themselves tend to improve (Sacerdote 2001; Hoxby 2000; Zimmerman 2003). Therefore, while remedial students are surrounded by other academically weak peers, similar students not placed into remediation could instead benefit from positive peers effects by interacting with higher-ability students in college-level classes. Additionally, remediation may be harmful in that it increases the number of requirements and extends the time to degree, which may lower the likelihood of degree completion. Finally, there also can be a stigma associated with remediation, and this psychological burden could negatively affect outcomes and discourage additional student effort.

B. Context of the Study: Remediation in Ohio versus Nationally

This study focuses on traditional-age (18 to 20 years old) college undergraduates who entered public colleges in Ohio as first-time freshmen during the fall of 1998. With longitudinal information from college transcripts, applications, and standardized tests reports with the accompanying student surveys, the analysis tracks these students over six years. The sample is limited to full-time students who took the

7. These results differ from earlier work that focused on math remediation at four-year colleges. The previous analysis tracked students for only four years and explored the possible signaling function of remediation in terms of redirecting underprepared students to less selective colleges. In contrast, this paper tracks students for six years, includes both four-year and two-year colleges, and focuses on students on the margin of needing the courses.

ACT (the primary admissions test in Ohio) and either attended a four-year college or signified the intent to complete a four-year degree on their community college application.[8] These restrictions are necessary because our estimation methodology requires preparation and achievement information from the ACT survey. Furthermore, so that degree completion is a relevant indicator of success, students needed to signify in some way the desire to get a degree and the ability to complete it in a reasonable amount of time (beginning college full-time). Students without valid zip code information to calculate college proximity were also dropped.

Table 1 provides summary statistics of the data.[9] As is typical in higher education, the sample is slightly more female, and the percentage of the sample that is African-American and Asian is similar to national college proportions (Hispanic students are underrepresented). These proportions are smaller than the figures for the entire cohort of students who entered that fall due to the sample restrictions. In terms of student outcomes, nearly 56 percent had completed a bachelor's degree after six years, a rate similar to the national average (Adelman 2006). Given the system-wide nature of the data, we can accurately track students across schools and include individuals who may have continued their educations or completed their degrees at different schools from the ones they originally entered. However, the data do not include students who transfer to private colleges or out of the state. The potential measurement error is likely to be very small since the percentage of students thought to transfer to such schools is a small fraction of the total number of observed dropouts (Bettinger 2004).

Although this paper focuses on students in Ohio, the results should have some external validity due to patterns of enrollment similar to national averages (Mortenson 2002; NCES 1996). Ohio has similar trends and practices regarding remediation as many institutions nationally. About two-thirds of campuses nationally restrict enrollment in some classes until remediation is complete (NCES 1996).[10] Similarly, most Ohio schools prohibit students from taking college-level courses in the same subject area until remediation is complete. While this rigidity may increase the time to graduation, it also may discourage certain majors, such as engineering, that are extremely demanding in terms of required credit hours and have little leeway for students to enroll in nonrequired classes. All public colleges in Ohio offer credit for remedial courses, though at most schools, this credit does not count toward degree completion and only becomes a part of the student's record (LOEO 1995); this is similar to national trends in which 90 percent of schools offer similar credit for remedial courses.

8. Half of traditional-age students (35 percent of all students) denote on their community college application intent to get a four-year degree or transfer to a four-year institution. The ACT requirement further emphasizes that this sample had some four-year intent as it is not required for admission. Technical colleges are excluded.

9. To be included in the sample, students must have had valid zip code information, and colleges needed to have clear records of which courses were considered remedial and which were not during the sample period. The sample excludes two schools due to the inability to identify which courses were remedial in 1998-99 (University of Cincinnati and Kent State University).

10. More than four-fifths of campuses nationally restrict enrollment in some college-level classes until remediation is complete, and most require those in need of remediation to participate in the courses (NCES 2003).

Table 1
First-time, Full-time Students in Ohio Public Colleges, Fall 1998

		Remedial Placement			Marginal Students Affected by Differences in Remediation Policies	
	Full Sample	No Remediation	In Math Remediation	In English Remediation	Math Sample	English Sample
Demographics and achievement						
Female	0.5569	0.5560	0.5940	0.4729	0.5815	0.5207
Black	0.0719	0.0452	0.1422	0.1854	0.0846	0.1009
Hispanic	0.0164	0.0140	0.0258	0.0221	0.0179	0.0201
Asian	0.0184	0.0212	0.0095	0.0122	0.0131	0.0172
ACT overall score (36 maximum)	21.92	23.37	18.26	17.21	20.36	19.77
	(4.30)	(3.84)	(3.03)	(2.77)	(3.23)	(3.52)
Math preparation and achievement						
ACT math score (36 maximum)	21.74	23.32	17.38	—	19.67	—
	(4.78)	(4.43)	(2.65)		(3.08)	
Grades in high school math	3.06	3.26	2.51	—	2.89	—
	(0.75)	(0.65)	(0.74)		(0.69)	
English preparation and achievement						
ACT English score (36 maximum)	21.25	22.77	—	15.77	—	18.64
	(4.93)	(4.43)		(3.38)		(3.98)
ACT reading score (36 maximum)	22.28	23.78	—	16.85	—	19.69
	(5.59)	(5.22)		(4.06)		(4.74)

(*continued*)

Table 1 (*continued*)

		Remedial Placement			Marginal Students Affected by Differences in Remediation Policies	
	Full Sample	No Remediation	In Math Remediation	In English Remediation	Math Sample	English Sample
Grades in high school English	3.23	3.38	—	2.75	—	3.04
	(0.68)	(0.57)		(0.63)		(0.64)
College of attendance and outcomes						
Attend selective four-year	0.5369	0.6438	0.2649	0.2099	0.4633	0.4431
Attend nonselective four-year	0.3581	0.3063	0.4634	0.5304	0.4079	0.4155
Attend community college	0.1049	0.0500	0.2717	0.2598	0.1287	0.1413
Math remediation	0.2237	0.00	1.00	0.5779	0.2925	0.3177
English remediation	0.1405	0.00	0.3608	1.00	0.1741	0.2249
Dropped out before Spring 2003	0.4005	0.3082	0.6519	0.6680	0.4685	0.4773
Total credit hours	81.20	91.10	54.97	51.47	72.39	75.95
Completed bachelor's degree within six years	0.5599	0.6636	0.2854	0.2529	0.4635	0.5109
Observations	28,376	20,332	6,349	3,986	18,917	15,013

Notes: Standard deviations are shown in the parentheses. Sample is restricted to traditional-aged (18-20), first-time students who entered full-time in Fall 1998 and had valid zip code information. Students are considered to have "dropped out" if they have not completed a bachelor's degree and are nowhere in the Ohio public higher education system in Spring 2003 (after five years). "Transfer up" is defined transferring to a more nonselective or higher level college while "Transfer Down" is the reverse.

At some Ohio colleges, similar to national patterns, remedial courses are offered institution-wide while others have the courses housed in individual departments.

Ohio is also a particularly relevant state for this analysis as it plays a prominent role in higher education. The only states with greater numbers of students in public colleges are California, Texas, New York, and Illinois (NCES 2000). Ohio has a mixture of selective and nonselective four-year institutions as well as two-year community and technical colleges spread geographically across the state. Finally, because only 12 percent of students take remedial courses at private, four-year colleges (NCES 2003), the focus on public colleges is likely to give an accurate picture of the general effects of remediation.

In Ohio, all but one of the public colleges offer remedial courses to entering freshmen. One major group of students in remedial education is underprepared recent high school graduates, many of whom exit secondary school without grade-level competency or the proper preparation for college-level material. In our sample, 37 percent of first-year students under the age of 19 fit into this category having graduated from high school without a college-prep curriculum (OBR 2002). Students who complete an academic core curriculum in high school are half as likely to need remediation in college in comparison to other students (OBR 2002; Hoyt and Sorensen 1999). Even so, 25 percent of those with a known core high school curriculum still required remediation (OBR 2002).

