How Standardized Testing Affects Students' College Readiness in Texas

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Selected Paper prepared for presentation at the 2018 Agricultural & Applied Economics Association Annual Meeting, Washington D.C., Aug 5-Aug 7

1 Introduction

College readiness can be broadly defined as being prepared for postsecondary entry-level courses and career readiness(Conley 2010) . Students who are not college ready are less likely to enroll in higher education institutions, and those who are enrolled are less likely to receive a degree(Royster, Gross and Hochbein 2015) . According to the ACT Report on College and Career Readiness (2017), on average only 39% of high school graduates meet three or four subject area (English, math, reading, and science) ACT College Readiness Benchmarks. College readiness rates are even lower for students who are minorities or from low-income families. How about higher education performance in Texas? From 2011 to 2015, only 27.6% of adults older than 25 hold a bachelor or higher degree, lower than the national average of 33.4%. However, more and more jobs in the United States started requiring college education beyond high school. Therefore, it is important for policy makers and educators to find ways to help Texas' high school students prepared to enroll and succeed at postsecondary institutions.

In 2012, The Texas standardized testing program—State of Texas Assessments of Academic Readiness (STAAR) program was introduced, including annual assessments for grade 3-8 in reading, writing, science, social studies, and End of Course (EOC) assessments—Algebra I, English I, English II, biology, and U.S. history for high school. The EOC assessments were established to meet the state of Texas standards to help high school students get ready for college and be able to succeed in entry-level courses in postsecondary institutions. The standards include multilevel of content knowledge including English/Language Arts, Social Sciences, Mathematics and Natural Sciences. Beyond content knowledge, the standards also aim to help develop students' critical thinking skills. The subjects of content knowledge are consistent with previous studies of definitions and dimensions for college readiness(Conley 2008; Geoffrey Maruyama 2012; Porter and Polikoff 2012) . Moreover, with the enactment of House Bill (HB) 3, the legislature required that STAAR EOC assessments can be applied to measure college and career readiness.

There is a commonly accepted definition of college readiness refers to as “the level of preparation a student needs in order to enroll and succeed, without remediation, in a credit-bearing general education course at a postsecondary institution that offers a baccalaureate degree or transfer to a baccalaureate program”(Conley 2008) . In his later book, he divided college readiness into three dimensions: college knowledge, academic behaviors, and content knowledge. College knowledge is defined as “contextual skills and awareness”. Academic behaviors refer to “range of behaviors that reflects greater student self-awareness, self-monitoring, and self-control of a series of processes and behaviors necessary for academic success”. Content knowledge is described as “core academic subjects knowledge and skills”, including English, mathematics, science, social studies, world languages, and the arts(Conley 2010) .

But how educators can quantitatively measure college readiness? Several college readiness measurement indicators were used in prior studies. These indicators include high school graduation rate (Greene and Forster 2003) , high school GPA (Conley 2008; Geiser and Studley 2002; Greene and Forster 2003) , class rank (Conley 2008; Greene and Forster 2003) , ACT/SAT score (Conley 2008; Geiser and Studley 2002; Greene and Forster 2003; Wyatt 2010) , self-reported first year GPA of postsecondary institutions (Wyatt 2010; Twing, Miller and Meyers 2008; Geiser and Studley 2002) , AP test scores (Conley 2008) . Why the rural matters report (Showalter, Johnson, Klein, et al. 2017) applied graduation rates for overall students and minority students, students eligible for free or reduced meal programs, and percentage of rural students taking AP course or SAT/ACT test to provide state-level rural high school rankings on college readiness. However, there are some doubts about the accuracy of using students’ high school performance to predict college readiness and success. High school GPA or class rank is a poor predicator of college readiness since there is absence of a nationally standardized grading system (Owen 2003; Thompson and Kobrak 1983) ; high school courses are under prepared for students who intend to apply for college (Jones and Watson 1990; Weissberg, Owen, Jenkins, et al. 2003) ; standardized tests are substantially different among states and fail to provide a complex array of skills for college (Thompson and Kobrak 1983) ; the number of students taking SAT/ACT is also considered as a poor measurement since not all college-ready students take these exams(Crystale M. Marsh, Michael A. Vandehey and George M. Diekhoff 2008) .

