The Effect of Remediation on Two-Year College Students*

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Abstract: Most two-year college students in the U.S. take remedial (or developmental) courses, yet their effectiveness remains ambiguous. Remedial classes prepare students for college-level courses by teaching foundational math and literacy skills. On the other hand, they also increase total years spent in college translated into higher foregone earnings as they do not bear credits toward a degree. This paper assesses these two opposite impacts of remediation using an instrumental variable based on U.S. state policy differences in remedial course taking. Results using the NLSY97 transcript data indicate that taking remedial classes induces students to transfer to a four-year college. This channel works mainly through students who would have earned a two-year degree and would not further pursue education. Remediation mostly helps median ability students and does not hinder low ability students' academic progress.

Keywords: developmental courses, postsecondary education, two-year colleges

JEL Codes: I23, I26, I28, J08, J24

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1 Introduction

Remedial (also called developmental) education prepares less-equipped students for college-level courses, and most two-year college students take some form of remediation.[1] It teaches foundational math and literacy skills needed in upper-level classes. However, most remedial courses do not bear credit for a degree and are prerequisites for advanced math and english classes. They extend total years spent in college leading to higher foregone earnings. Therefore, it is not clear whether remediation helps or hinders student achievement.

This paper investigates the impact of remediation on two-year college students using an instrumental variable based on U.S. state-level policy differences in remedial course placement. About one-half of the states in the U.S. have statewide mandatory remediation policy requiring two-year colleges to place students into remediation if they score below a cutoff. The remaining states do not have such a statewide policy, and they provide flexibility to colleges on placement into remediation. It has been found that the mandatory remediation policy increases student probability of taking remedial classes.

Results using the National Longitudinal Survey of Youth 1997 (NLSY97) transcript data indicate that taking developmental education increases one's probability of transferring to a four-year college. This increase is due to those students who would otherwise have earned a two-year degree but would not have transferred to a four-year college. Thus, remediation motivates them to experience four-year college after a two-year degree. On the other hand, remediation has no adverse affect on dropout rates or the number of failed courses.

The majority of the literature on remediation (Martorell and McFarlin (2011), Boatman and Long (2018)) use regression discontinuity design (RDD) to identify the causal impact of remediation. RDD identifies this impact on students around the placement test cutoff scores from either a single institution or a single U.S. state. This method does not allow to assess heterogeneities like whether different levels of pre-collegiate preparation are affected differently. By contrast, this paper uses a novel instrument that has more external validity than the RDD

[1] Two year college and community college is used interchangeably throughout the paper.

as it allows to test how remediation impacts students with different pre-collegiate preparation.

The human capital formation models of Cunha and Heckman (2007) are also relevant to this work as the material covered in remedial classes should have been learned in high school or even earlier. This framework helps to understand whether later-life interventions are effective in building more human capital.

The remaining of the paper proceeds as follows: section 2 gives background information about developmental education and the policy, section 3 presents models on how could remediation affect student outcomes, section 4 introduces datasets and a sample of analysis, section 5 presents results, section 6 checks robustness, and section 7 concludes.

2 Institutional Background

Many high school students in the U.S. graduate without being prepared enough to succeed in college level courses. National Center on Education and the Economy (2013) highlights the disconnect between high school requirements and the demands of college level courses in terms of the course content, and the expectations of the college faculty.

Developmental courses have been used to prepare less-prepared students to college level courses and in most of the cases, they do not count credits towards graduation. Remedial education is usually in reading, writing and mathematics subjects. According to National Center for Education Statistics (NCES) Integrated Postsecondary Education Data System (IPEDS), 89% of public two year colleges offer remedial courses. 68% of students starting at public community colleges took at least one level of developmental course during their enrollment. (Chen (2016))

In the 1950s and early 1960s, community colleges received a sizable share of well-prepared students as the higher education became popular across the country. However, the colleges experienced many blows starting in the late 1960s. Many prestigious universities relaxed their admissions and more financial aids became available to those institutions. Academic abilities of

high school graduates declined severely and the number of academic courses taken by applicants have declined. As a result, "the public community colleges bore the brunt of the poor preparation of students in the twentieth century." (Cohen et al. (2014))

Assessment and placement of these students became the next step consideration. In the 1980s, Florida, Tennessee, Arkansas and Georgia have introduced mandatory assessment and placement policies into remedial courses for those students below a cutoff score. Several other states have followed this trend and by the end of 2000s, about half of the states have implemented mandatory placement policies on developmental education.

The remaining states that do not have statewide policies on remediation have left this decision to community colleges itself. Most of these community colleges still offer remedial courses, but they might have more flexible policies. For example, some community colleges do not place vocational students into remedial courses by assuming that they will not need mathematics and english to learn an occupational skill.

I contacted state higher education boards to collect data on whether a state has a mandatory placement into remedial education, and if yes, which year this policy was implemented. This data is collected for thirty nine states. Twenty three of them have never mandated its community colleges to place students into remediation whereas the remaining sixteen states have implemented this policy at different times. Seven states have started to implement this policy before the NLSY97 sample period and the remaining nine of them have done it after 1997.

Figure 1 presents the collected data. A number of states like Georgia, and Texas have introduced mandatory remediation policy in the 1980s. Many other states have followed them during the 1990s and early 2000s. On the other hand, some other states like Pennsylvania, and New York have never mandated its community colleges to place students into developmental education.

3 Model

There is not a clear theoretical prediction of remediation on student outcomes, but there are a number of way in which it can affect them.

The main mechanism of remediation on student outcomes is its intended impact. It teaches prerequisite material for college level courses. This channel help students to succeed in academic courses when they are equipped with the foundational course material in those subjects. On the other hand, the opportunity cost of remediation can offset this positive impact. Majority of remedial courses do not count credits toward a degree which increase time for graduation. It translates into higher foregone earnings. This additional time of remediation could even be more pronounced in the two-year college context as those students do not have as many years of commitment for higher education as four-year college students do have.

Cunha and Heckman (2007) points critical period and sensitive period for learning certain skills. If these periods are earlier than college-level age for the foundational math, and literacy skills, then remedial courses would not have or would have minimal intended impact. It would further discourage student progression if they realize they have already passed these periods for learning these subjects.

