The Effect of Bilingual Education on Long-Run Outcomes and Spillover Effects*

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Abstract

We estimate the impact of bilingual education programs for English language learners (ELL) in first grade on high school graduation and college enrollment rates using a regression discontinuity design and administrative data. School districts in Texas are required to provide a bilingual education program in first grade when there are at least twenty ELL students with the same home language. This generates quasi-random exposure to bilingual education in first grade around this threshold. We do not find any statistically significant effect of bilingual education in first grade on elementary or middle school standardized test scores, but it increases the four-year university enrollment rate of ELL and non-ELL students by 6.4 p.p. (49%) and 6.8 p.p. (30%), respectively. These effects for both groups suggest that bilingual education has positive effects that are not well measured by short-run test scores and spill-over to the outcomes on non-ELL students.

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1 Introduction

A large and growing share of students in the United States arrive at school as English language learners (ELL), typically because they speak another language at home. In Fall 2020, 15% of public school first-graders were classified as ELL, and 76% of these students spoke Spanish as a first language [NCES [2023]]. Large achievement gaps between ELL and non-ELL students make it crucial for policy-makers to understand how to best educate these students [NCES [2018]]. This policy discussion has often focused on whether on not ELL students should be taught via their native language in separate classrooms known as bilingual education programs or in English-only classrooms with ELL and non-ELL students together known as English as a Second Language (ESL) programs.

There are a myriad of factors to consider when evaluating these education programs. Proponents of bilingual education argue that ELL students learn the core curriculum more effectively in their native language and have a more positive experience in school. However, bilingual education may slow the acquisition of English and harm ELL students in the long-run when they transition back to English-only classrooms. This debate emphasizes the importance of understanding not only the contemporaneous impact of bilingual education programs but also students' long-run outcomes. Nevertheless, most previous research has focused on short-run outcomes such as standardized test scores and has little to say about long-run achievement [Matsudaira [2005], Chin et al. [2013], Pope [2016]]. Because these program change the classmates for non-ELL students, it is also important to consider how these programs impact their outcomes as well.

In this paper, we study how bilingual education programs in first grade affect the future high school graduation and college enrollment rates of both ELL and non-ELL students. Our analysis focuses on Texas, where school districts are required to provide bilingual education in first grade if there are at least twenty ELL students with the same home language. This generates quasi-random variation in first-graders' exposure to bilingual education around this threshold. Chin et al. [2013] previously used this policy variation to estimate the impact of bilingual education in first grade on standardized test scores in elementary school for ELL and non-ELL students. Building on their work, we use administrative records from the Texas Education Research Center (ERC) that allows us to link first grade students to their future high school graduation and college enrollment records to estimate the impact of bilingual education on long-run outcomes. Using a fuzzy regression discontinuity regression, we do not find any statistically significant effect of bilingual education in first grade on elementary or middle school test scores, but we do find that it increases the four-year college enrollment rate of ELL and non-ELL students by 6.4 p.p. (49%) and 6.8 p.p. (30%), respectively.

These results suggest that bilingual education programs have positive effects that are not well measured by short-run test scores and spill-over to the outcomes of non-ELL students.

First, we verify that the twenty ELL student cut-off is a valid instrument for the provision of bilingual education in first grade as in Chin et al. [2013]. Because the vast majority of ELL students in Texas speak Spanish as a home language, we focus on the number of ELL students with Spanish as a home language in a school district. The school district rather than the campus is the relevant treatment unit because the policy is enforced based on the number of ELL students in the district. Following Chin et al. [2013], we restrict the sample to smaller school districts with less than 200 total first-graders in 2005 because these schools are more likely to respond at the policy threshold. Larger school districts with more funding are likely to provide bilingual education programs even when they have fewer than 20 Spanish-speaking ELL students. Although the analysis considers a selected sample of schools that are smaller and more rural, these school districts still cover a wide geographic range where the number of ELL students has increased in recent years. In this sample, districts that have more than 20 ELL first-graders with Spanish as a home language are 0.25 percentage points (p.p.) more likely to offer bilingual education. According to standard thresholds for weak instruments [Staiger and Stock [1997]], the 20 ELL student cut-off is a strong instrument for providing bilingual education in first grade for these school districts.

After confirming that the twenty student cut-off is a valid instrument, we examine how bilingual education exposure in the first grade affects students' test scores in elementary school and middle school. We find that enrolling in a school district that provides bilingual education in first grade does not have a statistically significant effect on math and reading test scores at either grade level for both ELL and non-ELL students. This is in contrast to the results of Chin et al. [2013], who found that bilingual education in first grade has a positive effect on test scores in elementary school. While our analysis is conducted directly on individual level data from the Texas Education Research Center, Chin et al. [2013] used data aggregated to the school-grade-year created by a Freedom of Information Act request. This aggregation may have led to a loss of information and power in their analysis because information is aggregated to the school-grade-year level, and groups with less than five students are masked for confidentiality purposes.

Moving beyond standardized test scores, we also consider how bilingual education in first grade affects future high school graduation and college enrollment rates. In our analysis, we find no statistically significant effect of bilingual education on high school graduation rates for ELL or non-ELL students. This is possibly because high school graduation rates are relatively high during this period of time for both ELL and non-ELL students, so there is little room for bilingual education to have a positive impact on students outcomes. Unlike

standardized test scores and high school graduation rates, bilingual education does have a large and statistically significant impact on college enrollment rates for both ELL and non-ELL students. The provision of bilingual education in first grade increases the probability of enrollment in a four-year public Texas university in Texas by by 6.4 p.p. (49.2%) for ELL students and 6.8 p.p. (30.0%) for non-ELL students.

These estimated effects of bilingual education programs in first grade are consistent with previous work which finds that education interventions in early life can have large long-run effects on student outcomes in adulthood. Previous research has found that pre-schools such as the Head Start program can positive effects on later life outcomes including high school graduation, college enrollment, and college completion [Deming [2009], Pages et al. [2020], Bailey et al. [2021], Gray-Lobe et al. [2023]]. Although the effect of bilingual education on college enrollment is large, it is similar in magnitude to that of having a same race teach in elementary school [Gershenson et al. [2022]]. These previous studies also point to role model effects from similar race teachers as a potential mechanism by which bilingual education impacts students outcomes. Our research emphasizes the importance of considering long-run student outcomes when evaluating education programs for ELL students.