Teacher quality is consistently considered to contribute to education performance and student achievement. Teacher's experience, highest education achievement, credentials, certification, and teacher-student ratio are all believed to be important to education performance (Goldhaber and Brewer 2000; Clotfelter, Ladd and Vigdor 2007) . In addition, teacher's characteristics also play an important role in high school student's college readiness and success (Ehrenberg and Brewer 1994; Reid and Moore III 2008) . Previous studies show teacher's additional experience doesn't affect students' test scores, meanwhile, any gains from experience happened first few years of career (Rivkin, Hanushek and Kain 2005; Rockoff 2004) . Family income is strongly associated with education performance. Since we are lack of household income data at school-level, percentage of economically disadvantaged students can be applied as a proxy variable for family economically disadvantaged status, which has been widely used in education socioeconomics study, is expected to be negatively correlated with college readiness (Reid and Moore III 2008; Blanden and Gregg 2004; Chevalier and Lanot 2002; Hobbs and Vignoles 2010) . In Texas Education Agency's Public Education Information Management System (PEIMS), an economically disadvantaged student is eligible for free or reduced-price lunch or eligible for other public assistance. This table also includes the percentage of bilingual students, high school student enrollment, several subjects class size and operating expense per student.

Zhang and Jin compared teacher quality on students' standardized score between urban and rural in Guangxi Province, China. They employed a teacher value-added model, which was nested in score, student, and teacher levels. Their findings showed that urban-rural gaps on students' standardized testing scores were largely dependent on teacher quality, rural students would have performed better if they had same high-quality teachers as urban schools. (Zhang, Jin, Torero, et al. 2018)

College enrollment rate is correlated with parents' educational achievement and family income background (Perna and Swail 2000) and parents who never went to college allow their children to choose less challenging courses in high schools. A recent study suggests parents' highest education is not correlated with children's college readiness but their highest education expectation for their kid is highly correlated with students' test scores (Asamsama, Octaviana Imelda Prima Hemmy, Mayo, Stillman, et al. 2016) .

A state-level study from Florida showed that math college readiness is correlated with advanced level math course taken in high school (Conger, Long and Iatarola 2009) , similarly, more rigorous algebra course can also improve students' chance of getting college ready (Gonzalez-Muniz, Klingler, Moosai, et al. 2012) . Strayhom examined the how students' perceptions of the extent to high school course, exposure to college information, and students' SES affect high school performance such as high school GPA, 12^{th}-grade NAEP math score, and 12^{th}-grade highest math level (Strayhorn 2014) .

There are several studies about college readiness in Texas. Barnes and Slate (2014) examined the college readiness rates of Black, Hispanic, and White public high school graduates from 2007 to 2009. The college readiness rates were defined as both Math and ELA ready, Math ready, and ELA ready. Their studies found out college readiness gaps remain large among minority groups of students (Barnes and Slate 2014) . Chandler and Slate (2014) investigated college readiness rates of economically disadvantaged, limited English proficient, and enrolled in special education students from 2007 to 2011 (Chandler, Slate, Moore, et al. 2014) . Another similar study has been conducted by Holden and Slate to examine the rates of learning disabled and economically disabled students (Holden, Slate, Moore, et al. 2017) . Welton and Williams (2015) use a qualitative case study to examine pressures of accountability on college-going culture in high “minority” and high poverty schools in Texas and revealed that accountability pressure leads schools to focus on the state exit exam. And high “minority” and high poverty schools suffer more from the accountability pressure sanctions (Welton and Williams 2015) . Marinez (2015) examined college readiness rates of students from low-income families and minority students from 2009~2012 and concluded that high-quality faculty and rigorous curriculum can help schools to better build up college-going culture (Martinez 2015) . However, most previous studies about Texas college readiness are more likely descriptive. Moreover, their data date back to 2012 when Texas' students still took TAKS tests. We also include a summary of the state percentage of both two subjects ready among different groups of students from 2009 to 2016 (see table6). Consistent with their findings before 2009, college ready gaps still remain big and both ready rate is slightly decreasing these years. Besides, there is no study related to college readiness for rural schools even though Texas has the most rural students across the country.

In this study, we want to analyze the effects of Texas' standardized tests on several college readiness measurement indicators for urban, suburban, and rural public schools in Texas.