Another potential channel of the impact of remediation on student outcomes is through peer effects. If high ability students positively impact low ability student academic success, then remedial courses would deteriorate student outcomes as they place all low-ability students into a classroom. Relatedly, placing low ability students into a classroom might also stigmatize them and might lead to a stereotype effect.[2]

The final channel of remediation is about the informational asymmetries. First-year students might not be fully aware of the fact that they will be placed into non-credit bearing math, reading, and writing if they score below a cutoff. This unexpected course load would also have negative effects to student success.

[2]Stereotype effect might be one of the reasons why educationists prefer the word developmental instead of remedial.

4 Data and Sample Construction

4.1 Data

4.1.1 NLSY97

NLSY97 is a nationally representative panel survey of 8,984 men and women started in 1997. Interviewees were between the ages of 12 and 16 at the beginning of 1997. They have been interviewed annually until 2011 and biennially thereafter.

Abilities: 79.3% of the NLSY97 interviewees have participated in the Armed Services Vocational Aptitude Battery (ASVAB) test from the summer of 1997 through the spring of 1998. They were around the ages between 13 and 17, so these test scores reflect pre-college abilities. The ASVAB score measures the respondents' knowledge in 12 different areas and they are used to construct student cognitive measure.[3] As respondents were at different ages during the ASVAB test, mean and variance of scores are normalized to their age-specific values following Altonji, Bharadwaj, and Lange (2012).

Transcript Data: The NLSY97 collected college transcripts in 2012-2013. 1,445 respondents had reported a post-secondary enrollment, but declined to provide a waiver. Another 310 of them provided waiver but the transcripts could not be collected. 3,818 of the respondents have at least one post-secondary transcript out of the remaining 4,339 youths. Each course is coded according to 2010 College Course Map guidelines. The data provides course level information about student progression.

Geocode Data: NLSY Geocode data provides information on the name and location of each college attended. It also includes a unique id for each college which allows the data to be merged with another data from the National Center for Education Statistics (NCES) Integrated Postsecondary Education Data System (IPEDS).

[3]Mathematics Knowledge, Word Knowledge, Numerical Operations, Arithmetic Reasoning, Assembling Objects, Auto Information, Coding Speed, Electronics Information, General Science, Mechanical Comprehension, Paragraph Comprehension, Shop Information

4.1.2 IPEDS

IPEDS is an annual data collected by NCES under the U.S. Department of Education. It provides detailed institutional-level information including type, size, tuition, student-faculty ratio, faculty salary information. The latter two variables proxies institutional quality information

4.2 Sample Construction

According to the NLSY97, there are 2,750 individuals with reported two-year college enrollment and NLSY97 transcript data has 2,415 students who have taken at least a course in a community college [4]; 1,988 of them have valid ASVAB scores in all twelve areas. 249 students have either missing state information or their state level policy have not collected yet. 198 students do not have college level information from the NCES IPEDS data so the final sample consists of the remaining 1,541 individuals. One observation per individual is used throughout the analysis and this observation is the first calendar year of enrollment to a two-year college. First-year of the college is vital as most students take remedial classes within that year.

Table 1 presents the summary statistics for the sample and the mean values for the two subgroups: remedial course takers vs non-remedial course takers.[5] The table also presents differences in means between the two subgroups and p-values from a t-test to observe whether the group differences are significant. The variables are grouped into four categories as individual, family, high school, and community college. In sum, the table presents some evidence that non-remedial students start college with certain advantages like having higher Asvab cognitive ability, higher family income, and better high school grades.

[4]NLSY97 college enrollees is calculated up to the year 2011. This is done to compare with the transcript data which was collected between 2012-2013. 1,719 students have both reported two-year college enrollment status and their corresponding transcript. 1031 respondents have reported a two-year college enrollment but do not have a transcript. 696 individuals have not reported a two-year college enrollment, but have a transcript from a two-year college.

[5]301 students have enrollment into two community colleges. These two college information is combined and their first two-year college information is used for the college level variables. Most of these students have taken remedial classes in the first institution.

4.3 Dependent Variables

The dependent variables are grouped into four categories as presented in Table 2 for the sample as well as remedial and non-remedial students. Transfer is transfer into a four-year college, and it is identified from the transcript data. If a student has a four-year college transcript in addition to a two-year college one and if the four-year college transcript indicates transferred credits, then the student is classified as transfer. A student is categorized as dropout if the student has not transferred, obtained a degree, earned a certificate, or enrolled to a two-year college before 2009. As the transcripts have collected in 2012-2013 period, two-year college students enrolled after 2009 are not classified as dropout even if they have not earned anything. Thus, a student can either transfer and/or obtain a degree, or dropout, or earn a certificate, or enrolled after 2009. GPA, credit, and course variables are obtained from the transcripts. Few students have enrollment into two two-year colleges, and combined final GPA and combined total credits combine those measures from the two institutions.

Main outcome variables indicate that about 40% of students have either transfer into a four-year college, or have earned an associate's degree. This ratio is similar between remedial and non-remedial students. However, majority of non-remedial students transfer into a four-year college without earning an associate's degree, whereas many of the remedial students earn an associate's degree and transfer into a four-year college simultaneously. As a result, 23% of remedial course takers have earned a degree, whereas only 10% of non-remedial ones have earned it.

All GPA variables indicate that non-remedial students have higher GPA, and the credits variables show that remedial students spend more time in the college, and they take more credits. Although remedial students take more courses, they fail more courses. On average, remedial students fail 25% of their courses whereas, non-remedial students fail 19% of their courses. Remedial classes have 40% ratio of failure indicating that these courses might be more difficult to pass as compared to the remaining courses.

5 Results

5.1 First-Stage Estimates

The impact of mandatory remediation policy on remedial course taking is estimated by the following equation:

$$Remediation_{ijst} = \delta \cdot MRP_{st} + \beta \cdot X_i + \gamma \cdot W_j + \kappa_s + \mu_t + \omega_{ijst} \quad (1)$$

where i represents person, j is institution, t is the calendar year of the first year in college, and s is state. Remediation$_{ijst}$ indicates remediation status and MRP$_{st}$ shows whether students' college is in a mandatory remediation policy state or not at the calendar year of college entrance. Individual control variables, X_i and institutional control variables W_j consist of the variables presented in Table 1. State and year fixed effects (κ_s and μ_t) enable to identify the remediation parameter ,δ, from the different timing of within-state changes in mandatory remediation status.

Table 3 presents the estimation results for the MRP variable. The table adds control variables sequentially. All columns indicate that mandatory remediation policy has increased one's probability of taking remedial courses by about 20%. The last column is taken to be the ideal first-stage equation as it has the highest R-squared. The equation (1) is also estimated for lagged MRP values to understand whether colleges have implemented these policies immediately or some time later. The results, not shown here, indicate that most of them have implemented these policies at the state implementation dates.