2 Policy Background

The education of ELL students and use of non-English languages in public schools have both been the subject of legal debate in the United States dating back to the 19th century.[1] Schools must strike a delicate balance between providing an adequate education for ELL students and not segregating these students from their non-ELL peers. While courts and federal policies have avoided specifying an exact education model, schools are required to provide a curriculum for ELL students that both teaches English and general academic content.

Programs for ELL students typically fall into one of two categories. English as a second language (ESL) is the most common form, accounting for the education of 77.6% of ELL public school students in 2019-20 [Williams and Zabala [2023]]. In these programs, ELL students and non-ELL students are taught in the same classroom via English for the core curriculum, and teachers for these classrooms do not necessarily have any additional skills beyond standard requirements. During a pull-out time, ELL students are taught English by a certified ESL teacher [TEA [2022a]]. In addition to standard teacher requirements, this certification in Texas requires 120-150 hours of coursework and passing an exam on topics including basic linguistics and ESL teaching methodologies. ESL certifications need to be

[1] See Wright [2010] for a summary of court rulings and laws effecting ELL student education in the USA.

renewed each five years, and renewal requires at least 150 hours of professional development [Anantha [2024]]. ELL students enrolled in ESL are exposed to a substantial amount of English during the core curriculum and with their ESL teacher, who may not even speak their home language. This may improve the speed at which they learn English but also hamper their understanding of material in the core curriculum. The presence of non-ELL students in the classroom may also change how teachers' teach the core curriculum.

In contrast to ESL, bilingual education programs separate ELL students into a different classroom taught by a certified bilingual educator. The core curriculum for ELL students is taught in their native language while students also learn English. Programs may either be classified as early-exit, meaning the students are expected to be reclassified as non-ESL in 2-5 years, or late-exit, where reclassification is expected in 6-7 years [TEA [2022b]]. In addition to standard teaching requirements, bilingual education teachers in Texas must pass exams on teaching methodologies and proficiency in the language of instruction. After passing exams, a one-year internship of teaching with a field supervisor must be completed for full certification [TTOT [2023]]. Hiring and retaining a bilingual certified teacher is the main hurdle for schools to implement a bilingual education program. While the number of ELL students in Texas has grown dramatically, the number of bilingual certified educators has actually declined [Lopez [2022]]. Relative to ESL, bilingual education exposes ELL students to less English. This may slow their English acquisition but also improve their understanding of the core curriculum.

Texas state law has several stipulations about when a school district must provide bilingual education.[2] In elementary school (grades 1 to 5), a school district with 20 or more ELL students with the same home language must provide a bilingual education program in that grade. School districts with less than 20 ELL students with the same home language are free to choose between providing a bilingual education or ESL program. Not all school districts above the 20 student threshold are able to provide bilingual education, largely because they do not have a bilingual education certified teacher. These districts must apply for and receive a waiver from the state board of Texas to not face sanctions. As part of the waiver, these districts must outline their plan for providing bilingual education in the future. After elementary school, districts can choose to provide either a bilingual education or ESL program regardless of the number of ELL students. The requirement that elementary school districts with 20 or more ELL students in the same grade with the same home language must provide a bilingual education program forms the basis of our empirical strategy discussed in

[2]Detailed instructions for requirements for education of ELL students can be found on the Texas Education Administration's website (https://tea.texas.gov/academics/special-student-populations/english-learner-support/bilingual-education-exception-and-esl-waiver-resources).

Section 3.

In Texas students are assigned an ELL status based on their home language and an English proficiency test.[3] Students who report English as their only home language classified as English proficient. If a student speaks a language other than English at home, they are required to take an English proficiency test specific to their grade level. The Texas Education Administration determines the passing threshold for this test, and students who score below the threshold are classified as ELL. Because ELL status is determined by a standard test and threshold, there is limited room for school districts to influence the number of enrolled ELL students. If the ELL student is enrolled in a district that provides bilingual education, the student are offered enrollment in the bilingual education course. However, parents may request that their child is not enrolled in the bilingual education program. Students who are enrolled in districts that do not provide bilingual education are offered enrollment in an ESL program. Again, parents can request that their child does not participate in the ESL program. Students lose their ELL status once they are able to pass the English proficiency test, which is administered each year to all ELL students. After passing the proficiency test, students who were previously classified as ELL are monitored for an additional two years to confirm English proficiency.

3 Empirical Strategy

To estimate the effect of bilingual education in first grade on student outcomes, we must compare students who did and did not attend a school district in first grade that provided bilingual education. However, a school district's choice to provide bilingual education is not random. For example, school districts may decide to provide bilingual education if their ELL students are performing particularly poorly in a standard classroom setting. In this scenario, we may estimate that ELL students do worse when a bilingual education program is provided, but bilingual education is actually provided because these ELL students are doing poorly. Additionally, there are likely other non-observable factors such as school resources and student quality that influence both the decision to provide bilingual education and students' outcomes.

To overcome these concerns, we follow Chin et al. [2013] and leverage policy variation in Texas that generates quasi-random exposure to bilingual education in first grade. As discussed in Section 2, Texas requires that school districts with 20 or more ELL students in an elementary grade with the same home language must provide bilingual education.

[3] A detailed flow chart for ELL students classification and progression can be found at https://tea.texas.gov/sites/default/files/eb-el-decision-chart-for-lpac-accessible-version.pdf.

School districts with 19 and 20 ELL first-graders are likely to be similar on average in most characteristics, but the school district with 20 ELL students is required to provide a bilingual education program. By comparing school districts just above and below this threshold, we are comparing similar sets of students except for the exposure to bilingual education in first grade. Any differences in outcomes between these two sets of students is the plausibly caused by the bilingual education program. This policy variation suggests a regression discontinuity design as discussed in Imbens and Lemieux [2008] and Lee and Lemieux [2010].

The previous work of Chin et al. [2013] leveraged this 20 ELL student cut-off to estimate the impact of bilingual education programs on elementary school test-scores. We extend this strategy to estimate the impact of bilingual education on students' non-test score and long-run outcomes including middle school test scores, high school graduation, and college enrollment. We estimate the effect of bilingual education at the individual level as our main interest is to measure the impact of bilingual education on each student's long-run outcomes. The goal is to understand how bilingual education helps or hurts students in developing language and academic skills.