Firstly, because one of the education goals set forth in HB 3 (81st Texas Legislature, 2009) is for Texas to rank nationally as one of the top ten states for graduating college-ready students by the 2019–2020 school year, we want to examine how the enactment of HB 3 affects college readiness, specifically how STAAR testing program affects college readiness compared to its previous testing program. Does STAAR work better than TAKS to help students prepare for college? Due to the high difficulty level assessment contents, EOC math and English pass rates dropped dramatically after Texas' students started taking STAAR test.

Secondly, we want to check if there are any college readiness differences between urban, suburban, exurban and rural Texas' public high schools. Also, according to the NCES report and what we find from our data set, rural high schools have the highest graduation rate compared to urban communities, on the contrary, the college enrollment rate of rural high schools is lower than suburban school, and slightly lower than urban high school in recent years.

We apply the percentage of rural population from the 2010 U.S. Census to divide Texas's 254 counties into four categories: urban (less than 20%), sub-urban (20%~50%), exurban (50%~80%), and rural (higher than 80%). Under this method, totally we have 45 urban counties, 73 sub-urban counties, 71 exurban counties, and 65 rural counties.

The remainder of this paper is organized as follows. In the next section, we provide a brief history of standardized testing and rural education in Texas. We then describe empirical approach and our data in section 3 and 4 followed by results section in 5.

2 Background

2.1 Standardized testing in Texas

Texas has a long history of the statewide standardized testing. In 1980, Texas State Legislature decided to test students on basic academic skills in third, fifth, and ninth grades in reading, writing, and mathematics. The testing program was called Texas Assessment of Basic Skills (TABS). This is also the first standardized testing program in Texas. Four years later, the Texas Educational Assessment of Minimum Skills (TEAMS) was launched because TABS was not considered rigorous enough. Later in 1991, another testing program with higher passing grade was introduced to replace the old one, which is Texas Assessment of Academic Skills (TAAS). Although TAAS had much tough requirements compared to TABS, it only covered Math and ELA. In 2001, a more comprehensive standardized testing program, Texas Assessment of Knowledge and Skills (TAKS) was introduced with two more subjects: social studies and science.

About ten years after the TAKS test was first implemented, in spring 2012 The State of Texas Assessments of Academic Readiness (STAAR) program, was implemented and currently employed in Texas' public schools. The STAAR test is considered to be the most difficult, highest stakes, and academically demanding standardized testing programs implemented in the state of Texas so far. The STAAR program was defined and designed, to help prepare students each year of their education to be on track for postsecondary readiness, including attending a college or university and career readiness. It includes annual assessment for grades 3 through 8 in reading, writing, science, social studies and End of Course (EOC) assessments for public high school students in Algebra I, English I, English II, biology, and U.S. history. The EOC test content standards are jointly supported by Texas' K–12 education, higher education agencies, and relative academic studies.

With the enactment of House Bill (HB) 3 (81st Texas Legislature, 2009), the legislature required that STAAR EOC assessments can be applied to measure college and career readiness. After taking these assessments, students are believed to potentially meet the college readiness performance standards and achieve postsecondary success. Therefore, it requires more rigorous courses, contents, assessments and graduation requirements than TAKS testing program. Since STAAR's high difficulty level, it has never stopped receiving criticisms from parents, students, and lawmakers. They criticize that STAAR has bigger graduation load for high school students, hurts chance of college administration, and lack of consistent statewide plans and standards.

2.2 Rural education in Texas

Because of Texas' demographic features of high student population and diversity, standardized testing is very important to Texas which aims to improve statewide academic performance. There are over 5 million students living in Texas as of 2015, and growing at a rate of 30,000 students per year in recent years. Almost half of these students are minorities, and one in fourteen is an English language learner (Showalter, Johnson, Klein, et al. 2017) . Because of the large high and African American student population in Texas, state educational gains depend heavily on how well these minority groups perform (Carnoy 2011) . According to the 2016-17 Texas Performance Texas Academic Performance Report, in academic year 2014/15, 74.5% students met the standard of college and career readiness, compared with only 62.9% African American and 71.8% Hispanic students that were college and career ready.