5.2 Main Results

The following equations are estimated to understand the impact of remedial course taking on academic outcomes

$$Remediation_{ijst} = \delta \cdot MRP_{st} + \beta \cdot X_i + \gamma \cdot W_j + \kappa_s + \mu_t + \omega_{ijst} \tag{2}$$

$$Y_{ijst} = \phi \cdot \widehat{Remediation}_{ijst} + \pi \cdot X_i + \alpha \cdot W_j + \rho_s + \tau_t + \upsilon_{ijst} \tag{3}$$

where Y_{ijst} consists of different academic outcomes presented in Table 2 and the remaining variables are same as in the first-stage equation (1).

Table 4 presents the coefficient estimates of the Remediation variable for the main outcome variables. The results indicate that taking remedial courses increase students' probability to transfer into a four-year college. The table shows that those students who would obtain a two-year degree and would not transfer to four-year college are induced into transferring into four year college after earning a two-year degree.

Table 5 presents the estimated coefficients for the other academic outcomes like credits or GPA. Panel A indicates that taking remediation does not impact persistence measures like total completed credits, total number of courses taken, or total number of failed courses. Rather, remediation affects academic performance measures like it increases total number of credits completed in the first year, the final GPA, or the total number of failed STEM courses.

5.3 Subgroup Analysis

This section provides subgroup analysis by Asvab cognitive ability level. Comparing different cognitive ability levels shed more light on whether low ability individuals, and middle ability individuals benefit differently from remediation such that those scored just below the threshold level might be performing poorly but those low ability students might be the ones benefiting from remediation.

Table 6 stratifies the sample into different quintiles by Asvab cognitive score and presents

the estimates of Remediation variable. The results from the table support the main results. The lowest ability students do not benefit much from remediation nor they are adversely affected by it. Rather, those students with middle cognitive ability level benefit the most. They are induced into four-year college after obtaining their degree as opposed to just earning an associate's degree.

6 Robustness Checks

This section provides two types of robustness checks. The first one is about the instrument, mandatory remediation policy, and the second one is about the sample of analysis.

6.1 Instrument Validity

6.1.1 Exclusion Restriction

States might have enacted a bundle of policies to improve two year college quality together with the mandatory remediation policy. Therefore, some of those other policies might have improved several measures in community colleges, and it would improve academic outcomes besides the impact of remedial courses. This would cast doubt on the exclusion restriction of the instrument.

To this end, the following equation is estimated:

$$StateGrantAid_{ijst} = \delta \cdot MRP_{st} + \beta \cdot X_i + \gamma \cdot W_j + \kappa_s + \mu_t + \omega_{ijst} \tag{4}$$

where StateGrantAid is the total grant aid received by the institution. All the remaining variables and the subscripts are the same as in the first-stage equation (1).

Table 7 presents the estimated coefficient for the MRP variable. Although the variable is positive, it is not statistically significant at the conventional level. This would indicate that states have not increased their fundings to community colleges when they have passed their mandatory remediation policies.

6.1.2 Falsification Test

State mandatory remediation policy should not have any impact on high ability students. Those students should be able to start to college level courses irrespective of the state remedial policy . To this end, students are divided into two groups based on their cognitive ability.[6] First stage equation (1) is estimated for these two groups separately.

The results presented in Table 8 show that those students who are below the median cognitive level are more likely to take remedial classes if they live in mandatory remedial state. On the other hand, the MRP variable has no impact onto remedial course taking behavior for high cognitive students. For them, the important variable is their cognitive abilities but not the state policy.

6.1.3 Difference in Differences Test

Six states have changed their remedial education policy after 2000 and twenty three states have never had a mandatory remediation policy. The latter group is used as a control group and the former ones are used for the treatment group.

The following equations are estimated to understand how the policy change impacted state-level variables:

$$RemedialRatio_{st} = \sum_{j=-5}^{6} \delta_j \cdot MRP_{st}^{j} + \beta \cdot X_{st} + \gamma \cdot W_{st} + \kappa_s + \mu_t + \omega_{ijst} \tag{5}$$

where s is state and t is time to policy. RemedialRatio is the ratio of remedial course takers among the community college students and the remaining variables are the state level averages of the equation (1). The first lag is omitted to capture the baseline differences.

Figure 2 indicates that the policy change has increased the percentage of remedial course takers among the community college students in mandatory remediation states. It further remained high even after six years of the policy change.

[6]Different partitions like quartiles, quintiles give similar results. Two groups below and above the median is provided for its convenience.

6.2 Endogeneity of the Sample

This section uses the entire NLSY97 sample with valid asvab scores, and valid MRP data. One observation per individual is chosen and it is the year after the last year in high school. This is chosen to understand how recent high-school graduates or dropouts post-secondary enrollment decisions are being affected by the policy change.

6.2.1 Falsification Tests

Mandatory remediation policy might have increased the number of community college enrollees. As a result, more people in mandatory remediation states would take remedial courses. To test this argument, the following equation is estimated

$$CommunityCollege_{ijst} = \delta \cdot MRP_{st} + \beta \cdot X_i + \kappa_s + \mu_t + \omega_{ijst} \tag{6}$$

where CommunityCollege indicates enrollment to a community college. It takes a value of 1 if someone is enrolled, and 0 otherwise. All the remaining variables are the same as in first-stage equation (1). The only difference is that controls for school characteristics are missing as the sample is the entire NLSY97 irrespective of schooling status.

Table 9 presents the estimated coefficient for the MRP variable. The coefficient is small and insignificant at the conventional level. It supports the claim that this policy has not increased the percentage of community college enrollees, rather it increased the percentage of remedial course takers among the enrollees.

One of the other concerns might be mandatory remediation states might have different community college population that non-mandatory remediation states. For example, if community college students in mandatory remediation states have higher cognitive abilities, they would have better outcomes even without the impact of remedial courses. To observe differences between students in mandatory remediation states vs non mandatory remediation states, the first-stage equation (1) is estimated with the dependent variable being the individual control variables as

the following:

$$IndividualControls_{ijst} = \delta \cdot MRP_{st} + \beta \cdot X_i + \gamma \cdot W_j + \kappa_s + \mu_t + \omega_{ijst} \tag{7}$$

where IndividualControls are the covariates that are presented in summary statistics Table 1.