The 20 ELL student cut-off is not strictly binding as discussed in Section 2, so we use a fuzzy regression discontinuity design where bilingual education provision is instrumented by the 20 ELL student cutoff. In order for the policy variation to be a valid instrument, the 20 ELL student threshold must be a strong predictor of bilingual education programs. We first verify that the cutoff is a valid instrument through the following first-stage regression:

$$BE_{idc} = \delta^{FS}\mathbf{1}\{\#ELL_{dc} \geq 20\} + f^{FS}(\#ELL_{dc}) + X'_{dc}\gamma^{FS} + \epsilon^{FS}_{idc}. \quad (1)$$

Here, BE_{idc} is an indicator for whether school district d of individual i provided bilingual education for cohort c in their first grade. The variable BE_{idc} takes a value one if there was any student who received bilingual education in school district d in the first grade for cohort c. The variable $\#ELL_{dc}$ is the number of ELL students in this district-cohort where f^{FS} is a continuous function of $\#ELL_{dc}$.[4] We additionally control for demographic characteristics of the first grade cohort c in school district d to alleviate the concern of ELL students sorting into school districts with certain demographic composition.

In addition to being a strong predictor of the provision of bilingual education, the instrument must not be correlated with other variables that impact student achievement. In the regression discontinuity framework, it is also important to check for bunching below the threshold, which would suggest that schools actively try to reduce ELL counts to not provide bilingual education. We show in Figure 3 that the density of school districts is smooth below

[4]We use a linear function of $\#ELL_{dc}$ where the slopes are allowed to be different below and above the 20 ELL cutoff for f^{FS}.

and above the 20 ELL student cutoff. Finally, we only use schools with 8-39 ELL students in the 1st grade cohort to accurately measure the local average treatment effect of bilingual education following the previous work by Chin et al. [2013].

After confirming that the cut-off is a valid instrument for bilingual education provision, we compare student outcomes at school districts just above and just below the threshold using the following regression:

$$y_{idc} = \delta^{SS}\mathbf{1}\{\#ELL_{dc} \geq 20\} + f^{SS}(\#ELL_{dc}) + X'_{dc}\gamma^{SS} + \epsilon^{SS}_{idc}. \tag{2}$$

Here, δ^{SS} captures the effect of a change in student outcomes y above the policy threshold. As mentioned previously, students just below and above this threshold should be similar on average except that students above the threshold are more likely to have been at a school district that provided bilingual education. Thus, δ^{SS} provides information about the impact of bilingual education on student outcomes. Furthermore, re-scaling δ^{SS} by the first stage coefficient gives an estimate of the effect of bilingual education on student outcomes.

4 Data

Our project leverages longitudinal administrative data from the Texas Education Research Center (Texas ERC) about K-12 public school students for academic years 1993-94 to 2018-2019. The data contains information about each student's home language and ELL status, so we are able to identify students who are eligible for additional help based on their English language abilities. We focus on ELL students whose home language is Spanish, because this accounts for the vast majority of ELL students in Texas and the United States. For ELL students, we also know whether they are enrolled in a bilingual education program or in ESL. Using this enrollment information, we can classify school districts as providing bilingual education or not.[5]

The longitudinal structure of the data allows us to analyze a rich set of student outcomes. This includes standardized test scores in math and reading for students from grades 3 to 8. ELL students in elementary school are allowed to receive these tests in their native language, while ELL students in older grades receive the test in English but with linguistic accommodations. These test scores will allow us to analyze how bilingual education programs impact academic achievement both when they are receiving the treatment in elementary school and in future grades.

[5]We do not observe directly whether a school district provides bilingual education or not. We identify a school district to provide bilingual education if there is any student who is enrolled in bilingual education.

In addition to test scores, we know whether a student graduated from a Texas public high school. For students who do not graduate from a Texas public high school, it is not clear whether they graduated from high school outside the Texas public school system or they dropped out of school. Because Texas is a large state, a majority of the first-graders from Texas public schools will also finish their schooling in Texas, and we are able to connect many high school graduates to their first grade school district and exposure to bilingual education. However, we must assume that the provision of bilingual education in first grade does not impact the probability that a first-grader moves to a school outside the Texas public school system.

Finally, the data contains information on college enrollment and graduation for Texas public colleges. Similar to high school graduation, many Texas students decide to enroll in Texas public colleges for their tertiary education, so we can match many Texas college students in the data to their first grade school district and exposure to bilingual education. If we assume that bilingual education exposure does not influence the decision of students to enroll in colleges outside of Texas public school system, then we can estimate the impact of bilingual education on college enrollment and graduation decisions.

Following Chin et al. [2013], we focus our analysis on first-graders whose district had between 8 and 39 ELL students because the regression discontinuity design is identified in the neighborhood of the 20 student cut-off. Additionally, we drop school districts with more than 250 students in the first grade cohort in 2004-2005 academic year. Larger school districts have more financial resources and are more likely to provide a bilingual education program regardless of whether they are above the cut-off. Restricting our sample to school districts with a relatively small number of ELL student and small total number of students is a limitation of our empirical strategy because these school districts are different from the average school district. However, changing migration trends and demographics had led the number of ELL students in smaller and more rural school districts to increase in recent years, so our analysis is still relevant to policy-makers.

5 Results

5.1 Validity of the Empirical Strategy

Discontinuity First, we test whether there is an increase in the probability of school districts providing bilingual education programs at the 20 ELL student cut-off. Figure 1 illustrates the fraction of districts that provide bilingual education as a function of the number of Spanish ELL first-graders in the district using the 1994-2008 first grade cohorts. Visually, it

Table 1: School District Information in 2005
by District Size and Number of Spanish ELL Students

Number of First Graders:	≤200		>200	
Number of Spanish ELL Students:	8-39	>39	8-39	>39
Avg. Number of Students	98	122	322	1,562
	(49)	(39)	(113)	(2,123)
Avg. Number of Campuses	1.099	1.091	2.899	15.894
	(0.351)	(0.302)	(1.972)	(22.269)
Frac. with Bilingual Education	0.271	0.727	0.443	0.953
Frac. Spanish LEP Students	0.225	0.593	0.068	0.267
Frac. FRL Students	0.618	0.764	0.475	0.500
Frac. Female	0.477	0.459	0.481	0.481
Frac. Black	0.078	0.039	0.115	0.127
Frac. Hispanic	0.511	0.804	0.271	0.526
Frac. White	0.404	0.154	0.592	0.321
Frac. Enroll in Community College	0.417	0.388	0.237	0.076
Frac. Enroll in 4-yr. University	0.195	0.199	0.120	0.034
Frac. Enroll in Any College	0.463	0.440	0.270	0.085
Avg. Grade 3 Reading Test Score	-0.069	-0.209	0.142	0.019
	(0.312)	(0.165)	(0.254)	(0.249)
Avg. Grade 3 Math Test Score	-0.116	-0.133	0.093	0.018
	(0.327)	(0.149)	(0.246)	(0.242)
Districts	181	11	79	170
First Grader Observations	17,743	1,347	25,475	265,595

Note: This table shows summary information for school districts based on the number of first-graders and Spanish-speaking ELL students. Test scores are normalized to have mean zero and variance one for all of Texas. Standard deviations are in parentheses.