Table 1 summarizes the characteristics of students placed into remediation versus those who are not.[11] As expected, students placed into remediation had lower ACT scores and high school GPAs. For example, students placed in math remediation scored a mean of 17.4 on the math section of the ACT while students who did not take the classes scored 23.3 (a similar gap, 15.8 versus 22.8, is found for English remediation). A simple comparison of the outcomes of students placed into remediation and those who are not suggests that remedial students had worse educational outcomes. After five years, a larger proportion of them dropped out of college without a degree (65.2 percent for those in math remediation versus 30.8 percent). After six years, fewer of them completed a baccalaureate degree (28.5 percent for those in math remediation versus 66.4 percent). However, this comparison does not take into account differences in the sample of remediated and nonremediated students.

C. Variation in Remediation Policies by Institution

Within the state of Ohio, public colleges and universities are independent and autonomous. Each is free to set their admissions, placement, and remediation policies (LOEO 1995).[12] All schools require entering freshmen to take placement exams, but the placement instruments vary by institution and include different combinations of ACT and SAT scores, high school transcripts, assessment exams, and

11. Bettinger and Long (2007) provides a more general description of students in remediation in Ohio including their backgrounds, academic preparation, and other characteristics. The sample in that analysis also includes older, nontraditional students and those not intending to complete a degree.
12. However, Ohio public institutions are subject to the state's "open admissions" law that requires high school graduates to be admitted to the public school of their choice with certain exceptions. Students who have completed a college prep curriculum are generally accepted unconditionally.

institutionally developed subject-area tests.[13] In addition, while there are statewide standards to distinguish between remedial and college-level work, given the autonomy of public colleges in Ohio, institutions differ in how they interpret these standards at the campus level (LOEO 1995). For example, the cut-off scores used to determine placement differ among institutions, reflecting the varying interpretations of what comprises college-level coursework (LOEO 1995). One survey found that cut-off scores for placement into writing remediation varied from 17 to 20 for the ACT writing score, 410 to 580 for the SAT verbal score, and 26 to 44 for the ASSET test (SHERAC 1997).

Our data provide further evidence of how remedial placement policies differ across institutions. Although we do not have remedial placement test scores for each student,[14] we use other academic proxies, some of which are actual determinants, as predictors of remedial placement. Figure 1 displays the degree of variation in placement policies using ACT score as a predictor of placement into remediation. Each row corresponds to a different group of colleges.[15] The lefthand graphs show the distribution of student body ACT scores at each set of institutions. To estimate the righthand graphs, we use a two-step process to identify the most likely remediation placement cutoff for each campus. First, for each campus and for each possible ACT score, we estimate Equation 1 using a Probit model:

$$(1) \quad Remediation_i = a + b * I(ACT > J)_i + e_i$$

where *Remediation* is an indicator for whether the student enrolled in remedial math classes, *I*(*ACT*>*J*) is an indicator for whether the ACT math score of student *i* is greater than *J*, and *J* varies over the possible range of ACT math scores (1–36). This gives us the likelihood that a student with a particular ACT score would be placed in remediation at a particular campus. We save these maximum likelihood estimates, and in the second step, we rescale them relative to the maximum value of the likelihood function within that campus. To the extent that colleges use the ACT score to assign remediation, these likelihood plots show a spike at the most likely remediation placement cutoff value used by an individual school.[16]

While the distribution of student body ACT scores (lefthand graph) looks similar across for each type of school except the selective universities, the most likely remediation cutoffs in the righthand column show much greater heterogeneity. For example,

13. The assessment exams include the Computerized Adaptive Placement Assessment and Support Systems (COMPASS) and the Assessment of Skills for Successful Entry and Transfer (ASSET), both published by ACT, Inc. Each consists of a variety of tests to measure students' skill levels. For example, the ASSET exam is a written exam with as many as 12 subsections, including in-depth assessment of students' writing, numerical, and reading skills.

14. These would not be sufficient to predict placement anyway given that schools often use a combination of measures in determining whether remediation is needed. Extended conversations with college officials made clear that standardized formulae are not used; instead the different instruments are sometimes weighted different amounts when making decisions. Therefore, it would be impossible for us to replicate the remedial placement decision even if we did have placement test scores.

15. Selective public institutions in Ohio require a certain academic standard but are not considered highly selective by national norms. Nonselective four-year colleges may require the ACT but are open admissions schools.

16. A similar methodology is used in Kane (2003).

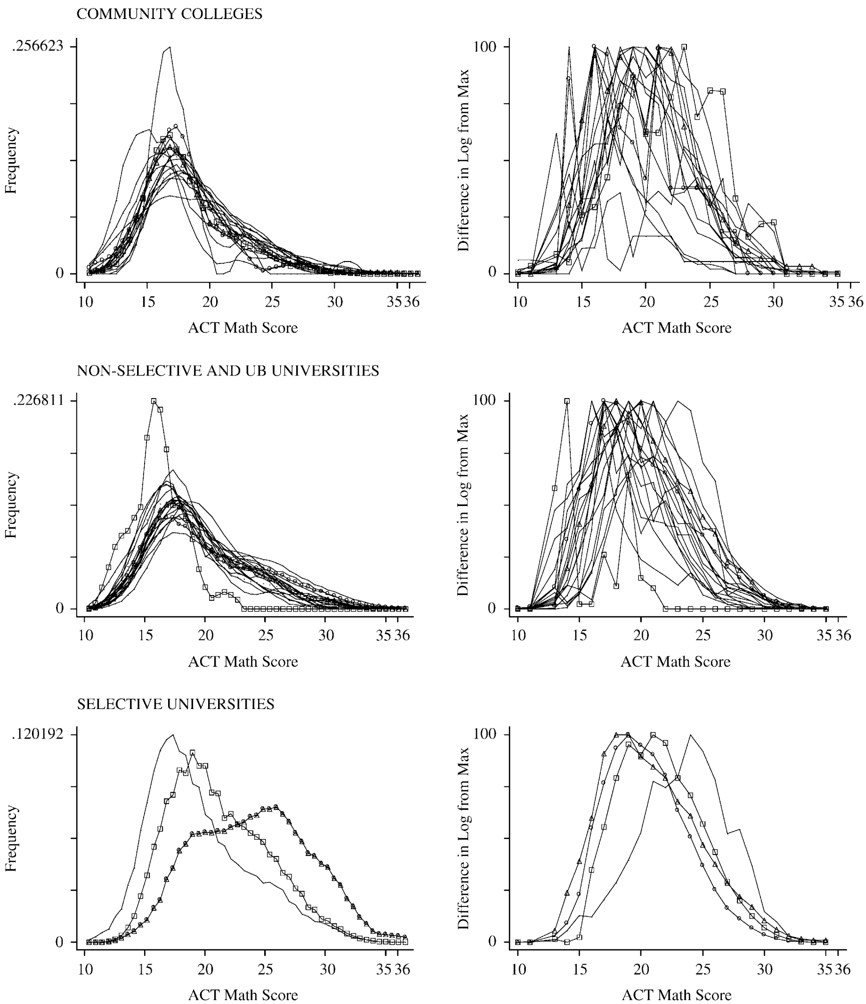

Figure 1

The Distribution of ACT Scores and Likely Remediation Cutoff Score by Institution

Notes: Each line represents a different institution. The graphs on the left are of the distribution of ACT scores. The graphs on the right show the likelihood of being placed in remediation for each ACT score. In the results, we focus on the students who might plausibly be placed in remediation. Therefore, while the overall ACT scores of students at selective, four-year universities are higher, the scores of the subset of students who could plausibly be placed in remediation are much more similar to those of students at nonselective colleges.

the student bodies look similar among nonselective, four-year public institutions (middle row), but the predicted ACT cutoffs vary across these institutions from a score of 14-23. Hence, while all the four-year and two-year nonselective colleges in the state serve similar-ability students (comparing the lefthand graphs of the first two rows), they use different thresholds to determine placement into remediation (the righthand graph). As expected, the ACT scores of students at the selective, four-year universities are higher, but as explained below, only students at these schools who might plausibly be placed in remediation are used in the main results. The scores of this subset of students are much more similar to those of students at nonselective colleges.