Table 10 indicates that the main differences between these two populations are about the type of residences. Those students in MRP are more likely to be in urban residences, and they are less likely to be in MSAs. Cognitive, race, sex, age, and household characteristics between these two types of states are not significantly different from one another. This would provide some evidence that students in MRP and non-MRP are not very different.

6.2.2 Difference in Differences Test

States can be compared with respect to their ratio of community college enrollees among the entire population. The following equation is estimated to understand this:

$$CCRatio_{st} = \sum_{j=-5}^{6} \delta_j \cdot MRP_{st}^{j} + \beta \cdot X_{st} + \kappa_s + \mu_t + \omega_{ijst} \tag{8}$$

where CCRatio is the ratio of community college students divided by the entire population. The remaining controls are the state level averages of the variables in equation (7).

Figure 3 indicates that mandatory remediation states have not seen a significant change in their percentage community college students after the policy change. This further presents evidence that the policy change has not affected the decision to enroll in community colleges.

7 Conclusion

Millions of students take remediation in U.S. two-year institutions each year and the cost of remediation is considerable. However, there is a disagreement on who should take remediation or even whether students need to take it. This study investigates college remediation from a

multidimensional ability perspective.

This paper assesses the causal impact of remediation on two-year college student achievement. Remedial course taking is instrumented with statewide policies mandating two-year colleges to place students based on certain assessment. The first stage of the instrumental variable indicates that this policy has increased the number of students taking remedial courses. The IV results show that developmental education rises one's likelihood of transferring to a four-year college. It induces those students who would have otherwise earned a two-year degree but would not further pursue studies. Results from the ability stratified version support this claim as showing those on the median level of cognitive ability benefit most from these courses, and the other ability groups are not affected much by taking remediation.

These results indicate a positive impact of remediation on student academic achievement, especially those at the median pre-college preparation. Further studies are needed to understand which theoretical model aligns well with the empirical evidence presented in this paper.

8 References

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Table 1: Summary Statistics of Two-Year College Students, NLSY97 Data

	(1) **All Sample**	(2) **Remedial**	(3) **Non-Remedial**	(4) **Difference**	(5) **p-values**
Variable	Mean	Mean	Mean	Mean	
Individual					
Asvab cognitive	0.48	0.46	0.50	-0.04	0.0000
Women	0.55	0.57	0.51	0.06	0.0228
Pregnant	0.07	0.09	0.04	0.04	0.0006
Child	0.16	0.17	0.14	0.03	0.0593
Living with partner	0.17	0.16	0.18	-0.02	0.3328
Age	20.35	20.06	20.91	-0.84	0.0000
Time: full-time	0.33	0.39	0.22	0.17	0.0000
Time: part-time	0.22	0.20	0.28	-0.08	0.0010
Urban: Urban	0.77	0.78	0.75	0.03	0.2451
Urban: Rural	0.19	0.18	0.22	-0.03	0.1414
Race: White	0.54	0.50	0.61	-0.10	0.0001
Race: Black	0.23	0.26	0.18	0.08	0.0002
Race: Hispanic	0.22	0.22	0.21	0.01	0.5313
MS: Not married, cohab	0.09	0.09	0.10	-0.01	0.4423
MS: Not married, not cohab	0.81	0.82	0.79	0.03	0.2057
MS: Married, with spouse	0.07	0.07	0.08	-0.01	0.5077
MSA: in central city	0.34	0.35	0.34	0.01	0.6729
MSA: not in central city	0.52	0.51	0.54	-0.03	0.2319
MSA: not in MSA	0.13	0.13	0.12	0.01	0.5140
Health: Excellent	0.32	0.32	0.33	0.00	0.9348
Health: Very Good	0.36	0.34	0.39	-0.05	0.0359
Health: Good	0.24	0.26	0.21	0.06	0.0104
Health: Fair	0.07	0.07	0.07	0.00	0.9977
Mental Health Scale (2000)	14.24	15.15	15.41	-0.26	0.0405
Delinquency Score Index	2.35	2.34	2.38	-0.04	0.5286
Substance Use Index	1.90	1.91	1.88	0.03	0.3832
Family					
Family Income	$58,084	$53,672	$66,782	-$13,110	0.0000
Household Size	3.77	3.84	3.63	0.21	0.0147
Members Under Six	0.25	0.26	0.23	0.03	0.3039
Members Under Eighteen	0.90	0.96	0.78	0.18	0.0033
Mother's Education	12.88	12.77	13.09	-0.32	0.0839
Father's Education	12.88	12.71	13.23	-0.52	0.0151
Observations	1,541	1,022	519		

Notes: This table reports summary statistics for the whole sample as well as two subgroups. Remedial column consists of individuals who have taken at least one remedial course, and Non-Remedial column consists of students without any remedial courses. Non-Remedial students have only taken college-level courses.

Summary Statistics of Two-Year College Students, NLSY97 Data

	(1)	(2)	(3)	(4)	(5)
	All Sample	**Remedial**	**Non-Remedial**	**Difference**	**p-values**
Variable	Mean	Mean	Mean	Mean	
High School					
Diploma	0.87	0.88	0.86	0.02	0.3706
Grades: Mostly As	0.12	0.09	0.19	-0.11	0.0000
Grades: Half As and half Bs	0.24	0.24	0.25	-0.01	0.5229
Grades: Mostly Bs	0.18	0.19	0.16	0.03	0.1438
Grades: Half Bs and half Cs	0.25	0.27	0.21	0.07	0.0034
Grades: Mostly Cs	0.11	0.11	0.11	0.00	0.9410
Grades: Half Cs and half Ds	0.04	0.04	0.03	0.02	0.0351
Grades: As to Cs	0.03	0.03	0.03	0.00	0.7015
Type: Public	0.87	0.87	0.87	0.00	0.8326
Type: Private, not parochial	0.03	0.03	0.04	-0.01	0.2432
Size: 100-299 students	0.04	0.03	0.04	-0.01	0.4373
Size: 300-499 students	0.08	0.09	0.07	0.02	0.1331
Size: 500-749 students	0.10	0.10	0.09	0.01	0.6479
Size: 750-999 students	0.08	0.08	0.07	0.00	0.7256
Size: 1000+ students	0.60	0.59	0.62	-0.04	0.1617
Student-teacher ratio: < 14	0.25	0.26	0.24	0.03	0.2629
Student-teacher ratio: 14-17	0.27	0.26	0.28	-0.02	0.4426
Student-teacher ratio: 18-21	0.21	0.20	0.24	-0.03	0.1583
Student-teacher ratio: ≥ 22	0.17	0.17	0.16	0.01	0.7904
College					
Type: Public	0.95	0.97	0.90	0.07	0.0000
Type: Private for profit	0.04	0.02	0.08	-0.06	0.0000
Size: 0-999 students	0.05	0.04	0.09	-0.05	0.0004
Size: 1,000-4,999 students	0.25	0.25	0.23	0.03	0.2423
Size: 5,000-9,999 students	0.22	0.24	0.18	0.05	0.0135
Size: 10,000-19,999 students	0.30	0.29	0.32	-0.03	0.1928
Size: 20,000+ students	0.17	0.18	0.16	0.02	0.4251
Student-faculty ratio	20.70	20.70	20.67	0.03	0.9380
Faculty salary	\$53,531	\$53,059	\$54,462	-\$1,403	0.0352
In-state tuition	\$1,735	\$1,645	\$1,910	-\$268	0.0064
Observations	1,541	1,022	519		