According to the U.S. Department of Education's National Center for Education Statistics, Texas has more schools in rural areas than any other U.S. states with over 20 percent of all Texas public schools are in rural areas. For year 2015~2016, there are 608,390 rural students in Texas, which is the highest number of rural student enrollment across states, much higher than the number of U.S. median 94,096. Rural family diversity and poverty are critical issues in Texas. About 44.7% students from a rural minority family, and 53.3% rural students are eligible for the free or reduced lunch program. Around 8.2% rural students are English Language Learners, compared to state average of 3.5%. Rural school districts are also struggling. They are facing with a financial and academic crisis, declining student enrollment, technological disadvantages, trouble recruiting and retaining high quality teachers, and even facing possible chances of shutting down because of their poor education performance and inferior financial conditions.

National Center for Education Statistics (NCES) 2014 report showed that rural high schools have the second highest graduation rate of any locale category, while less than one percentage point Suburban and Town categories, but almost ten percentage points higher than the graduation rates of the City category. Despite the facts of second highest graduation rates, the enrollment rates in higher education institutions are lower than any other locale recognized by NCES. From 2009~2015, rural schools have the highest high school graduation rate compared to urban and suburban areas (see Figure 5), almost same for both Math and ELA college ready rate (see figure 2), however, the enrollment rate of attending postsecondary institutions are lower than suburban high schools (see figure1). According to previous studies, this is probably caused by the natural character of rural economies which plays an important role shaping students' education attainment thoughts. As a result of small-scale land-based economies, students from rural areas do not value higher education necessary or valuable of participating in the rural economy (Atkin 2003; Howley and Howley 2010; Stone 2017) . Therefore, in our study, we would like to apply Hierarchical Linear Model (HLM) to look into deeply what higher level (district or county) factors stop rural high school graduates attending higher education institutions.

3 Empirical Approach

Hierarchical model, also referred to as multilevel or multi-effect model, is one of the widely used models in education literature (Bryk and Raudenbush 1988; Lee and Bryk 1989; Marsh 1990; Raudenbush and Bryk 1986) . The use of single-level model may conceal more than it will reveal, since the effects of policies or changes implemented at the school, district or county level may occur within schools (Raudenbush and Bryk 1986) .

There are several papers using Hierarchical Linear Model to examine college readiness. Strayhom applied a two-level (student, high school) HLM to see how students' perceptions of the extent to high school courses, exposure to college information, and students' SES affect college readiness indicators including high school GPA, 12^{th}-grade NAEP math score, and 12^{th}-grade highest math level (Strayhorn 2014) . DeAngelo and Franke (2016) used a two-level (student, higher education institution) Hierarchical Generalized Linear Model (HGLM) model to examine the relationship between first-year retention and student-level factors associated with socioeconomic status (DeAngelo and Franke 2016) . Another two-level HLM analysis was conducted to illustrate first-year college GPA is the best predictor for college readiness (Geiser and Santelices 2007) . In our study, we will apply a two-level (school, county) HLM model to see how standardized testing affects college readiness measurement indicators.

In the first stage, the college readiness indicators were regressed on standardized test pass rates and other school characteristics within each school. Then the estimated slopes, school-level estimation regression coefficients, from this first stage become the outcomes in the second stage analysis, which attempts to explain variations in slopes on the basis of a range of county-level socioeconomics variables.

First stage, school level (within county):

$$y_{ij} = \beta_{j0} + \beta_{j1}X_{ij1} + \beta_{j2}X_{ij2} + \cdots + \beta_{jK-1}X_{ijK-1} + \varepsilon_{ij}$$

Second stage, county-level (between county):

$$\beta_{jk} = \theta_{0k} + \theta_{1k}Z_{1j} + \theta_{2k}Z_{2j} + \cdots + \theta_{P-1,K}Z_{P-1,j} + u_{jk}$$

for $i = 1, \dots, N$ schools in county j ; $j = 1, \dots, J$ counties; $k = 0, \dots, K-1$ intendent variables in the school level; y_{ij} are outcomes of college readiness indicators; X_{ijk} are school level standardized pass rate and school characteristics variables; ε_{ij} is random errors; β_{jk} are regression coefficients characterizing school effects; for $p = 0, \dots, P-1$ independent variables in the county. level; Z_{pj} are county level independent variables; θ_{pk} are the county level regression coefficients. Errors are clustered at county level. We assume ε_{ij} and u_{jk} are normally distributed, $\varepsilon_{ij} \sim N(0, \sigma^2)$, $u_{jk} \sim N(0, \tau_j^2 I)$.