Table 2: Statistics about School Districts Over Time

	1994-1998	1999-2008	2009-2019
Avg. Number of Students	102	99	103
	(53)	(50)	(65)
Avg. Number of Campuses	1.123	1.105	1.243
	(0.486)	(0.425)	(0.860)
Frac. with Bilingual Education	0.213	0.262	0.267
Frac. Spanish LEP Student	0.200	0.214	0.219
Frac. FRL Student	0.639	0.610	0.623
Frac. Female	0.483	0.484	0.486
Frac. Black	0.073	0.084	0.093
Frac. Hispanic	0.506	0.497	0.500
Frac. White	0.416	0.410	0.376
Frac. Enroll in Community College	0.443	0.438	–
Frac. Enroll in University	0.220	0.201	–
Frac. Enroll in Any College	0.483	0.485	–
Avg. Grade 3 Reading Test Score	-0.022	-0.058	-0.032
	(0.248)	(0.279)	(0.465)
Avg. Grade 3 Math Test Score	-0.021	-0.117	-0.072
	(0.265)	(0.307)	(0.446)
Districts	595	1,659	2,321
First Graders Observations	57,678	154,771	229,473

Note: This table shows summary information for school districts with less than 200 first-graders and between 8 and 39 Spanish-speaking ELL students based on the cohort. Standard deviations are in parentheses.

confirms that there is a discontinuous jump in the probability at the 20 ELL student cutoff. The relationship between the probability of providing bilingual education and the number of Spanish ELL students in the district becomes noisier above the cutoff. To be more statistically precise, we estimate equation 1 to check if there is a statistically significant change in the probability of providing bilingual education at the cut-off. Results are presented in Table 3. The F-statistics for the instrument during the time period 1994 to 2008 are between 10 and 27, which is above the standard threshold for weak instruments [Staiger and Stock [1997]]. This suggests that the 20 ELL student cut-off is a strong instrument for the provision of bilingual education. This confirms that the 20 Spanish-speaking ELL student cut-off is a strong predictor for the provision of bilingual education in first grade.

Although we do have information about first grade cohorts up through 2019, we restrict our analysis to the 1994-2008 cohorts for two reasons. First, we are interested in how bilingual education affects long-run outcomes, and the 2008 cohort will be the last cohort that has reached high school graduation and college enrollment by the end of our sample in 2019. Second, the strength of the 20 ELL student cut-off as an instrument has weakened considerably over-time. This can be seen in Table 3, where the coefficient on the 20 ELL student cut-off is not statistically significant for cohorts between 2009 and 2019 together. Figure 2 also shows how the estimated first stage coefficient has changed for each cohort. The first stage coefficient is typically large and statistically significant for cohorts before 2008, but small and often statistically insignificant for cohorts after 2008. Future research should consider how the provision of bilingual education has changed in Texas after 2008.

One potential reason for this change is changes in Texas funding for public schools following the 2008 Financial Crisis. In Texas, the source of state funding for all public school districts is the Texas Foundation School Program (FSP). FSP allocates the state funding primarily based on the average daily attendance of students. Furthermore, FSP adjusts the allocation based on the district and student characteristics to meet the needs of districts. For instance, having more ELL students will allocate more funding to the district. However, Rolle and Jimenez-Castellanos [2014] concludes that the FSP formula was not enough to balance out another big source of revenue to the school districts: the revenue generated from local property values. According to their analyses, the districts with the highest percentage of ELL students generated on average $1,300 less per pupil than districts with the lowest percentage of ELL students[6]. In fact, Texas recently passed House Bill 3 (HB 3) by the 86th Texas Legislature in 2019, where the State upward adjusted the weight for ELL students in the FSP formula, which was originally set in 1984 and never changed, to better fund

[6]The total difference amounts to approximately $5.9 million, which translates to funding the salaries and benefits for 90 Texas teachers annually [Rolle and Jimenez-Castellanos [2014]].

Table 3: First Stage Coefficient Over Time

	1994-1998	1999-2008	2009-2019
Coef., No Controls	0.292	0.260	0.031
	(0.086)	(0.056)	(0.064)
Coef., Controls	0.260	0.254	0.031
	(0.080)	(0.049)	(0.053)
Districts	595	1,659	2,321
Campuses	668	1,833	2,902
Students	60,614	164,671	240,998

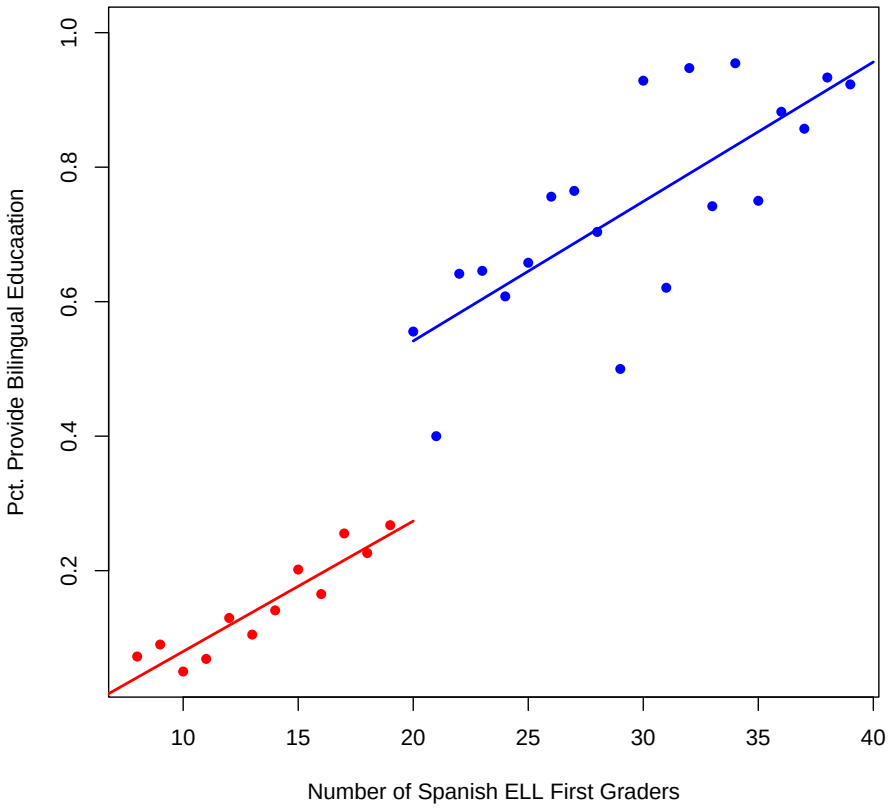
Note: This table shows the estimated first stage coefficient for the regression equation 1 for three time periods. The first two rows show the estimated coefficient and standard deviation in parentheses without controls in the regression, and the next two rows show the estimates and standard deviations in parentheses without control.