The results in Figure 1 are an oversimplification of individual colleges' remediation assignment rules. They focus on only one dimension (ACT scores) to illustrate the heterogeneity. As previously mentioned, remediation placement criteria also can include high school curricula, high school grades, and other indicators. As we explain below in our subsequent analysis, we use more flexible specifications that allow these other possible criteria to matter. In these augmented specifications, we can test whether the remediation placement rules are equivalent across campuses, and as we describe later, in these tests we soundly reject that the placement rules are equivalent. In summary, a student who might place out of remediation at some Ohio colleges could be put into remedial courses at others. We discuss the potential reasons for this variation in remediation policies below.

III. Empirical Framework

A. *Biases in the Study of Remediation*

To understand the impact of remedial education policies, we compare the outcomes of students placed in remediation to those who are not. However, selection issues preclude a straightforward analysis because there are inherent differences between students placed in remediation from those who pass out of the courses. Additionally, enrollment in a particular college may be an endogenous choice reflecting both student ability and preferences about remediation. For example, a student wishing to avoid remediation might choose a college with a very low placement threshold. However, this second concern may not be as much of an issue as multiple studies note the surprise of many students when they are placed in remediation (Venezia, Kirst, and Antonio 2003; Trouson 2002). Moreover, many papers decry the disconnect between what high schools tell students to do versus what college professors require (Kirst and Venezia 2001; Venezia, Kirst, and Antonio 2003).[17]

To address these selection issues, we focus on the remediation policy at the four-year college *closest* to a student's home.[18] Previous research has shown that students are more likely to attend one school over another based on how close the colleges are to their homes (Rouse 1995; Card 1995; Long 2004). This is particularly relevant in

17. Other studies document the fact that most high school students are unaware of college admission procedures, costs, and aid (Avery and Kane 2004).

18. In previous versions, we used a two-part instrument that was a weighted average of the remediation probabilities for a given student across all the campuses with the weights being determined by the student's distance from each campus. The results are similar to those presented here. When deciding to use the closest four-year college as the focal of the instrument, we also tested using the closest two-year campus or the closest campus overall (either four-year or two-year). The analysis suggests that the strongest predictor is the closest four-year campus.

Ohio; in our sample, the median distance from a student's home to their college is only 26 miles with nearly 60 percent of students attending a college within 50 miles of their homes.

Card (2001) among others has criticized the use of school proximity as an instrument for college choice.[19] However, one mitigating factor in our study is the geographic placement of colleges throughout the state. In order to improve access to college, Ohio Governor James Rhodes (1963–71 and 1975–83) deliberately influenced the location of colleges so that every state resident was located within thirty miles of a college campus (OBR 2001). Moreover, our instrument focuses on the *interaction* between distance and institutional remediation policies, and so our identification comes from the interaction between the likelihood of being remediated at a college and the college's proximity to a student. To exploit institutional variation across the state, students are assigned the remediation probability of the closest four-year college. All of our regression specifications also control for the distance between the student and the nearest college. The following sections further discuss the validity of distance as an instrument.

B. Constructing the Instrument

Because placement test scores are not available and schools do not follow uniform testing policies, we instead model a university's remediation policy by using probits to estimate the likelihood of taking math remediation. It is estimated as a function of students' math ACT scores, the scores squared, high school overall GPA, high school math GPA, the number of math classes taken in high school and a number of personal characteristics, including race, gender, age, the type of high school attended, family financial background, postsecondary degree intent while in high school. We also saturate the model with dummy variables for each college and separate interactions between the college dummy and the student's math ACT, math grades in high school, and years of math.[20] Using these coefficients, we then predict the likelihood of math remediation for each student at the closest college to their home. The same methodology was followed to predict the likelihood of English remediation (replacing math scores, grades, and semesters of courses with verbal scores and English grades and courses in high school). Because we control for the same individual characteristics estimating the remediation placement rules as when we estimate the effects of remediation, we result in predicting remediation while controlling for the average likelihood of a given characteristic (for example, ACT score). Likelihood ratio tests reject the hypothesis that the coefficients on the college dummy variables are the same. Therefore, institutional remediation rules do not appear to be equal and attending a different college could dramatically change the likelihood that an individual student would be placed into remediation.

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19. In Card's study of men in the National Longitudinal Study, for example, he finds that men who grew up near a university have higher IQs than others.

20. By estimating this as one large model with dummy variables for each college, we hold constant across schools the role of student demographic characteristics (race, gender, and age), family income, type of high school, and type of high school degree in determining the probability of remediation. The remediation probability is only related to the math ACT score, years, and grades in high school math, and the general placement threshold of the school.

C. Testing the Validity of the Instrument

Our first-stage regressions appear in Table 2. In our results of the first-stage equation for math remediation, the coefficient of the instrument is 0.5194 with a standard error of 0.0180, thereby making it significant at the 99 percent level (Column 1). In a similar fashion, the coefficient on the IV for English remediation is 0.3923 with a standard error of 0.0173 (Column 3). The results suggest that the instrument strongly predicts the likelihood of math and English remediation.

Our underlying assumption is that variation in institutional remediation policies are not related to the characteristics of nearby students. Ideally, we would like to test this assumption directly; however, the small sample size of colleges in our study (42 institutions) results in imprecise estimates.[21] Another possible test of the relationship of between institutional remediation policies and the characteristics of local students is to compare the average characteristics of students close to schools with low-remediation thresholds to schools with high remediation thresholds. However, it is first worth noting concerns about this method of analysis. Again, a concern is whether there is sufficient power to make inferences. The key variable of interest (college remediation policies) varies from campus to campus. This suggests that we should correct the standard errors for correlation between students living near the same college. In addition, the distribution of remediation policies across institutions does not lead to obvious grouping of the colleges into ''low'' versus ''high'' groups. Changing the definition of ''low-threshold'' or ''high-threshold'' just slightly could lead to big differences in the estimates and their variability. Therefore, caution should be taken while reviewing this analysis. After presenting these results, we present a second method for testing the validity of the instrument.

For the comparison of students near ''low-threshold colleges'' to students near ''high-threshold colleges,'' we used the cutoffs estimated using maximum likelihood models for each school (as shown in Figure 1). We defined ''low-threshold'' schools as having an ACT math cutoff for remediation of 17 or below; ''high-threshold'' schools are defined as universities where the estimated ACT math cutoff for remediation is 19 or above (a number of schools have an estimated cutoff of 18).[22] Even with the methodological concerns listed above, we find little difference between students living near high-threshold colleges versus those near low-threshold colleges. As shown in Appendix Table A1, the mean ACT Composite score differs slightly (a quarter of a point) as does the ACT English score (0.62 points), but the most important indicator of math remediation—the mean ACT Math score—is not statistically different between the groups. The only other statistically significant

21. In previous versions of this paper, we regressed indicators of schools' remediation policies (such as ACT cutoff scores, percent of students in remediation) on the characteristics of the college and the neighboring community; however, these efforts were largely uninformative due to the small sample size. While we did not find statistically significant relationships between remediation policies and both institutional and nearby school characteristics, we did not have statistical precision in our estimates, and the confidence intervals were large.