Meanwhile, we will apply a Bayesian model to our hierarchical linear model. There are several advantages of the application of Bayesian methodology in a hierarchical model: a) prior may contain knowledge from the data; b) flexibility of dealing with multilevel structures of using priors; c) ability to handle model misidentification. May (2006) used a Multilevel Bayesian Model to handle two primary problems when measuring students' SES across multiple countries: missing data and incomparable data (May 2006) . A Bayesian pattern-mixture model has the flexibility to incorporate models with missing data on both dependent variables and time-varying independent variables (Kaciroti, Raghunathan, Schork, et al. 2006) .

Here is a generalized Bayesian empirical approach to hierarchical model,

For the first stage—school level,

$$\boldsymbol{y}_j = \boldsymbol{X}_j\boldsymbol{\beta}_j + \boldsymbol{R}_j$$

where $\boldsymbol{y}_j$ is a $n_j \times 1$ vector of outcomes, $\boldsymbol{X}_j$ is a $n_j \times K$ matrix of intendent variables at school level, $\boldsymbol{\beta}_j$ is a $K \times 1$ vector of parameters, $\boldsymbol{R}_j$ is a $n_j \times 1$ vector of random errors, where $\boldsymbol{R}_j \sim N(0, \sigma^2)$. Since $\widehat{\boldsymbol{\beta}}_j = \boldsymbol{\beta}_j + \boldsymbol{v}_j$, then $var(\boldsymbol{v}_j|\boldsymbol{\beta}_j) = var(\widehat{\boldsymbol{\beta}}_j - \boldsymbol{\beta}_j|\boldsymbol{\beta}_j) = var(\widehat{\boldsymbol{\beta}}_j|\boldsymbol{\beta}_j) = \sigma^2(\boldsymbol{X}_j{}'\boldsymbol{X}_j)^{-1} = \boldsymbol{V}_j$, where $\boldsymbol{v}_j$ a $K \times 1$ vector of random error of $\boldsymbol{\beta}_j$ and $\boldsymbol{V}_j$ is a $K \times K$ matrix of sample variance for each $\hat{\beta}_{jk}$ correspondingly.

For the second stage—county level,

$$\boldsymbol{\beta}_j = \boldsymbol{Z}_j\boldsymbol{\theta} + \boldsymbol{U}_j$$

where $\boldsymbol{Z}_j$ is a $K \times P$ vector of county level independent variables, $\boldsymbol{\theta}$ is a $P \times 1$ vector of county level regression coefficients, and error $\boldsymbol{U}_j \sim N(0, \tau_j^2)$. Then $var(\boldsymbol{U}_j|\boldsymbol{Z}_j) = var(\boldsymbol{\beta}_j - \boldsymbol{Z}_j\boldsymbol{\theta}|\boldsymbol{Z}_j) = var(\boldsymbol{\beta}_j|\boldsymbol{Z}_j) = \boldsymbol{T}_z$, where $\boldsymbol{T}_z$ is a $K \times K$ matrix of parameter dispersion after accounting for county level effects.

Therefore, $\widehat{\boldsymbol{\beta}}_j = \boldsymbol{\beta}_j + \boldsymbol{v}_j + \boldsymbol{Z}_j\boldsymbol{\theta} + \boldsymbol{U}_j$ and the total dispersion of coefficients can be divided into sample variance and parameter dispersion,

$$\mathrm{var}(\widehat{\boldsymbol{\beta}}_j|\boldsymbol{Z}_j) = \mathrm{var}(\widehat{\boldsymbol{\beta}}_j|\boldsymbol{\beta}_j) + \mathrm{var}(\boldsymbol{\beta}_j|\boldsymbol{Z}_j) = \boldsymbol{V}_j + \boldsymbol{T}_z$$

Under OLS and GLS theory,

$$\widehat{\boldsymbol{\beta}}_j = (\boldsymbol{X}_j{}'\boldsymbol{X}_j)^{-1}(\boldsymbol{X}_j{}'\boldsymbol{y}_j) \text{ and } \widetilde{\boldsymbol{\beta}}_j = \boldsymbol{Z}_j\boldsymbol{\theta}^*, \text{ where } \boldsymbol{\theta}^* = \left(\boldsymbol{Z}_j{}'\boldsymbol{T}_z^{-1}\boldsymbol{\beta}_j\right)^{-1}(\boldsymbol{Z}_j{}'\boldsymbol{T}_z^{-1}\boldsymbol{\beta}_j)$$