bilingual education.

Bunching and Balance Test Although the 20 ELL student cutoff is a strong predictor for the provision of bilingual education, there are still threats to identifying the effect of bilingual education on student outcomes. First, school districts may strategically reduce the number of ELL students in their classes to avoid providing bilingual education. If school districts strategically reducing ELL student counts are systematically different compared to those that do not, then the estimated effect of bilingual education would be biased (McCrary [2008]). However, as shown in Figure 3, we do not see any bunching of the districts or school campuses around the 20 ELL student cutoff. The distribution of the districts is smooth along the number of ELL students in each district.

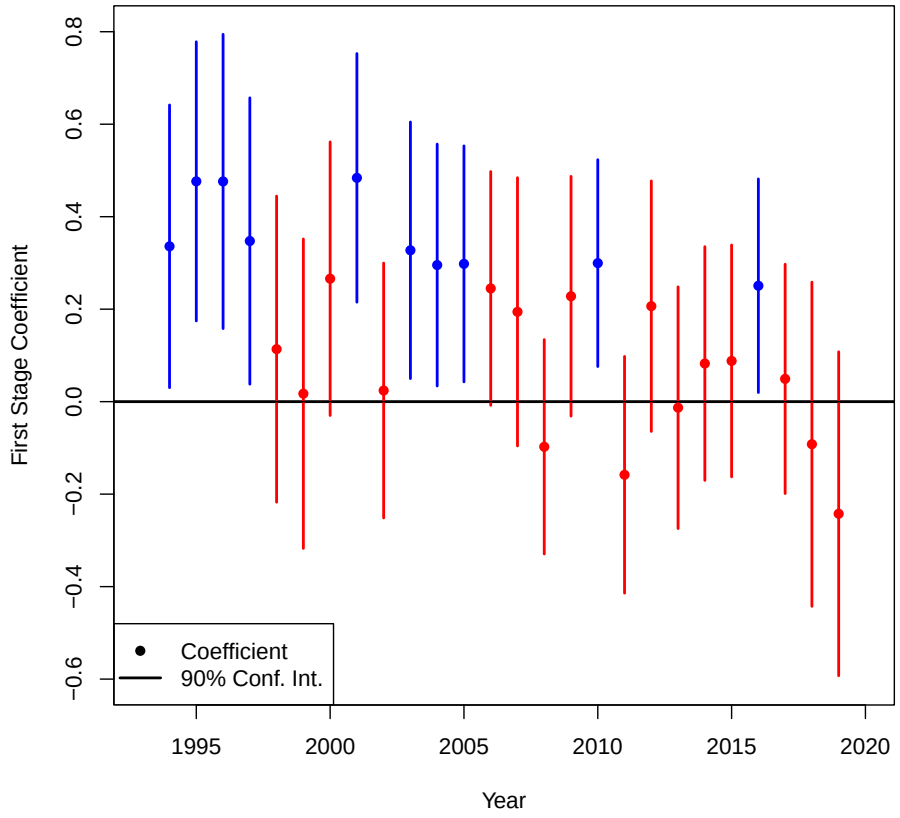
Furthermore, we also test whether student characteristics for school districts change discretely at the 20 ELL student cutoff. Even if schools does not strategically adjust the number of ELL students, parents might strategically respond to the provision of bilingual education. For example, parents may be less likely to enroll their student in private school if their school district is providing bilingual education. If the students whose parents respond strategically to the provision of bilingual education are systematically different compared to those that do not, then this will influence our estimated effects of bilingual education. We consider students' sex, ethnicity, and free-or-reduced-lunch status in first grade in this balance test.

Figure 1: Discontinuous Change in Probability of Providing Bilingual Education at the Cut-off



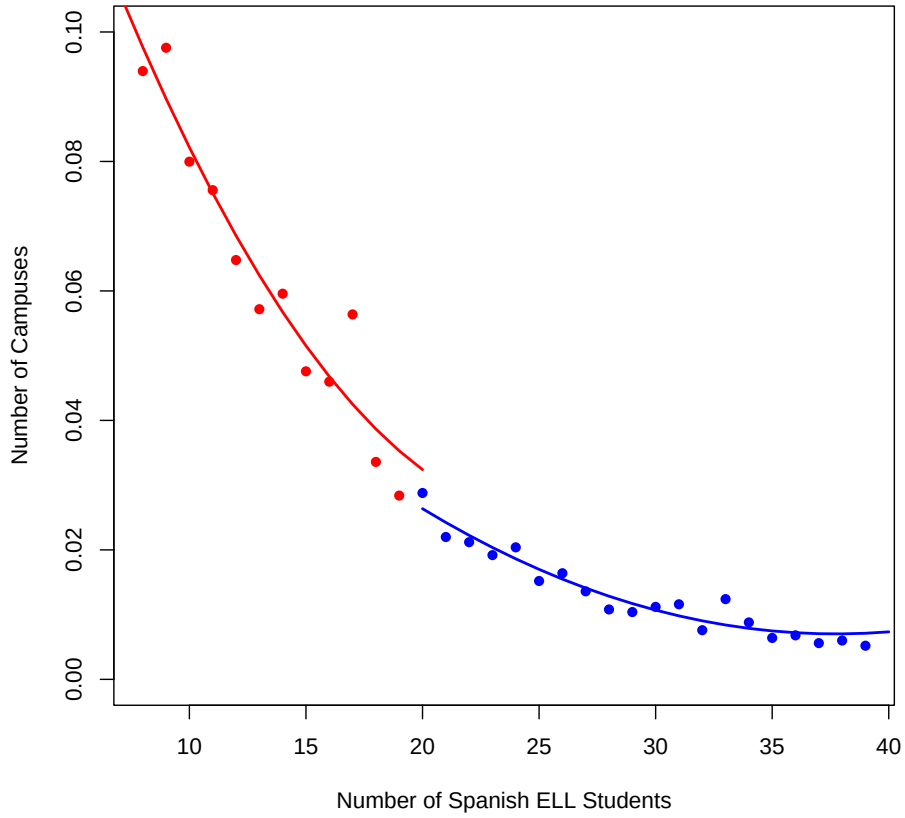
Note: This figure shows the fraction of school districts that provide bilingual education based on the number of Spanish-speaking ELL students.