Notes: This table reports summary statistics for the whole sample as well as two subgroups. Remedial column consists of individuals who have taken at least one remedial course, and Non-Remedial column consists of students without any remedial courses. Non-Remedial students have only taken college-level courses.

Table 2: Summary Statistics of Outcome Variables

	(1) **All Sample**	(2) **Remedial**	(3) **Non-Remedial**	(4) **Difference**	(5) **p-values**
Variables	Mean	Mean	Mean	Mean	
Main Outcomes					
Transfer without degree	0.21	0.17	0.30	-0.13	0.0000
Transfer and degree	0.09	0.12	0.05	0.07	0.0000
Degree without transfer	0.09	0.12	0.05	0.06	0.0000
Dropout	0.50	0.50	0.49	0.02	0.5423
Only Certificate	0.06	0.06	0.07	-0.01	0.5174
Currently Enrolled	0.04	0.03	0.04	-0.01	0.4265
Total	1.00	1.00	1.00	0.00	
GPA					
Final GPA	2.20	2.17	2.27	-0.10	0.1591
Combined final GPA	2.34	2.33	2.36	-0.04	0.6260
First-year GPA	2.07	2.01	2.20	-0.19	0.0167
First two-years GPA	1.99	1.90	2.18	-0.28	0.0002
STEM GPA	1.94	1.79	2.29	-0.50	0.0000
Math GPA	1.85	1.69	2.29	-0.60	0.0000
Credits					
Total credits	31.99	36.88	22.34	14.54	0.0000
Combined total credits	43.93	53.12	25.81	27.31	0.0000
First year credits	7.71	8.07	7.00	1.07	0.0156
First two-years credits	16.06	17.92	12.39	5.53	0.0000
Courses					
Number of Courses	17.99	21.86	10.38	11.48	0.0000
Number of Failed Courses	4.27	5.45	1.94	3.51	0.0000
# of Remedial Courses	2.19	3.30	0.00	3.30	0.0000
# Failed Remedial Courses	0.88	1.32	0.00	1.32	0.0000
STEM Course Takers	0.60	0.64	0.52	0.12	0.0000
Number of STEM Courses	2.06	2.42	1.35	1.08	0.0000
Failed STEM Courses	0.43	0.52	0.26	0.27	0.0000
Math Course Takers	0.35	0.39	0.28	0.11	0.0000
Number of math courses	0.62	0.70	0.45	0.25	0.0001
Failed math courses	0.16	0.19	0.08	0.11	0.0000
Total semesters	5.10	5.83	3.66	2.18	0.0000
Observations	1,541	1,022	519		

Notes: This table reports summary statistics of outcome variables for the whole sample as well as two subgroups. Remedial column consists of individuals who have taken at least one remedial course, and Non-Remedial column consists of students without any remedial courses. Transfer is defined as those who have transferred into a four-year college from a two-year college. Dropout is 1 if a person has not earned any degree, certificate, or has not transferred into a four-year college and enrolled in a college in 2009 or earlier. Transcripts have collected during 2012-13, those who have enrolled 2010 or later are not classified into these outcome variables as they are considered in progress. Combined final GPA and combined total credits merge these statistics for those students who have two two-year college enrollment. STEM and Math GPAs are calculated for those who have taken these type of courses. # is a shortening for "number".

Table 3: The Effect of Mandatory Remediation Policy on Remedial Course Taking

Dependent Variable :	All Sample Remediation$_{ijst}$				
	(1)	(2)	(3)	(4)	(5)
MRP	0.1936***	0.1713***	0.1739***	0.1743***	0.2022***
	(0.0605)	(0.0519)	(0.0517)	(0.0549)	(0.0588)
Constant	1.0574***	2.0074***	1.9745***	2.1058***	2.7924***
	(0.0587)	(0.2185)	(0.2142)	(0.2322)	(0.2132)
Year Fixed Effect	✓	✓	✓	✓	✓
State Fixed Effect	✓	✓	✓	✓	✓
Individual Controls	X	✓	✓	✓	✓
Family Controls	X	X	✓	✓	✓
High-School Controls	X	X	X	✓	✓
College Controls	X	X	X	X	✓
R^2	0.0788	0.1311	0.1394	0.1538	0.1838
N	1,541	1,541	1,541	1,541	1,541

Notes: This table reports a linear probability model where MRP is a dummy variable representing mandatory remediation status of a state. Remediation is also a dummy variable representing whether remedial courses have taken. Regressors sequentially include variables presented in Table 1. Their estimated coefficients are suppressed. Standard errors are clustered at the state level and they are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: The Effect of Remediation on Main Academic Outcomes

	(1)	(2)	(3)	(4)
Panel A		**IV**		
		All Sample		
Dependent Variable :	$\text{TRwithoutDGR}_{ijst}$	DGRandTR_{ijst}	$\text{DGRwithoutTR}_{ijst}$	Dropout_{ijst}
Remediation	0.2171	0.2959*	-0.4917**	-0.1816
	(0.1845)	(0.1656)	(0.1945)	(0.3891)
First-stage F-stat	11.82	11.82	11.82	11.82
A-R Wald Test	1.22	7.23	4.22	0.22
N	1,541	1,541	1,541	1,541
Year Fixed Effect	✓	✓	✓	✓
State Fixed Effect	✓	✓	✓	✓
Individual Controls	✓	✓	✓	✓
Family Controls	✓	✓	✓	✓
High-School Controls	✓	✓	✓	✓
College Controls	✓	✓	✓	✓

Notes: This table reports an instrumental variable linear probability model. TRwithoutDGR means transfer to a four-year college without obtaining a two-year college degree, DGRandTR means obtaining a two-year degree and then transferring to a four-year college, and DGRwithoutTR means earning a two-year degree without transferring to a four-year college. Someone is classified as dropout if no transfer, degree, certificate have occurred, and not currently enrolled in the college.