The empirical Bayes theory yields the following weighted estimation coefficients,

$$\boldsymbol{\beta}_j^* = \boldsymbol{W}_j\widehat{\boldsymbol{\beta}}_j + (I - \boldsymbol{W}_j)\widetilde{\boldsymbol{\beta}}_j$$

where $\boldsymbol{W}_j = \boldsymbol{T}_z(\boldsymbol{V}_j + \boldsymbol{T}_z)^{-1} \in [0,1]$ is a reliability coefficients, as the ratio of true parameter variance to the total observed variance. The Bayes estimate $\boldsymbol{\beta}_j^*$ is weighted combination of estimation of each school within counties $\widehat{\boldsymbol{\beta}}_j$ and mean slope for the population of counties $\widetilde{\boldsymbol{\beta}}_j$. $\boldsymbol{\beta}_j^*$ primarily depends on the more reliable parameter between school level $\widehat{\boldsymbol{\beta}}_j$ and county level $\widetilde{\boldsymbol{\beta}}_j$.

4 Data

Our dataset includes four different categories: student performance on standardized tests, school demographics, college readiness indicators and county level demographics.

The first three categories are school-level data from Texas Academic Performance Report (TAPR), Academic Excellence Indicator System (AEIS), and Texas Higher Education Coordinating Board (THECB). These data are all available to the public. These data contain information on all Texas public high schools, Texas public two-year colleges, and Texas public four-year universities from 2009~2016 (higher education institution data are available 2009~2015). County-level demographics data are collected from U.S. Census Bureau to account for higher level countywide peer effects (Sass 2006) . Data is also available from 2009 to 2016 (see table 13). We exclude charter schools from our study because of the wide variability of curricula, school structures, grade levels, and student diversity (Barnes and Slate 2014) and schools under Alternative Education Accountability Rating System. Schools not rated and data not reported due to confidentiality are also excluded from our dataset. Texas Academic Performance Report (TAPR) was available from 2013~2017, and Academic Excellence Indicator System (AEIS) was available from 2003~2012. Both of these two reports include statewide comprehensive information of Texas students' performance and school demographic characters for each academic year. There are a few reasons that we use school level aggregated data in our research. First, this is the lowest level of unit of observation provided in the public dataset, and it allows to control for within schools variations; second, policymakers and public pay more focus on school level performance (Papke and Wooldridge 2008) , which also determines the school's capability of receiving funding from government; and third, aggregated school-level data focusing on urban-rural disparities can reveal differences among these groups (Barnes and Slate 2014) .

4.1 School demographics

Table 1 summarizes school demographic data from 2009 to 2016, include the number of total students, number of grade 12 students, percentage of economically disadvantaged students, operating expense per student, average teaching experience and number of students per teacher. Rural schools have the smallest school size, highest operating expense per student (12089.61), highest average teaching experience (13.89), and lowest number of students per teacher (9.29). Urban schools have the highest percentage of economically disadvantaged (53.38), lowest average teaching experience (11.81), and highest number of students per teacher (14.97). We also include school demographics summary of excluded schools. Compared to schools in our dataset, the excluded schools have smaller size of students, especially 12th grade students, higher rate of economically disadvantaged students, less average teaching experience, and smaller teacher student ratio (see table 12). Expenditure per student, teacher experience, and pupil teacher ratio are often considered to measure school quality(Card and Krueger 1992; Ehrenberg and Brewer 1994) .

4.2 Standardized Tests Pass Rate

Table 2 summaries the standardized testing pass rate for STAAR and TAKS. The standard of passing STAAR/TAKS assessments in Phase1 is Level II: Satisfactory Academic Performance.