22. The low-threshold colleges are Central State University, Shawnee State University, and University of Akron. The high-threshold colleges are Youngstown State University, Ohio University, University of Toledo, and Bowling Green State University.

Table 2
First-stage IV Estimates of the Likelihood of Math and English Remediation

	Math Remediation		English Remediation	
	Full Sample (1)	LATE Sample (2)	Full Sample (3)	LATE Sample (4)
Remediation probability at nearest four−year college	0.5194** (0.018)	0.5258** (0.0226)	0.3923** (0.0173)	0.3811** (0.0242)
Overall ACT score	−0.0089** (0.0009)	−0.0086** (0.0012)	−0.0091** (0.001)	−0.0079** (0.0014)
ACT math score	−0.0114** (0.0009)	−0.0115** (0.0011)		
ACT English score			−0.0089** (0.0008)	−0.0110** (0.0013)
High school GPA	−0.0430** (0.0071)	−0.0399** (0.009)	−0.0415** (0.0064)	−0.0345** (0.0090)
High school math GPA	−0.2651** (0.0465)	−0.2813** (0.0589)		
High school English GPA			−0.0170** (−0.0047)	−0.0164** (0.0067)
Semesters of high school math	−0.0118** (0.0026)	−0.0099** (0.0032)		
Semesters of high school English			−0.0063* (0.0033)	−0.0048 (0.0044)
Distance to nearest college	−0.0054 (0.0057)	−0.0139* (0.0083)	−0.0142** (0.0042)	−0.0327** (0.0117)
F−statistic (on excluded instruments)	829.9	543.6	516.9	248.8
R−Squared	0.3128	0.3097	0.2669	0.2701
Observations	28,376	17,936	28,376	14,199

**Significant at the 5 percent level *Significant at the 10 percent level
Notes: Robust standard errors are reported. The instrument is the "Remediation Probability at Nearest Four-year College," which is defined as the percentage of students in the state who would be placed in remediation at that school. Additional dummy variables for race, gender, age, high school rank, family financial background, type of high school, and college degree aspirations while in high school are included in the models (each of these are categorical variables that were transformed into dummy variables for each category).

differences are age and the proportion who are black.[23] As we would expect given our observations about the importance of proximity in college choice, more students who live near high-threshold colleges are eventually placed into remediation than their counterparts (26.1 percent versus 18.6 percent, respectively).[24]

Another possible check of our strategy is to examine whether our instrument (remediation policies at the closest four-year college) is really the mechanism of interest. To do this, we estimate alternative specifications using the remediation policies at the closest, *second* closest, and *third* closest college. The first-stage results for this exercise appear in Appendix Table A2. When including the second closest college (Columns 2 and 5), the coefficient on our primary instrument falls in absolute value but remains highly statistically significant. By contrast, the coefficient on the remediation policy at the second closest university is much smaller. When including the third closest college (Columns 3 and 6), the variable is not statistically significant, and the coefficients for the closest and second closest colleges barely change. The pattern of results is very similar for the first-stage IV estimates focusing on English remediation (Columns 4, 5, and 6). We present the results using this alternative instrument (the closest *and* second closest college) in the Appendix, and the results are similar to the main results of the paper.

There are other more qualitative reasons to believe remediation policies are exogenous to our outcomes of interest (student persistence and graduation). For instance, remediation cutoffs are often set according to the beliefs and opinions of the administration about remediation. One four-year university in Ohio decided to eliminate remediation after a change in college leadership. Students requiring remediation are now referred to a local community college (Sheehan 2002). Additionally, prior research has shown that the academic departments responsible for teaching remedial courses often determine the remediation policies, and these policies are not based on systematic research (OBR 2001). Once established, remediation policies tend to stay fixed. Finally, colleges are largely unaware of the effectiveness of remediation policies. A 1991 internal report by the Ohio Board of Regents found that "very few institutions conduct consistent followup students of students completing developmental programs or track the students to completion of their educational goals" (LOEO 1995).[25]

D. Estimating the Effects of Remediation on the Marginal Student

We measure the effects of remediation using the regression model shown in Equation 2:

23. Of the campuses in the "low" category, the largest by far is the University of Akron, which is located near one of the largest African-American, college-bound populations. If another campus had been defined as a low-threshold campus, the correlation would have been weaker and the results different.

24. We produced similar analyses varying the way we defined a "low-threshold" school. For instance, we compared students within 20 miles (instead of 10 miles) of one of the low-threshold colleges to other students. While there are statistical differences by demographics, there are no differences by ACT math score, high school math grades, or number of semesters of math taken in high school. Similar results are found if the comparing students near the four lowest-threshold colleges.

25. Although the Ohio Board of Regents collects and assembles student unit record data, most schools do not have the information themselves nor the resources to analyze it to reflect on their own remediation policies.

$$(2) \quad Outcome_i = \alpha + \beta\, Remed_i + \gamma X_i + e$$

where X is a matrix of individual characteristics that may influence both assignment to remediation and students' outcomes. The model controls for race, gender, age, ACT composite score, ACT math (or English and Reading) score, high school GPA, high school rank, family income, high school types, semesters of high school math (or English), high school grades in math (or English), distance in miles from the nearest campus, and type of high school degree (dummy variable for GED). Remediation enters as a dummy variable equal to one if the person enrolled in any remedial course. To test whether there are different effects for math versus English remediation, we report separate estimates by subject. The outcomes are measured for six school years from fall 1998 to spring 2004. Students are considered "dropouts" if they are no longer at any public, Ohio college at the end of the time period and have not received a four-year degree. Students who have "transferred down" are at a less selective or lower-level college (university branch campuses are considered less selective than four-year colleges). Students who have "transferred up" went to a more selective or higher-level college. Unlike other studies, students who transferred to other colleges are not considered dropouts due to our ability to track students. It is important to note that this is the "intention to treat" effect as some students placed in remediation never complete the courses.

Our estimation strategy and results rely on students for whom the probability of remediation differs according to the college they attend. Therefore, the estimates do not include students who would either have always or never been in remediation because keeping these students in the sample would skew the results.[26] The target sample is instead marginal students for whose need for remediation is questionable. This margin may be especially important, as states and colleges try to determine ways to reduce and/or shift remedial services without terminating them completely.

To better focus on students on the margin of needing remediation, we imposed the following sample limitations. First, we dropped students who had less than a 25 percent chance of being placed in remediation at one of the most stringent schools (defined to have the 90$^{\text{th}}$ percentile placement threshold, one of the highest in the public college system).[27] In other words, students who had only a small probability of remediation under very rigorous standards are assumed to rarely be placed in remediation. Second, students who had at least a 25 percent chance of remediation at one of the most lenient schools (defined to have the 10th percentile placement threshold, one of the lowest) were also dropped. We assumed these students would almost always be placed into remediation regardless of the school

26. When estimating the results using the full sample, students who would never or always be placed in remediation effectively drop out of the sample due to lack of variation in the treatment. Therefore, this restriction mainly affects students who rarely would be placed in remediation or rarely place out. However, because the aim of this paper is to understand the effects on students truly on the margin of needing remediation, we chose to exclude these outliers.

27. So that the definition of the marginal sample is not driven by a single, outlier college, the 90th percentile is used rather than the college with the highest overall placement threshold. Similarly, the 10th percentile is used.

policy. Finally, we dropped students who did not have much variation in the probability of remediation at each school. We defined this as having less than a 25 percentage-point difference between the 90th and 10th percentile remediation probabilities across the schools.[28] Because there are other possible ways to define the marginal group, the results below were also estimated using different cutoffs. For instance, rather than the 25 percent cutoffs used in the above definition, 33 percent cutoffs were used. The results are robust to these different definitions. Additionally, results using the full sample of students may be thought of as a lower bound of the effect on the marginal student: The full sample is essentially equivalent to using the least restrictive possible definition of this group.