Figure 2: First Stage Over Time



Note: This figure shows the estimated first stage coefficient with 90% confidence intervals for each cohort. Coefficients that are statistically significant are shaded in red, while those that are not are shaded in blue.

Figure 3: Density of School Campuses Around the Cutoff



Note: This figure shows the density of school campuses around the 20 ELL student cut-off based on the number of Spanish-speaking ELL students.

Tables 4 to 7 show that the characteristics of students do not change in a statistically significant way around the 20 student cutoff. This suggests that our estimated effects from the instrumental variable strategy are driven by the provision of bilingual education rather than the strategic responses of parents.

Discussion Returning to Table 3, we observe that the probability of complying to the policy has changed over time. After 2008, which is the last first grade cohort in our sample, the jump in the probability at the cutoff falls significantly from around 0.2-0.3 to less than 0.06. Figure 2 plots the point estimate of δ^{FS} in equation 1 and its 90% confidence interval. In the 2010s, we cannot reject that the jump in the probability at the cutoff is statistically significantly away from zero. In some cases, the point estimate is even below zero, which means it is less likely that a district provides bilingual education when it has more than 20 ELL students who speak Spanish as their home language.

Table 4: Balance Test for All Students

	(1)	(2)	(3)	(4)	(5)	(6)
Coefficient	-0.012	0.009	-0.003	-0.001	-0.003	0.001
	(0.011)	(0.008)	(0.016)	(0.028)	(0.005)	(0.003)
Outcome Mean	0.587	0.484	0.091	0.431	0.098	0.031
Observations	151,709	151,709	151,709	151,709	151,709	151,709
Outcome	FRL Status	Female	Black	Hispanic	Special Ed.	Gifted
Sample	All	All	All	All	All	All

Note: Standard errors in parentheses are clustered by school district.

Table 5: Balance Test For Spanish-Speaking ELL Students

	(1)	(2)	(3)	(4)	(5)	(6)
Coefficient	-0.026	-0.006	0.000	-0.007**	-0.003	0.002
	(0.016)	(0.015)	(0.001)	(0.002)	(0.008)	(0.005)
Outcome Mean	0.848	0.486	0.001	0.992	0.072	0.011
Observations	23,465	23,465	23,465	23,465	23,465	23,465
Outcome	FRL Status	Female	Black	Hispanic	Special Ed.	Gifted
Sample	Spanish, ELL	Spanish, ELL	Spanish, ELL	Spanish, ELL	Spanish, ELL	Spanish, ELL

Note: Standard errors in parentheses are clustered by school district.

Table 6: Balance Test for Non-Spanish, Non-ELL Students

	(1)	(2)	(3)	(4)	(5)	(6)
Coefficient	-0.007	0.012	-0.003	0.001	-0.003	0.000
	(0.014)	(0.008)	(0.019)	(0.036)	(0.005)	(0.003)
Outcome Mean	0.539	0.483	0.108	0.328	0.103	0.035
Observations	128,244	128,244	128,244	128,244	128,244	128,244
Outcome	FRL Status	Female	Black	Hispanic	Special Ed.	Gifted
Sample	Non-Spanish, Non-ELL	Non-Spanish, Non-ELL	Non-Spanish, Non-ELL	Non-Spanish, Non-ELL	Non-Spanish, Non-ELL	Non-Spanish, Non-ELL

Note: Standard errors in parentheses are clustered by school district.

Table 7: Balance Test at School District Level

	(1)	(2)	(3)	(4)	(5)	(6)
Coefficient	-0.024	0.017	-0.029	0.007	-0.002	-0.001
	(0.027)	(0.013)	(0.023)	(0.024)	(0.019)	(0.004)
Outcome Mean	0.621	0.472	0.085	0.503	0.106	0.027
Observations	2,019	2,019	2,019	2,019	2,019	2,019
Outcome	FRL Status	Female	Black	Hispanic	Speceial Ed.	Gifted
Sample	School level	School level	School level	School level	School level	School level

Note: Standard errors in parentheses are clustered by school district.

Table 8: Effect of Bilingual Education on Test Score Outcomes

	(1)	(2)	(3)	(4)
2SLS Coefficient	-0.082	-0.021	0.051	0.052
	(0.080)	(0.075)	(0.095)	(0.068)
FS Coefficient	0.231	0.231	0.232	0.232
	(0.047)	(0.047)	(0.047)	(0.047)
RF Coefficient	-0.020	-0.005	0.012	0.012
	(0.019)	(0.018)	(0.022)	(0.016)
Outcome Mean	-0.060	-0.039	-0.048	-0.017
Observations	808,221	808,221	620,285	620,285
Outcome	Math	Reading	Math	Reading
Grade Level	Elementary	Elementary	Middle	Middle
Sample	All Students	All Students	All Students	All Students

Note: Standard errors in parentheses are clustered by school district.

5.2 Test Scores

Having confirmed the validity of the empirical research design, we now examine the effect of bilingual education in first grade on elementary and middle school test scores. Tables 8-10 report the reduced form and two-stage least squares (2SLS) effects of bilingual education on test scores and the first-stage results for the instrument. Throughout Section 5, we focus on the IV estimates (δ^{SS}) because they are interpretable as the effect of bilingual on the outcome variable. Results are presented separately by grade level and test subject. Table 8 reports the estimated effect for all students, while Tables 9 and 10 split the sample into Spanish-speaking ELL students and non-Spanish non-ELL students. Splitting the sample allows us to test for direct effects on the Spanish-speaking ELL students and who would enroll in the bilingual education program, and spillover effects on non-ELL students who do not enroll in the bilingual education program.