A student can only pass the STAAR/TAKS test whose score is within Level II or III (Advanced Academic Performance), otherwise fails when scoring at level I (Unsatisfactory Academic Performance). TAKS test include four subjects at grade 11, mathematics, English, science and social science. Since we would like to compare students who graduate in the same year, then TAKS pass rate data are from the next year of reports, namely students who graduate at grade 12. Starting from 2011-12, students from Texas public high school have to take a new standardized testing program—STAAR End of Course (EOC) test as part of their graduation requirement. The EOC test includes five subjects: mathematics, biology, English1, English2 and U.S. history. High school students enrolled in grade 9 at 2011–12 school year will be required to take the STAAR End of Course (EOC) assessments, and students enrolled in grade 9 before that will continue to take TAKS test through they graduation. The last group of students who take TAKS test graduated in 2014. Therefore, TAKS test pass rate in our data set is from 2009 to 2014. Unlike TAKS test that students having to take it at the fixed grade, students can take STAAR EOC test whenever they complete the course, which brings some difficulties to our data collection. We contacted a local principal and got information that usually high school students take Algebra 1 at grade 9 and English II at grade 10. Indeed, we use this information to measure our STAAR EOC pass rate. To be consistent with students graduating at grade 12, 2015 Algebra 1 is from report of 2012, English II is from report of 2013; 2016 Algebra I is from report of 2013, and English II is from report of 2014. Both two standardized testing programs include mathematics, English language arts (English1, English2), science(biology) and social science (U.S. history), these subjects are consistent with previous studies of knowledge required for high school students. In order to consistently measure Mathematics and ELA college ready, we only report Math and English pass rates for both two tests: we use TASK grade 11 math and English, STAAR EOC Alegra1 and English II. Moreover, since the satisfactory levels of standardized tests vary every single year, it would be meaningless if we just compare with the average score of each school. The pass rate can perfectly avoid this problem, meanwhile, policymakers are more interested in passing rate instead of average scores. However, in order to protect students' confidentiality, if the numerator is less than 5 and the denominator is less than 5, then the pass rate is recorded as missing. We have to exclude these parts from our data. From table 1 we can clearly see that STAAR test pass rate is significantly lower than TAKS test for both two subjects, drops from 86% to 77% of math and decreases from 93% to 76% of ELA. These changes are from the rigor of items by assessing students' skills at a deeper level for STAAR test. We don't observe big differences among four areas, rural schools even perform a little better than other three areas.

4.3 College Readiness Indicators

Table 3 summarizes three categories of school-level college readiness measurement indicators, including % meeting exit level, SAT/ACT performance, high school graduation or drop rate, also we include data of student's postsecondary institution enrollment rate. Data is reported in the next year of TAPR or AEIS.

Both Ready rate is defined of graduates meeting or exceeding the Texas Success Initiative (TSI) criteria in both reading/English language arts (ELA) and mathematics on the exit-level of standardized test, SAT, or ACT test. The college readiness criteria are established by Texas Education Agency, also the criteria are consistent for both TAKS and STAAR test periods. When a student receives higher than 2200 scale score on ELA test and a "3" or higher on essay, indicating the student meets exit-level of ELA standardized test and marked as "Reading Ready"; similar to ELA, if a student receives higher than 2200 scale score on Math test, indicating the student meets exit-level of Math standardized test and marked as "Math Ready"; if a student achieves both these two criteria at the same time, then it can be marked as “Both Ready”. We cannot observe significant differences among these four areas, rural schools perform slightly worse than urban schools. Alternatively, TEA also applies college entry tests--SAT/ACT scores to measure college readiness. If the student’s score is above the criterion, then the student is marked as “SAT/ACT Above Criteria”. The criterion scores are defined as a combined score of 1110 on the critical reading and mathematics sections of the SAT and a composite score of 24 on the ACT. Urban schools have the highest SAT/ACT taking rate and above criteria rate, suggesting graduates from urban areas are more likely to enroll in higher education institutions. Even though rural schools’ SAT/ACT taking rate is second highest, their above criteria rate is the lowest. And in figure 4, we can observe that in 2014, rural schools’ average SAT/ACT above criteria rate experienced a big increase, which may be led by oil crash starting from 2014. Graduates from rural areas cannot find a job after graduation, instead they are going to college or universities. This observation is consistent with Figure 7 of higher education enrollment rate. Four-year graduation rate and drop rate are also included. For some schools which don’t have four-year graduation rate or drop rate, we use five-year graduation rate, or graduation/drop rate of Minimum High School Program (MHSP), Recommended High School Program (RHSP), or Distinguished Achievement Program (DAP). Many parents and educators criticize that STAAR hurts student’s high school graduation rate, however, based on our observations, high school graduation rate slightly increase after the enactment of STAAR testing. And rural schools have the highest high school graduation rate, oppositely, urban schools have the lowest graduation rate.