The last two columns of Table 1 provide summary statistics of the sample on the margin of needing remedial courses or not. Using the definition described above is very inclusive of many students, and the results apply to a large proportion of college students. The sample size drops only by a third for the Math Remediation group (slightly larger for the English remediation group), suggesting that variation in the remediation cutoff is important for the *majority* of students. In comparison to the full sample, fewer students are from the selective four-year colleges, but these students still make up the largest group. The marginal samples also have lower average ACT scores than the full sample, again suggesting that students at the top of the distribution who would never be placed in remediation have been dropped; students who would have always been in remediation have also been dropped, but there are fewer of them. For instance, the sample of marginal students for the math analysis does not include any student with a math ACT score of eleven or below, and many students with math ACT scores of 12, 13, and 14 also are excluded due to having a high likelihood of being placed in remediation regardless of which college they attend.

IV. The Effects of Math and English Remediation

A. The Overall Effects of Remediation

This section discusses the impact of remediation on persistence, transfer behavior, and degree completion for similar students placed in and out of remediation. Tables 3 and 4 report the basic results of the impact of remediation on a variety of various outcomes using OLS and IV regression analysis.[29] The left panel displays results for the full sample while the right side focuses on the subset of students on the margin of needing remediation. Means of the outcome variable are shown to aid in interpretation. Each coefficient under the OLS and IV columns represents a separate regression with controls for race, gender, age, ACT

28. Of the restrictions, the first (dropping students who would rarely be in remediation) and third (dropping students without much variation in their probability of remediation) are the most binding. These restrictions also are reinforcing: nearly all of the students dropped due to the first restriction also qualify to be dropped under to the third. Very few students would have been placed in remediation at the most lenient schools (the second restriction).

29. Some of the estimates have fewer then the total number of observations due to the fact that students at selective four-year cannot transfer up and students at community colleges cannot transfer down.

Table 3
Effect of ENGLISH Remediation—Full Sample versus the Effects on the Marginal Students

	Full Sample				Marginal Students Affected by Differences in Remediation Policies			
	Dependent Variable Mean	Remediation OLS	Coefficient IV	Observations	Dependent Variable Mean	Remediation OLS	Coefficient IV	Observations
Negative educational outcomes								
Dropped out during first year	0.0825	0.0127**	0.0496*	28,376	0.0847	0.0200**	0.0207	14,199
		(0.0053)	(0.0281)			(0.0074)	(0.0408)	
Dropped out by Spring 2003	0.4005	0.0931**	−0.1157**	28,376	0.4773	0.1012**	−0.1522**	14,199
		(0.0092)	(0.0473)			(0.0127)	(0.0686)	
Transferred down during first year	0.0582	−0.0067	−0.0394	25,177	0.0600	−0.0049	0.0089	12,609
		(0.0055)	(0.0269)			(0.0073)	(0.0367)	
Transferred down as of last record	0.1498	0.0116	−0.1929**	25,398	0.1624	0.0188	−0.2009**	12,700
		(0.0089)	(0.0445)			(0.0121)	(0.0618)	
Positive educational outcomes								
Total credit hours completed	81.20	−9.1958**	−20.5342**	28,376	75.95	−8.7843**	−19.9652**	14,199
		(0.7652)	(4.0099)			(1.0659)	(5.8001)	
Transferred up as of last record	0.1610	−0.0306**	−0.0610	12,965	0.1723	−0.0294**	0.0570	6,847
		(0.0081)	(0.0759)			(0.0107)	(0.1040)	
Completed bachelor's degree in four years	0.2391	−0.0141**	0.2875**	28,376	0.2340	−0.0090	0.3125**	14,199
		(0.0051)	(0.0317)			(0.0071)	(0.0467)	
Completed bachelor's degree in six years	0.5599	−0.0889**	0.1066**	28,376	0.5551	−0.0943**	0.1056	14,199
		(0.0087)	(0.0447)			(0.0120)	(0.0645)	

** Significant at the 5 percent level * Significant at the 10 percent level

Notes: Each coefficient under the OLS and IV columns represents a separate regression with controls for race, gender, age, ACT composite score, ACT English score, ACT Reading score, high school GPA, high school rank, family income, high school type, semesters of high school English, high school grades in English, and type of high school degree (dummy variable for GED). Standard errors are shown in the parentheses. Students are considered "dropouts" if they are no longer at any public, Ohio college at the end of the time period and have not received a Bachelor's degree. Students who "transferred down" were at a less selective or lower-level college as of their last enrollment record. Students who have "transferred up" went to a higher-level college or more selective college.

Table 4
Effect of MATH Remediation—Full Sample versus the Effects on the Marginal Students

	Full Sample				Marginal Students Affected by Differences in Remediation Policies			
	Dependent Variable Mean	Remediation OLS	Coefficient IV	Observations	Dependent Variable Mean	Remediation OLS	Coefficient IV	Observations
Negative educational outcomes								
Dropped out during first year	0.0825	−0.0090**	0.0306	28,376	0.0836	−0.0109*	0.0558*	17,936
		(0.0045)	(0.0231)			(0.0057)	(0.0287)	
Dropped out by Spring 2003	0.4005	0.1366**	−0.1389**	28,376	0.4685	0.1331**	−0.0709	17,936
		(0.0080)	(0.0397)			(0.0100)	(0.0487)	
Transferred down during first year	0.0582	0.0044	0.0250	25,177	0.0666	0.0068	0.0200	15,950
		(0.0048)	(0.0243)			(0.0060)	(0.0279)	
Transferred down as of last record	0.1498	0.0625**	−0.0175	25,398	0.1807	0.0688**	0.0073	16,078
		(0.0077)	(0.0372)			(0.0096)	(0.0434)	
Positive educational outcomes								
Total credit hours completed last record	81.20	−11.0609**	−15.4093**	28,376	72.39	−10.693**	15.972**	17,936
		(0.6817)	(3.4108)			(0.8518)	(−4.2101)	
Transferred up as of last record degree in four years	0.1610	0.0340**	−0.1335**	12,965	0.1569	0.0358**	−0.1170*	8,515
		(0.0077)	(0.0513)			(0.0092)	(0.0571)	
Completed bachelor's	0.2391	−0.0629**	0.1596	28,376	0.2299	−0.0604**	0.1253**	17,936
		(0.0049)	(0.0293)			(0.0062)	(0.0359)	
Completed bachelor's degree in six years	0.5599	−0.1180**	0.0152**	28,376	0.5522	−0.1130**	0.0136	17,936
		(0.0077)	(0.0373)			(0.0096)	(0.0458)	

**Significant at the 5percent level *Significant at the 10percent level

Notes: Each coefficient under the OLS and IV columns represents a separate regression with controls for race, gender, age, ACT composite score, ACT math score, high school GPA, high school rank, family income, high school type, semesters of high school math, high school grades in math, and type of high school degree (dummy variable for GED). Standard errors are shown in the parentheses. Students are considered "dropouts" if they are no longer at any public, Ohio college at the end of the time period and have not received a Bachelor's degree. Students who "transferred down" were at a less selective or lower-level college as of their last enrollment record. Students who have "transferred up" went to a higher-level college or more selective college.

composite score, ACT math (or English and Reading) score, high school GPA, high school rank, family income, high school type, semesters of high school math (or English), high school grades in math (or English), distance from the nearest college, and type of high school degree (dummy variable for GED).