Table 5: The Effect of Remediation on Academic Outcomes

	(1)	(2)	(3)
		IV	
Panel A		All Sample	
Dependent Vrb. :	Total Credits$_{ijst}$	NumberofCoursesTaken$_{ijst}$	NumberofFailedCourses$_{ijst}$
Remediation	1.3158	-0.9317	4.3763
	(10.3671)	(5.5184)	(2.8846)
A-R Wald Test	0.01	0.03	1.91
		IV	
Panel B		All Sample	
Dependent Vrb. :	CreditsFirstYear$_{ijst}$	Final GPA$_{ijst}$	NumberofFailedSTEM$_{ijst}$
Remediation	20.0636***	2.1830***	-1.4261**
	(5.5382)	(0.6525)	(0.5654)
A-R Wald Test	11.54	11.06	5.98
Year Fixed Effect	✓	✓	✓
State Fixed Effect	✓	✓	✓
Individual Controls	✓	✓	✓
Family Controls	✓	✓	✓
High-School Controls	✓	✓	✓
College Controls	✓	✓	✓

Notes: This table reports an instrumental variable linear probability model. NumberofFailedSTEM means number of failed STEM courses. It is only estimated to those students who have taken STEM courses. STEM courses are identified using the two-digit codes in the 2010 College Course Map by National Center of Education Statistics.

Table 6: The Effect of Remediation on Academic Outcomes by Cognitive Ability Level

		(1)	(2)	(3)	(4)
Asvab Cognitive			**IV**		
Quintile	Dep. Vrb.	TRwithoutDGR$_{ijst}$	DGRandTR$_{ijst}$	DGRwithoutTR$_{ijst}$	Dropout$_{ijst}$
Bottom	Rem.	0.9703*	0.2669	-0.4789	0.2807
		(0.5445)	(0.2371)	(0.3466)	(0.4312)
Bottom Two	Rem.	0.3367	0.8510**	-0.7149***	-0.3903
		(0.2863)	(0.3448)	(0.2560)	(0.3272)
Bottom Three	Rem.	0.7454***	0.5149***	-1.1930***	0.0108
		(0.2922)	(0.1648)	(0.3952)	(0.2366)
Bottom Four	Rem.	0.7538***	0.0422	-0.4172*	-0.4952
		(0.2172)	(0.1600)	(0.2361)	(0.3917)
All Sample	Rem.	0.2171	0.2959*	-0.4917**	-0.1816
		(0.1845)	(0.1656)	(0.1945)	(0.3891)
All Controls		✓	✓	✓	✓

Notes: This table stratifies the sample according to the Asvab cognitive scores. Only coefficients of remediation variable is presented.

Table 7: The Effect of Mandatory Remediation Policy on Average Amount of State Grant Aid Received

	(1)
	All Sample
Dependent Variable :	$\text{StateGrantAid}_{ijst}$
MRP	13.8531
	(54.3457)
Constant	314.4272
	(280.6941)
All Controls	✓
R^2	0.3117
N	1,494

Notes: This table reports a regression model where MRP is a dummy variable representing mandatory remediation status of a state. StateGrantAid is a numeric variable from NCES IPEDs data on the average amount of state grant aid received in a year. Standard errors are clustered at the state level and they are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: The Effect of Mandatory Remediation Policy on Remedial Course Taking

	(1)	(2)
	Below Median	Above Median
Dependent Variable :	Remediation$_{ijst}$	Remediation$_{ijst}$
MRP	0.2786***	0.0405
	(0.0932)	(0.0703)
ASVAB Cognitive	-0.1002	-1.0813***
	(0.2275)	(0.2213)
Constant	2.3076***	3.2354***
	(0.2540)	(0.3510)
All Controls	✓	✓
R^2	0.2463	0.2066
N	771	770

Notes: This table reports a linear probability model where MRP is a dummy variable representing mandatory remediation status of a state. Remediation is a dummy variable representing whether remedial courses have taken. Cognitive measure is constructed using the 12 Asvab scores in the NLSY97 data. Standard errors are clustered at the state level and they are in parentheses. * $p < 0.10$,** $p < 0.05$, *** $p < 0.01$

Table 9: The Effect of Mandatory Remediation Policy on Community College Enrollment

	(1)
Dependent Variable :	TwoYearCollegeEnrollment$_{ijst}$
MRP	0.0119
	(0.1095)
Constant	0.1156
	(0.0749)
Individual Controls	✓
HS Controls	✓
Year FE	✓
State FE	✓
R^2	0.0455
N	5,131