Table 9: Effect of Bilingual Education on Test Score Outcomes

	(1)	(2)	(3)	(4)
IV Coefficient	-0.105	-0.130	0.299	0.261
	(0.181)	(0.181)	(0.254)	(0.288)
FS Coefficient	0.262	0.262	0.256	0.256
	(0.046)	(0.046)	(0.051)	(0.051)
RF Coefficient	-0.029	-0.035	0.081	0.070
	(0.049)	(0.048)	(0.068)	(0.077)
Outcome Mean	-0.488	-0.550	-0.355	-0.469
Observations	95,783	95,783	35,552	35,552
Outcome	Elementary Math	Elementary Reading	Middle Math	Middle Reading
Sample	Spanish, ELL	Spanish, ELL	Spanish, ELL	Spanish, ELL

Note: Standard errors in parentheses are clustered by school district.

Table 10: Effect of Bilingual Education on Test Score Outcomes

	(1)	(2)	(3)	(4)
IV Coefficient	-0.082	-0.019	0.058	0.049
	(0.084)	(0.078)	(0.101)	(0.073)
FS Coefficient	0.222	0.222	0.225	0.225
	(0.049)	(0.049)	(0.049)	(0.049)
RF Coefficient	-0.019	-0.005	0.013	0.011
	(0.020)	(0.018)	(0.023)	(0.016)
Outcome Mean	-0.014	0.019	-0.024	0.018
Observations	665,756	665,756	523,281	523,281
Outcome	Elementary Math	Elementary Reading	Middle Math	Middle Reading
Sample	Non-Spanish, Non-ELL	Non-Spanish, Non-ELL	Non-Spanish, Non-ELL	Non-Spanish, Non-ELL

Note: Standard errors in parentheses are clustered by school district.

We do not find any statistically significant effects of bilingual education programs on test scores across grade levels, subjects, and subgroups. However, large standard errors imply that we cannot reject that the effect of bilingual education on test scores is economically meaningful. For example, the 95% confidence interval for the effect of bilingual education on elementary school reading test scores ranges from -0.168 to 0.126. The endpoints here are roughly as large as the standard deviation of teacher value added found in Chetty et al. [2014]. Therefore, the effect of bilingual education on test scores could be as large as decreasing or increasing teacher value added by one standard deviation.

These results are in contrast to the conclusion of Chin et al. [2013], who report some statistically significant positive effects of bilingual education on elementary school test scores. They find that bilingual education on average increases elementary math and reading test scores by 0.206 and 0.143 standard deviations, respectively. Their estimates are also noisy, and the effect on math test scores is statistically significant only at the 10% level. Although Chin et al. [2013] also studies the effect of bilingual education in Texas using the same regression discontinuity strategy, our data sets are not identical. While we have direct access to the individual-level data from the Texas ERC, Chin et al. [2013] received aggregated data from the Texas Education Agency (TEA) through a Freedom of Information Act request. Sample selection rules or aggregation techniques implemented by the TEA may lead to different samples and results compared to ours.

5.3 High School Graduation and College Enrollment

Although we do not find any statistically significant effects of bilingual education on test scores, these programs may still benefit students along other dimensions. While these effects are not well-measured by standardized tests, they may appear in students' future outcomes. To investigate this, we estimate the effect of bilingual education in first grade on high school graduation and college enrollment rates. Tables 11-13 present the reduced form and 2SLS estimates of the effect of bilingual education provision in first grade on high school graduation and college enrollment. Table 11 reports the estimated effect for all students, while Tables 12 and 13 split the sample into Spanish-speaking ELL students and non-Spanish non-ELL students. Splitting the sample allows us to test for direct effects on the Spanish-speaking ELL students and who would enroll in the bilingual education program, and spillover effects on non-ELL students who do not enroll in the bilingual education program.

We find no statistically significant effect of bilingual education on high school graduation rates, and the point estimate is rather small. For the pooled sample of all students, the provision of bilingual education in first grade increase high school graduation rates by 0.7 p.p.

(0.9%) on average. Like the analysis of test scores, the estimation here yields large standard errors, and we cannot rule out economically meaningful effects of bilingual education on high school graduation. The 95% confidence interval ranges from -6.4 to 7.8 p.p., so bilingual education programs could plausibly decrease or increase high school graduation rates by about 10%. For the subgroups of Spanish-speaking ELL students and non-Spanish non-ELL students, the estimates are also noisy and statistically insignificant.

Despite these uninformative results for high school graduation rates, we do find that the provision of bilingual education in first grade has a positive effect on four-year university enrollment rates. For the pooled sample of all students, bilingual education in first grade increases four-year university enrollment by 5.9 p.p. (28%), and this effect is statistically significant at the 10% level. This large, positive, and statistically significant effect exists for both the Spanish-speaking ELL and non-Spanish non-ELL subgroups. The provision of bilingual education in first grade increases the four-year university enrollment rate by 6.4 p.p. (49%) for Spanish-speaking ELL students and 5.2 p.p. (30%) for non-Spanish non-ELL students. These results show that although bilingual education does not have positive effects that are well-measured by test scores, the benefits are observable in long-run outcomes such as four-year university enrollment.

In contrast to four-year university enrollment, we do not find any statistically significant effects of bilingual education on community college enrollment. As usual, large standard errors imply that we cannot rule out economically meaningful effects. Because we do not find any statistically significant effect of bilingual education on community college enrollment, it is possible that the increase in four-year university enrollment is generated by substitution away from community college. To formally test for this, we estimate the effect of bilingual education on enrollment in any college (either a four-year university or community college). For the sample of all students and Spanish-speaking ELL students, the estimated effect is statistically insignificant. However, the effect for non-Spanish non-ELL students is statistically significant at the 10% level: the provision of bilingual education in first grade increases their probability of enrolling in any college by 8.2 p.p. (16%). Overall, it is difficult to conclude whether the positive effect on four-year university enrollment rates is driven by substitution away from community college or not due to large standard errors.

Table 11: Effect of Bilingual Education on Long-Run Outcomes

	(1)	(2)	(3)	(4)
2SLS Coefficient	0.007	0.060	0.059	0.058
	(0.036)	(0.040)	(0.033)	(0.045)
FS Coefficient	0.231	0.231	0.231	0.231
	(0.047)	(0.047)	(0.047)	(0.047)
RF Coefficient	0.002	0.014	0.014	0.013
	(0.008)	(0.009)	(0.007)	(0.010)
Outcome Mean	0.751	0.505	0.212	0.461
Observations	823,660	823,660	823,660	823,660
Outcome	HS Graduation	Any College Enroll.	4-year Univ. Enrollment	CC Enrollment
Sample	All Students	All Students	All Students	All Students

Note: Standard errors in parentheses are clustered by school district.