The first thing that is obvious from the results is the difference between the OLS and IV results. As discussed above, a simple comparison of students in and out of remediation is likely to suggest negative effects due to important academic differences in the underlying populations. For instance, as shown in Table 3, students in English remediation are found to be 9.3 percent more likely to drop out by Spring 2003 and 8.9 percent less likely to complete a four-year degree within six years than students not in remediation. However, when using the IV strategy to deal with such biases, these negative estimates disappear. Students are about 12 percentage points *less* likely to drop out and 11 percentage points *more* likely to graduate within six years.

A second major pattern in the results is the difference between those estimated for the entire sample versus the results on the marginal remedial students. As discussed above, the estimation strategy relies upon the sample of students for whom the likelihood of remediation varies across schools. As would be expected, many of the results become stronger once focusing more finely on this marginal group. As shown in the IV column of results for the marginal sample, students in remedial English courses are 15.2 percent less likely to drop out than similar students. Table 4 shows similar results for math remediation in terms of persistence and degree completion. Focusing on the IV results, students in math remediation are 13.9 percent less likely to drop out and 1.5 percent more likely to graduate in six years than similar students although these results are no longer significant in the sample of marginal students.[30]

Although the magnitude of many of the estimates is high relative to the mean, the results are likely to be an upper bound for what the effects might be for the overall population. The strongest results are for students at the margin of needing remediation, and we find that as we use more restrictive sample limitations to define the subset of marginal students (focusing more narrowly on students on the margin of needing remediation), the estimated effects increase in size and become more positive. For example, if we restrict the sample to students with at least a one-third chance (33 percent) of being placed into remediation at their most stringent school and less than one-third chance (33 percent) at their most lenient, the estimated effects increase.

B. The Effects of Remediation by Student Ability

While the previous tables suggest that remediation has a positive effect overall on student outcomes, the next part of the analysis tests whether the effect differs by ability level as measured by ACT score. Table 5 displays the results from including an interaction between the student's ACT score and the remediation dummy variable;

30. Appendix Tables A3 and A4 compare the instrumental variable estimates when we use just the closest remediation policy to those when we use the remediation policies at the two closest schools. The estimates are very similar.

Table 5
IV Estimates—Interactions with ACT Score

	Dropped Out by Spring 2003	Transferred Down as of Last record	Total Credit Hours	Transferred Up as of Last Record	Completed Bachelor's Degree in Six Years
	(1)	(2)	(3)	(4)	(5)
A. English remediation					
Effect of remediation	0.2027*	−0.0779	9.3557	0.1423	−0.2230*
	(0.1041)	(0.0989)	(9.0796)	(0.0931)	(0.1004)
Remediation* ACT English score	−0.0258**	−0.0097	−2.5797**	−0.0216*	0.0244**
	(0.0101)	(0.0092)	(0.8819)	(0.0114)	(0.0097)
ACT English score	−0.0131**	−0.0070**	0.4029**	0.0049	0.0122**
	(0.0020)	(0.0015)	(0.1708)	(0.0043)	(0.0019)
Observations	14,199	12,700	14,199	6,847	14,199
	(6)	(7)	(8)	(9)	(10)
B. Math remediation					
Effect of remediation	0.1900	0.0643	3.9512	0.2516*	−0.1590
	(0.1403)	(0.1438)	(12.0372)	(0.1392)	(0.1338)
Remediation* ACT math score	−0.0193**	−0.0040	−1.4722	−0.0321**	0.0108
	(0.0112)	(0.0109)	(0.9602)	(0.0125)	(0.0107)
ACT math score	−0.0165**	−0.0032**	0.9117**	−0.0071**	0.0142**
	(0.0019)	(0.0014)	(0.1627)	(0.0034)	(0.0018)
Observations	17,936	16,078	17,936	8,515	17,936

**Significant at the 5 percent level *Significant at the 10 percent level
Notes: Each specification represents a separate regression with controls for race, gender, age, ACT composite score, ACT math (or English and Reading) score, high school GPA, high school rank, family income, high school type, years of high school math (or English), high school grades in math (or English), and type of high school degree (dummy variable for GED). Standard errors are shown in the parentheses. Students are considered "dropouts" if they are no longer at any public, Ohio college at the end of the time period and have not received a Bachelor's degree. Students who "transferred down" were at a less selective or lower-level college as of their last enrollment record. Students who have "transferred up" went to a higher-level college or more selective college.

the top panel has the results for English while the bottom focuses on math. Although the coefficients for English remediation suggest it has a detrimental impact on student dropout behavior, once the results are evaluated at the mean ACT English score, the results are similar those found above. For example, evaluated at the mean ACT English score of students in English remediation (mean 15.77), students in remedial English courses are 41.1 percent less likely to drop out of college by Spring 2003. Similarly, we find that remediation has positive effects on the degree completion behavior of students near the mean English ACT score. As shown by the sign of the interaction, the beneficial effects of remediation on stopping out increase with the ACT score. However, while students in English remediation *generally* tend to complete more credit hours and are more likely to transfer up, this positive effect declines the higher the ACT score.

The results in the bottom half of the tables also are similar to the earlier results once evaluated at the mean. Using a mean math ACT score of 17.38 for the group in remediation, the results suggest that they are 43.2 percent less likely to stop out of college by Spring 2003. The impact of math remediation on reducing the probability of dropping out also appears to increase with ability as shown by the negative sign on the interaction between the remediation dummy variable and the ACT English score.[31]

C. The Effects of Remediation on Student Interest

The final section of analysis examines whether the effects of remediation vary across students with different academic interests. For instance, the impact of remedial courses may differ depending on whether the student intended to major in a subject related to the field or not. On one hand, math remediation may send an especially influential signal to students intending to major in math-type courses that they will not succeed and should change to something different or dropout altogether. On the other hand, students intending to do math-type majors may view it as a necessary step and be especially motivated to succeed in the courses. Another question related to the issue is whether it makes sense to require math remediation for students not intending to major in math-related fields. Table 6 displays analyses of these questions by interacting the remediation variable with a dummy variable measuring students' precollege interest in a related major. This information comes from the survey students fill out when taking the ACT, and so this variable is not influenced by their performance on the ACT or placement into or out of remediation. We categorize the college major choices as being a math- or English-related major for the analysis.[32]

As shown in the first row of each section of the table, remediation is estimated to have the same general effects—students in remediation are less likely to drop out and

31. Additional analysis ran separate regression models for each ACT score and compared the coefficients on the remediation dummy variable. These results reinforce the conclusions drawn from Table 5.

32. The following are considered math-related majors: Mathematics, Statistics, Sciences (biology, chemistry, physics, etc.), Business, Computer Science, Engineering, and Architecture. The following are considered English-related majors: humanities, foreign languages, social sciences, journalism, communications, education, and social work. Students who did not declare a major in college are excluded from the analysis.