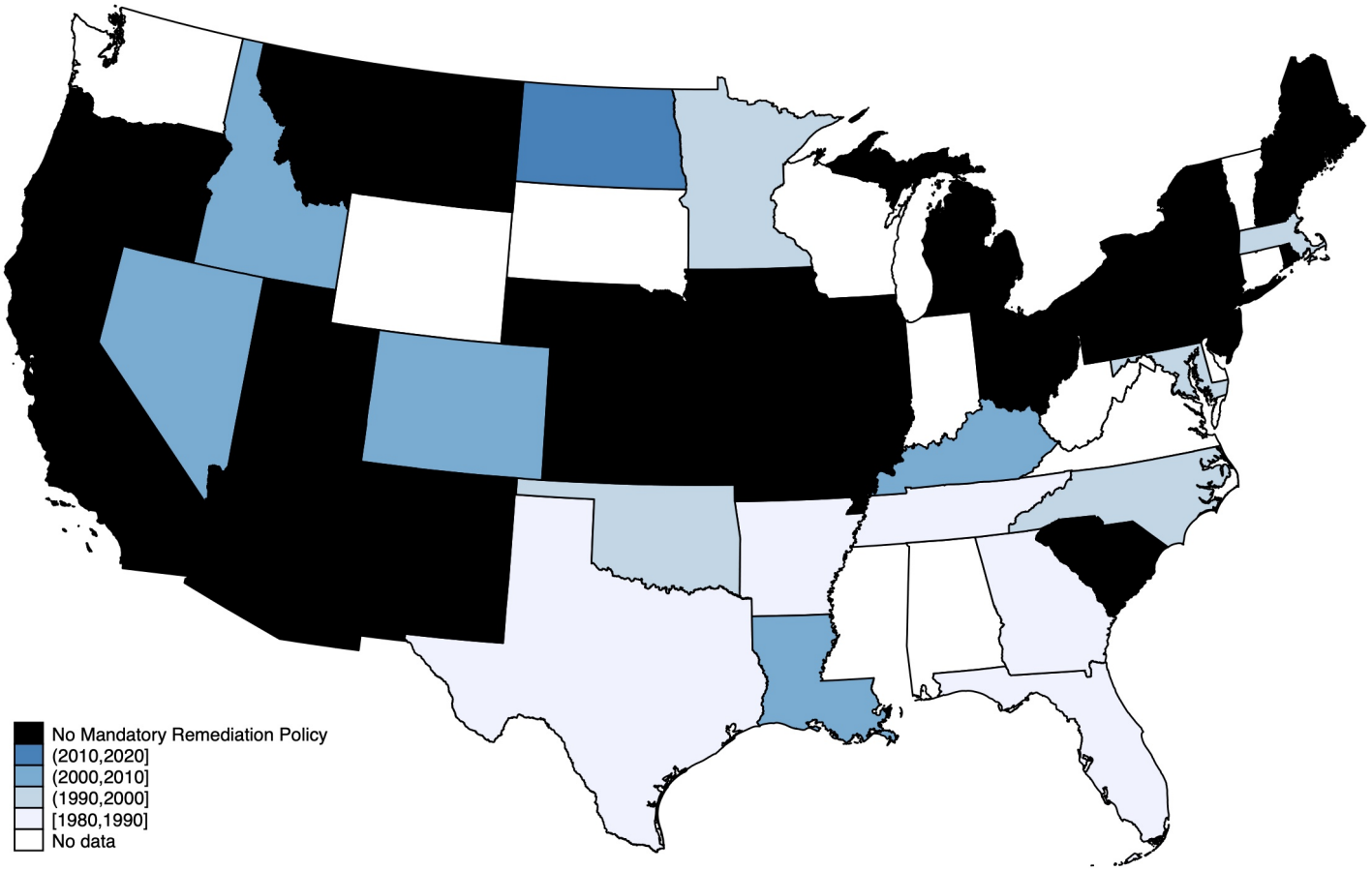
Notes: This table reports a linear probability model where MRP is a dummy variable representing mandatory remediation status of a state. Community College is also a dummy variable taking the value 1 if ever enrolled to a community college. Standard errors are clustered at the state-level and they are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: The Effect of Mandatory Remediation Policy on Covariates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable :	$ASVAB_{ijst}$	Men_{ijst}	$White_{ijst}$	$Black_{ijst}$	$Hisp._{ijst}$	Age_{ijst}	$Urban_{ijst}$	MSA_{ijst}	$HHSize_{ijst}$
MRP	-0.0234	0.1008	-0.0415	-0.0217	-0.0629	0.0145	0.1985***	-0.1415***	-0.2318
	(0.0224)	(0.0736)	(0.0423)	(0.0327)	0.0503	(0.1308)	(0.0729)	(0.0543)	(0.3053)
Constant	0.6429***	0.3434	0.9428***	0.2925*	-0.2655*	16.2895***	0.3313*	2.5406***	5.1228***
	(0.0594)	0.2125	(0.1940)	(0.1681)	(0.1412)	(0.3900)	(0.1989)	(0.3208)	(0.7129)
Individual Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
HS Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
College Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
State FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
R^2	0.2173	0.0603	0.3006	0.2912	0.2370	0.8698	0.2659	0.3619	0.1469
N	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530

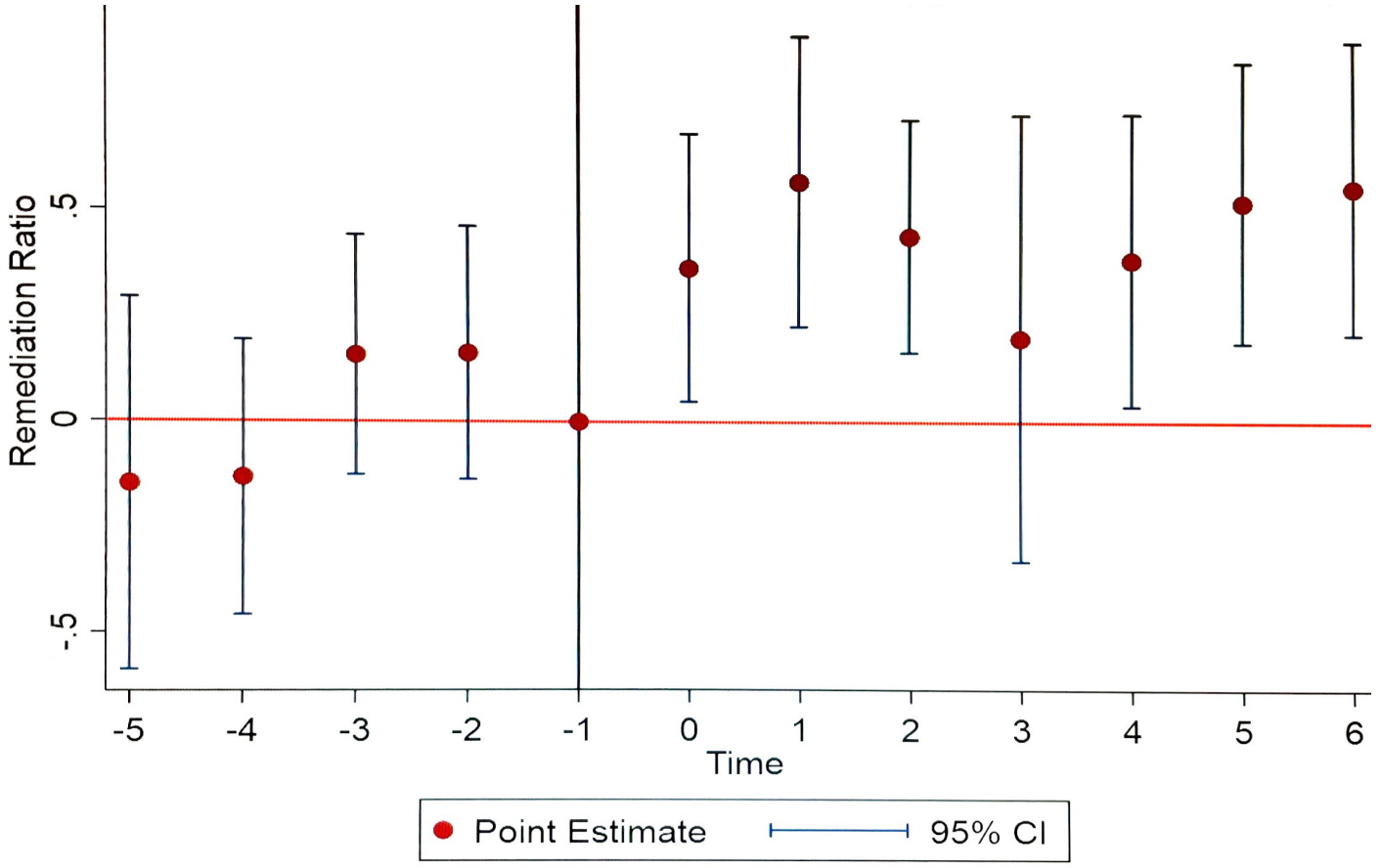
Notes: This table reports simple linear regression or linear probability models. MRP is a dummy variable representing mandatory remediation status of a state. ASVAB is the cognitive measure constructed from the 12 Asvab scores in NLSY97 data. Men is a dummy variable on gender. White, Black, and Hisp. are all dummy variables on race. Age is the age on the first-year in a community college. Urban is a dummy variable on urban-rural status, MSA is a dummy variable on metropolitan statistical area status, HHSize is the household size on the first-year of community college. Standard errors are clustered at the state-level, and they are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1. State Policies on Mandatory Placement into Developmental Education