Table 12: Effect of Bilingual Education on Long-Run Outcomes

	(1)	(2)	(3)	(4)
2SLS Coefficient	-0.052	-0.012	0.064	-0.013
	(0.058)	(0.059)	(0.038)	(0.062)
FS Coefficient	0.263	0.263	0.263	0.263
	(0.044)	(0.044)	(0.044)	(0.044)
RF Coefficient	-0.014	-0.003	0.017	-0.003
	(0.015)	(0.016)	(0.009)	(0.016)
Outcome Mean	0.742	0.391	0.130	0.360
Observations	127,013	127,013	127,013	127,013
Outcome	HS Graduation	Any College Enroll.	4-year Univ. Enrollment	CC Enrollment
Sample	Spanish, ELL	Spanish, ELL	Spanish, ELL	Spanish, ELL

Note: Standard errors in parentheses are clustered by school district.

Table 13: Effect of Bilingual Education on Long-Run Outcomes

	(1)	(2)	(3)	(4)
2SLS Coefficient	0.025	0.082	0.068	0.079
	(0.039)	(0.048)	(0.040)	(0.052)
FS Coefficient	0.221	0.221	0.221	0.221
	(0.050)	(0.050)	(0.050)	(0.050)
RF Coefficient	0.005	0.018	0.015	0.017
	(0.009)	(0.010)	(0.008)	(0.011)
Outcome Mean	0.752	0.526	0.227	0.480
Observations	668,247	668,247	668,247	668,247
Outcome	HS Graduation	Any College Enroll.	4-year Univ. Enrollment	CC Enrollment
Sample	Non-Spanish, Non-ELL	Non-Spanish, Non-ELL	Non-Spanish, Non-ELL	Non-Spanish, Non-ELL

Note: Standard errors in parentheses are clustered by school district.

6 Mechanisms for the Effect of Bilingual Education

In light of the effects estimated in the previous section, we now discuss the mechanisms that may generate these effects.

The direct effect of bilingual education is to change the language of instruction for ELL students to their native language. This should improve their performance in the core curriculum subjects such as math. However, we do not find any statistically significant effect of bilingual education on test scores in elementary or middle school for Spanish-speaking ELL students. Nevertheless, large standard errors mean that it is possible that bilingual education does improve ELL student comprehension and performance. Conversely, bilingual education may slow the acquisition of English for ELL students by reducing exposure. This would likely result in ELL students performing worse once they have exited the bilingual program. But we do not observe any statistically significant negative effects of bilingual education on middle school test scores. Thus, we do not find any evidence in support of this narrative.

Beyond the direct effect from changing the language of instruction, bilingual education may have indirect effects. For the ELL students enrolled in bilingual education, bilingual education teachers may improve student outcomes because they have a similar race or background to their ELL students. Previous research has found that teachers with similar backgrounds enhance students' short-run test scores and behavior ([Dee [2004], Fairlie et al. [2014], Egalite et al. [2015]]) as well as long-run outcomes including high school graduation [Delhommer [2022], Gershenson et al. [2022]]. These indirect effects may exist because teachers better understand how to educate student with a similar background beyond the language of instruction or because they serve as role models for students with a similar background.

In addition to these mechanisms, bilingual education programs substantially change the classroom composition that students experience. ELL and non-ELL students are mixed in the same classroom under an ESL program but will be placed in a separate classroom to non-ELL students. ELL students on average come from a lower socioeconomic background and have lower test scores compared to their non-ELL peers, so bilingual education reduces the average quality of an ELL student's classmates while increasing the average quality of a non-ELL student's classmates. Previous research has explored how the quality of a student's peers can impact the students' outcomes finding mixed results [Sacerdote [2011]]. In addition to test-scores, interacting with English proficient peers may be an important channel by which ELL students learn English. When separated into the bilingual education classroom, ELL students will have no classmates who are fully proficient in English, which potentially hampers their acquisition of English.

Furthermore, the goal of bilingual education is for ELL students to return to the standard classroom. This return to the standard classroom in a substantially different learning environment, and this abrupt change may have negative impacts on ELL students in the long-run, even if bilingual education may raise ELL student test scores in the short-run.[7]. Bilingual education may also provide students with improved abilities or desire to learn that does not appear in contemporaneous test scores, but does appear in future test scores and future outcomes such as college enrollment. Previous research has shown that some early education intervention can have limited lasting impacts on student test scores but long-run improvements in students future outcomes [Bailey et al. [2021]].

7 Conclusion

In this paper, we have analyzed how school districts' provision of bilingual education vs. ESL in first grade impacts student outcomes both in the short-run (elementary school test scores) and long-run (middle school test scores, high school graduation, and college enrollment). Our empirical strategy leverages policy variation in Texas that requires school districts with 20 or more ELL students with the same home language in the same elementary grade to provide bilingual education. Schools below this cut-off are able to choose bilingual education or ESL programs for their ELL students. Students above and below this cut-off should be similar except that students above the cut-off are more likely to have been at a school district that provided bilingual education. In our analysis, we find that bilingual education has no observable impacts on elementary school test scores but improves four-year college enrollment. These results suggest that bilingual education in elementary grades improves students' ability that is not well measured by elementary school tests but appears in high school and beyond. Additionally, positive effects are found for both ELL and non-ELL students, suggesting that peer effects within the classroom between ELL and non-ELL students are important mechanisms impacting student outcomes.

This study and most previous studies have focused on the effectiveness of ESL compared to bilingual education, but schools may choose a variety of bilingual education programs to implement. Bilingual education programs differ in the speed in which ELL students are transitioned back to the standard classroom (early vs. late exit programs). They also differ in the extent to which they promote proficiency in the native language (transitional vs. dual language programs). Some bilingual education programs even combine native and non-native

[7]Previous research has found mixed results on changing school environments on student outcomes in the context of school closings [Brummet [2014]], grade promotion [Rockoff and Lockwood [2010]], and voluntary student moves [Hanushek et al. [2004]].

English students into the same classroom (two-way immersion programs). Understanding the effectiveness of these different modes of bilingual education is an important next step for future research, especially for large school districts with many ELL students.

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