Table 6
IV Estimates of the Impact of Remediation by Precollege Plan of Study

	Dropped Out by Spring 2003	Transferred Down as of Last record	Total Credit Hours	Transferred Up as of Last Record	Completed Degree in Six Years	Choose Major in Field of Interest
	(1)	(2)	(3)	(4)	(5)	(6)
A. English Remediation						
Remediation	−0.1064	−0.2133**	−25.3124**	0.0977	0.0617	0.0723
	(0.0684)	(0.0560)	(5.9965)	(0.1200)	(0.0066)	(0.0643)
Remediation* precollege interest in English−related field	−0.0238	0.0046	−3.6108	0.0058	0.0136	−0.1257**
	(0.0542)	(0.0518)	(4.7479)	(0.0634)	(0.0522)	(0.0509)
Precollege interest in English−related field	−0.0260**	−0.0097	3.3902**	0.0279	0.0411**	0.3193**
	(0.0119)	(0.0096)	(1.0436)	(0.0187)	(0.0115)	(0.0112)
Observations	14,199	12,700	14,199	6,847	14,199	14,199
	(7)	(8)	(9)	(10)	(11)	(12)
B. Math Remediation						
Remediation	−0.0703	0.0041	−16.0469**	−0.1243*	−0.0199	0.2939**
	(0.0501)	(0.0411)	(4.3510)	(0.0664)	(0.0483)	(0.0480)
Remediation* precollege interest in math−related field	0.0018	0.0144	0.0773	−0.0372	0.0250	−0.0895**
	(0.0331)	(0.0300)	(2.8733)	(0.0151)	(0.0319)	(0.0317)

Precollege interest in math−related field	−0.0100	−0.0087	0.4979	−0.0392**	−0.0062*	0.3067**
	(0.0105)	(0.0082)	(0.9121)	(0.0151)	(0.0101)	(0.0101)
Observations	17,936	16,078	17,936	8,515	17,936	18,917

**Significant at the 5 percent level *Significant at the 10 percent level

Notes: Each specification represents a separate regression with controls for race, gender, age, ACT composite score, ACT math (or English and Reading) score, high school GPA, high school rank, family income, high school type, years of high school math (or English), high school grades in math (or English), and type of high school degree (dummy variable for GED). Standard errors are shown in the parentheses. Students are considered ‘‘dropouts’’ if they are no longer at any public, Ohio college at the end of the time period and have not received a Bachelor’s degree. Students who ‘‘transferred down’’ were at a less selective or lower-level college as of their last enrollment record. Students who have ‘‘transferred up’’ went to a higher-level college or more selective college. The following are considered math-related majors: Mathematics, Statistics, Sciences (biology, chemistry, physics, etc.), Business, Computer Science, Engineering, and Architecture. The following are considered English-related majors: Humanities, Foreign Languages, Social Sciences, Journalism, Communications, Education, and Social Work. Students who did not declare a major in college are excluded from the analysis.

more likely to complete a degree in six years. However, the second row of results displays the differential effect of remediation for students who need English or math remediation and intended to major in a field related to English or math respectively. These students did not benefit from remediation at any statistically significant, differential rate for most of the outcomes. The key difference is that remediation may have impacted their major choice.

The last column examines the possible discouragement effect of remediation as the dependent variable measures whether students majored in an English-related subject. The coefficient on the dummy variable signifying precollege interest in an English-related field suggests these students were much more likely to major in such a subject as expected. However, students who had English remediation were less likely to major in an English-related subject than their peers with similar interests. By contrast, math remediation increases the likelihood that a student majors in a math-related field of interest. The rate is slightly lower for students who expressed an interest in math-related fields prior to college, but the net effect is still positive. Therefore, although remediation generally has no effect on students' choices of subject, it seems to discourage students from choosing English as a major but increase the probability of students choosing math as a major.

V. Conclusions

In summary, we estimate that students in remediation have better educational outcomes in comparison to students with similar backgrounds and preparation who were not required to take the courses. While OLS estimates suggest remediation has a negative effect, once controlling for selection issues, the results become positive, thereby emphasizing how inappropriate it is to simply compare the outcomes of remediated and nonremediated students. Instead, by exploiting institutional variation in remedial placement policies and the importance of proximity in college choice, our analysis provides plausible estimates of the causal effects of remediation. Math and English remediation are estimated to reduce the likelihood of dropping out after five years and increase the likelihood of completing a degree within four to six years. Lending further support to the results, as theory would predict, the estimates are more positive for the group of students on the margin of needing remediation than the general sample. Furthermore, as the definition of the marginal subsample becomes more restrictive, the estimates continue to increase in size. While the subsample of students is only on the margin of needing remediation (they would be assigned to the classes at some schools while not at others), the results clearly suggest that remedial classes still have beneficial effects for them.

While the sizes of the general results are similar for math and English remediation, once focusing on particular kinds of students, differences are found by remedial subject. The impact of math remediation appears to increase as the student's ACT increases across all of the outcomes. Meanwhile, the positive impact of English remediation increases with ACT score in terms of reducing the probability of stopping out, but it declines as ability increases for the other outcomes. In terms of student interests, math remediation increases the likelihood of degree completion among students intending to major in math-related fields and it slightly increases the likelihood of majoring in such a field. English remediation is estimated to have a strong discouragement effect on students who intended to major in English-related fields.

In conclusion, remediation is an important part of higher education, and it plays a very significant role in attempting to address the needs of the thousands of underprepared students who enter postsecondary institutions each year. While we find it to have a positive impact on educational outcomes, further research is needed to more completely understand its other effects. By focusing on the group of marginal students, we do not investigate the effects of remediation on students who are extremely underprepared for college-level work (in other words, we do not have an appropriate control group for them because they are nearly always in remediation regardless of the college they attend). Future analysis needs to establish the impact of remediation on this group of students. Additionally, while our results give a general sense of the impact of remediation, it may be the case that certain types of instruction and supports are more beneficial than others, and this should be investigated.

Additional research on how to maximize the benefits of remediation is essential, as the cost of not offering the courses appears to be expensive. Our results suggest that underprepared students without the courses are more likely to drop out of college and less likely to complete their degrees. Many sources document the higher incidence of unemployment, government dependency, and incarceration among individuals with less education, and the costs associated with these kinds of activities are large. Moreover, the increasing demands of the economy in terms of skill and international competition encourage the country to find an effective way to train its workers. As noted in a *Time* magazine article, eliminating remediation in higher education could ‘‘effectively end the American experiment with mass postsecondary education’’ (Cloud 2002). With persistent concerns about the abilities of high school graduates, higher education must find ways to address the needs of underprepared students.

Table A1
Comparisons of Students Located Near "High" Math Remediation Schools to those Near "Low" Math Remediation Schools

	Within 10 miles of "*High*" Threshold College	Within 10 miles of "*Low*" Threshold College	Difference and Standard Error
	(1)	(2)	(3)
ACT composite score	21.598	21.340	−.2579*
	(0.0761)	(0.0950)	(0.1217)
ACT math	21.240	21.116	−0.124
	(0.0837)	(0.1058)	(0.1349)
ACT English	21.175	20.559	−.6159**
	(0.0895)	(0.1073)	(0.1397)
ACT reading	21.907	21.759	−0.149
	(0.0996)	(0.1217)	(0.1573)
ACT science	21.551	21.399	−0.153
	(0.0747)	(0.0951)	(0.1210)
Age	18.368	18.432	.0645**
	(0.0093)	(0.0115)	(0.0148)
Female student	0.5652	0.5682	0.0030
	(0.0089)	(0.0106)	(0.0138)
Black student	0.0836	0.1250	.0414**
	(0.0050)	(0.0071)	(0.0086)
High school rank	1.804	1.788	−0.016
	(0.0147)	(0.0177)	(0.0230)
High school grade point average	3.099	3.086	−0.013
	(0.0105)	(0.0128)	(0.0166)
High school math grades	3.003	3.003	0.000
	(0.0136)	(0.0168)	(0.0216)
High school English grades	3.194	3.185	−0.009
	(0.0116)	(0.0140)	(0.0182)
Semesters of high school math	7.306	7.355	0.049
	(0.0202)	(0.0248)	(0.0320)
Semesters of high school English	7.861	7.827	−0.034
	(0.0115)	(0.0164)	(0.0201)
Math remediation	0.2615	0.1855	−.0760**
	(0.0079)	(0.0083)	(0.0115)

**Significant at the 5 percent level *Significant at the 10 percent level
Notes: Standard errors appear with the differences. "Low" remediation schools are defined as universities where the estimated ACT math cutoff for remediation is 17 or below. "High" remediation schools are defined as universities where the estimated ACT math cutoff for remediation is 19 or above.