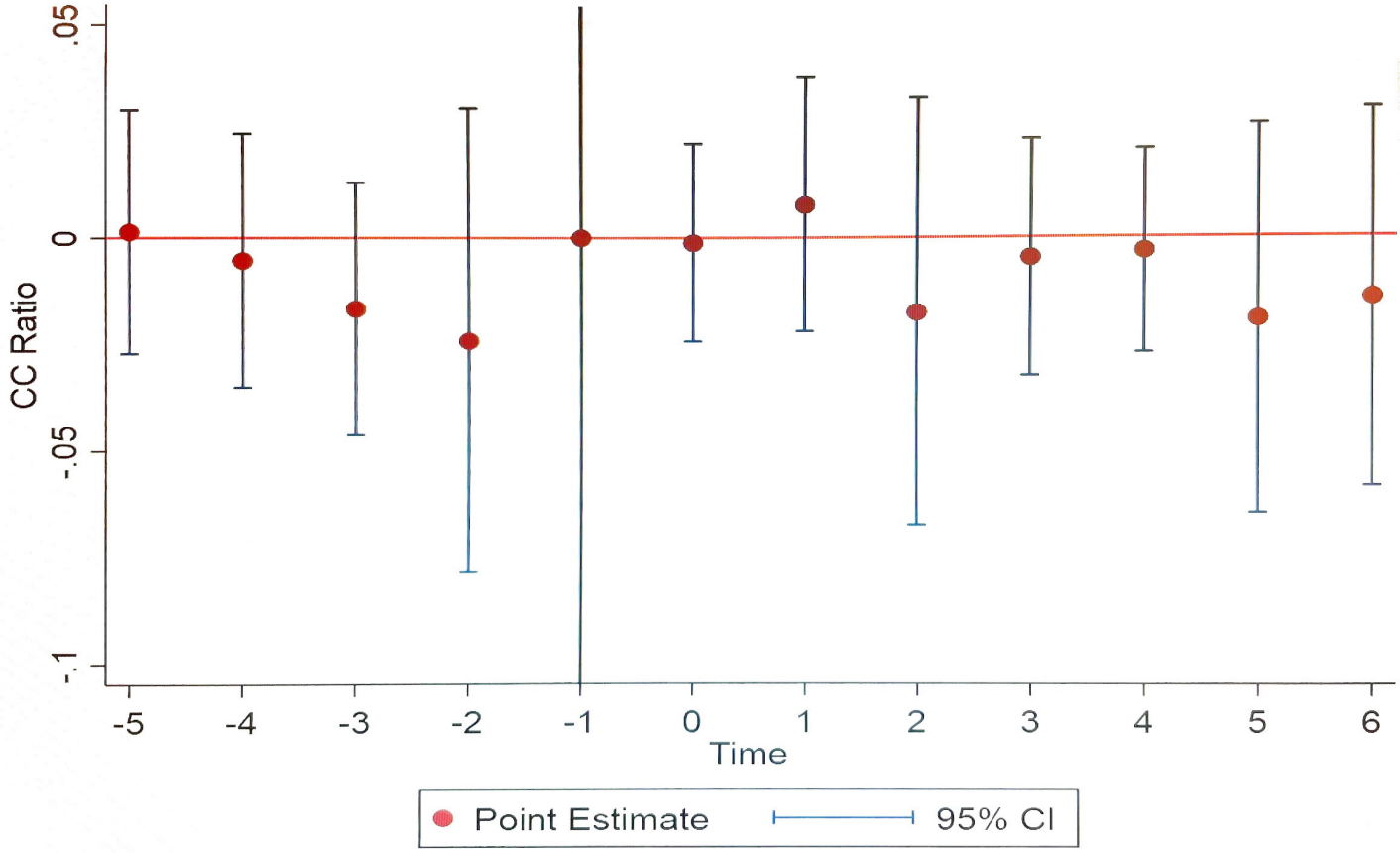
Notes: This figure shows the collected data via phone interviews with the state higher education board staffs combined with the sources below. The numbers indicate the implementation date of the policy. 12 states do not have the mandatory remediation policy data yet.
Sources: Prince (2005), Dougherty and Reid (2007), Fulton (2012), and phone interviews

Figure 2. Event Study on the Mandatory Remedial Policy Change on Remediation



Notes: This figure shows difference in the ratio of remedial course takers over the two-year college students between the states that have implemented the policy vs. those who have not implemented it. Year -1 is taken to be the base year. 0 is the time of policy implementation.

Figure 3. Event Study on the Mandatory Remedial Policy Change on Enrollment



Notes: This figure shows difference in the ratio of two year college enrollment among the high school students between the states that have implemented the policy vs. those who have not implemented it. Year -1 is taken to be the base year. 0 is the time of policy implementation.