Table A2

First-stage IV Estimates using the Remediation Rule of the Nearest College

	Math Remediation			English Remediation		
	(1)	(2)	(3)	(4)	(5)	(6)
Remediation probability of nearest four−year college	0.5179**	0.4604**	0.4515**	0.6470**	0.6049**	0.5959**
	(0.0180)	(0.0190)	(0.0202)	(0.0150)	(0.0167)	(0.0169)
Remediation probability of second closest four−year college		0.1555**	0.1541**		0.1337**	0.1215**
		(0.0153)	(0.0152)		(0.0170)	(0.0172)
Remediation probability of third closest four−year college			0.0212			0.0778**
			(0.0178)			(0.0156)
Overall ACT score	−0.0089**	−0.0088**	−0.0088**	−0.0062**	−0.0056**	−0.0051**
	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)
ACT math score	−0.0115**	−0.0104**	−0.0103**			
	(0.0009)	(0.0009)	(0.0009)			
ACT English score				−0.0023**	−0.0003	0.0009
				(0.0008)	(0.0008)	(0.0008)
High school grade point average	−0.0430**	−0.0391**	−0.0386**	−0.0237**	−0.0185**	−0.0152**
	(0.0071)	(0.0071)	(0.0071)	(0.0060)	(0.0060)	(0.0060)
High school math grade point average	−0.0267**	−0.0247**	−0.0245**			
	(0.0047)	(0.0046)	(0.0047)			
High school English grade point average				−0.0078**	−0.0066**	−0.0063**
				(0.0031)	(0.0031)	(0.0031)

(*continued*)

Table A2 (*continued*)

	Math Remediation			English Remediation		
	(1)	(2)	(3)	(4)	(5)	(6)
Semesters of high school math	−0.0119**	−0.0072**	−0.0068**			
	(0.0026)	(0.0027)	(0.0027)			
Semesters of high school English				0.0025	0.0033	0.0036
				(0.0032)	(0.0032)	(0.0031)
F-statistic on excluded instruments	824.3	490.8	328.7	1852.9	1047.3	741.8
$R-$squared	0.3125	0.3157	0.3157	0.3256	0.3287	0.3300
Observations	28,376	28,376	28,376	28,376	28,376	28,376

**Significant at the 5 percent level *Significant at the 10 percent level

Notes: Robust standard errors are reported. Additional dummy variables for race, gender, age, high school rank, family financial background, type of high school, and college degree aspirations while in high school are included in the models (each of these are categorical variables that we transformed into dummy variables for each category).

Table A3
Alternative IV Estimates of the Effects of English Remediation

	Full Sample			Marginal Students Affected by Differences in Remediation Policies		
	Remediation Coefficient			Remediation Coefficient		
	IV Closest UM	IV 1st and 2nd Closest	Observations	IV Closest UM	IV 1st and 2nd Closest	Observations
Negative educational outcomes						
Dropped out during first year	0.0505*	0.0508*	28,376	0.0597	0.0616	15,013
	(0.0281)	(0.0281)		(0.0498)	(0.0498)	
Dropped out by Spring 2003	−0.1144**	−0.1138**	28,376	−0.1774**	−0.1741**	15,013
	(0.0473)	(0.0472)		(0.0806)	(0.0804)	
Transferred down during first year	−0.0374	−0.0374	24,398	−0.0171	−0.0167	12,743
	(0.0269)	(0.0269)		(0.0466)	(0.0465)	
Transferred down as of last record	−0.1901**	−0.1900**	25,177	−0.2764**	−0.2745**	12,891
	(0.0444)	(0.0444)		(0.0787)	(0.0785)	
Positive educational outcomes						
Total credit hours completed	−20.7543**	−20.8211**	28,376	−24.4127**	−24.8663**	15,013
	(4.0077)	(4.0085)		(6.7434)	(6.7552)	

(*continued*)

Table A3 (*continued*)

	Full Sample			Marginal Students Affected by Differences in Remediation Policies		
	Remediation Coefficient			Remediation Coefficient		
	IV Closest UM	IV 1st and 2nd Closest	Observations	IV Closest UM	IV 1st and 2nd Closest	Observations
Transferred up as of last record	−0.0630 (0.0760)	−0.0612 (0.0757)	12,965	0.2672 (0.1796)	0.2665 (0.1738)	8,242
Completed bachelor's degree in four years	0.2856** (0.0316)	0.2855** (0.0316)	28,376	0.3222** (0.0527)	0.3198** (0.0526)	15,013
Completed bachelor's degree in six years	0.1030** (0.0447)	0.1020** (0.0447)	28,376	0.2242** (0.0762)	0.2163** (0.0764)	15,013

Notes: Each coefficient represents a separate regression with controls for race, gender, age, ACT composite score, ACT math score, high school GPA, high school rank, family income, high school type, semesters of high school math, high school grades in math, and type of high school degree (dummy variable for GED). Standard errors are shown in the parentheses. Students are considered ''dropouts'' if they are no longer at any public, Ohio college at the end of the time period and have not received a Bachelor's degree. Students who ''transferred down'' were at a less selective or lower-level college as of their last enrollment record. Students who have ''transferred up'' went to a higher-level college or more selective college.

Table A4
Alternative IV Estimates of the Effects of Math Remediation

	Full Sample			Marginal Students Affected by Differences in Remediation Policies		
	Remediation Coefficient			Remediation Coefficient		
	IV Closest UM	IV 1st and 2nd Closest	Observations	IV Closest UM	IV 1st and 2nd Closest	Observations
Negative educational outcomes						
Dropped out during first year	0.0334 (0.0232)	0.0033 (0.0232)	28,376	0.0098 (0.0472)	0.0005 (0.0470)	18,917
Dropped out by Spring 2003	−0.1358** (0.0398)	−0.1371** (0.0398)	28,376	−0.3634** (0.0814)	−0.3756** (0.0813)	18,917
Transferred down during first year	0.0235 (0.0243)	0.0238 (0.0243)	25,177	−0.0703 (0.0478)	0.0765 (0.0479)	16,307
Transferred down as of last record	−0.0194 (0.0372)	−0.0190 (0.0372)	25,398	−0.0357 (0.0757)	−0.0311 (0.0754)	16,482
Positive educational outcomes						
Total credit hours completed	−15.618** (3.418)	−15.579** (3.417)	28,376	−30.181** (6.7507)	−28.814** (6.712)	18,917

(*continued*)

Table A4 (*continued*)

	Full Sample			Marginal Students Affected by Differences in Remediation Policies		
	Remediation Coefficient			Remediation Coefficient		
	IV Closest UM	IV 1st and 2nd Closest	Observations	IV Closest UM	IV 1st and 2nd Closest	Observations
Transferred up as of last record	−0.1356**	−0.1359**	12,965	0.0099	0.0121	10,014
	(0.0515)	(0.0515)		(0.0848)	(0.0844)	
Completed bachelor's degree in four years	0.1575**	0.1578**	28,376	0.0277	0.0271	18,917
	(0.0293)	(0.0293)		(0.0487)	(0.0483)	
Completed bachelor's degree in six years	0.0172	0.0167	28,376	0.0656	0.0748	18,917
	(0.0374)	(0.0374)		(0.0732)	(0.0729)	

Notes: Each coefficient represents a separate regression with controls for race, gender, age, ACT composite score, ACT math score, high school GPA, high school rank, family income, high school type, semesters of high school math, high school grades in math, and type of high school degree (dummy variable for GED). Standard errors are shown in the parentheses. Students are considered ‘‘dropouts’’ if they are no longer at any public, Ohio college at the end of the time period and have not received a Bachelor's degree. Students who ‘‘transferred down’’ were at a less selective or lower-level college as of their last enrollment record. Students who have ‘‘transferred up’’ went to a higher-level college or more selective college.

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