The enrollment rate is students enrolled in Texas Public Higher Education Institutions 2009~2015 including four-year universities and two-year institutions. Texas higher education enrollment rate is slightly decreasing in the past years until 2014. As explained before, it may be cause by oil crash in Texas starting from 2014. More graduates choose to continue their studies instead of working directly. Enrollment rates of these four areas are pretty similar, exurban has the lowest rate (51.90%). From Figure7, generally, students from rural or exurban areas are less likely to enroll in colleges or universities in the following fall after graduation compared to urban or suburban peers.

Table 4 summarizes high school graduates' performance in Texas public higher education institutions from 2009 to 2015. These part of data shows students' performance of the next following academic year after graduation. Student performance is measured by the first year GPA earned by high school graduates who attended Texas public four-year university or two-year college in the following year. If a high school has fewer than five students attending Texas public higher education institutions, or a high school has less or equal than 25 graduates, then there is no data reported. First-year college GPA is often considered as a more accurate college readiness measurement indicator than student high performance. From our data, we can see that over 30% schools receiving GPA under 2 from their first year of two-year college, and around 23% students receiving GPA under 2 from their first year of four-year university. Even though almost 50% students are considered both Math and ELA ready to enroll in college, their academic performance at first year of college is comparatively bad. Still, there are not significant differences between these four areas. For both enrollment rate and first year GPA, given by the limitation of dataset, we may lose some observations, but we still would like to see enrollment trend and students' higher education performance.

4.4 County-level Demographics

Table 5 summaries county-level data including median household income, the percentage of adults holding a high school or higher degree, the percentage of adults holding a bachelor or higher degree, and unemployment rate in order to account for higher level effects on college readiness. Also, there are big disparities of county-level among four communities. The percentage of adults holding a bachelor or higher degree (27.19%) and median household income (52247.57) from urban areas are highest than the other three areas, compared with only 16.86% adults from rural areas holding a bachelor or higher degree.

5 Preliminary Results

5.1 Single-level school fixed effects

We begin with single level—school level model, on the relative contribution factors on college readiness indicators. We apply Math/ELA both ready, SAT/ACT performance, SAT/ACT taking rate and high school graduation rate to see how standardized pass rate, school demographics, test dummy and county demographics variables affect college readiness indicators in Table 7. We apply within-school fixed effect model to see how these predictors affect college readiness indicators within each year across years.

There are three main conclusions drawn from Table 7. First off, math pass rate of standardized tests within each school help students prepare better for both math and ELA college ready, SAT/ACT test performance and improve high school graduate rates; ELA pass rate also has significantly positive effect on both ready and SAT/ACT performance. For example, if math pass rate at one school increases by 1 unit, then then both ready rate will increase by 0.24 correspondingly. Moreover, from the test dummy variable that, TAKS test work better than STAAR on both ready, and STAAR perform better on SAT/ACT performance and high school graduation rate. This finding suggests that no matter either TAKS or STAAR test, with more students meeting satisfactory level standards for mathematics and ELA, the percentages of students getting ready for college are higher. If a student is well prepared for standardized test in Texas, he/she is more likely to get ready to enroll in higher education institutions.

Second, school demographics characteristics play important roles on graduates' college readiness. Average teaching experience has positively significant effects on both ready and SAT/ACT above criteria rate. If a school has more experienced teachers, the students from this school can better prepare for college. However, it shows a negative effect on high school graduation rate. Teacher/student ratio also positively affects high school graduation rate. It is important to improve teacher quantity and quality in order to increase students' college ready rate. We use percentage of economically disadvantage students to capture family income effects. Operating expense per student doesn't demonstrate significant effects within schools on college readiness indicators except for SAT/ACT taking rate, which we will discuss later. Meanwhile, we include some county level variables in single level model to see how county effects account for college readiness indicators. From the results of Table 7, the percentage of adults holding a bachelor degree has a significant positive effect on school's college readiness within schools across years, suggesting with more people higher educated in the counties, there are more high school students getting ready for college. Meanwhile, median household income also positively affects both ready rate and high school graduation rate.

Finally, we do not observe quite many factors contributing to SAT/ACT taking rate, that's why we would like to dig deep to apply a two-level hierarchical model (multilevel model) to account for countywide mixed effects to see what other higher-level factors affecting college readiness. The multilevel model allows us to see college readiness indicators–-into both within-groups and between-group components.

5.2 Hierarchical model estimation

Table 8 presents the results of two-level analysis of college readiness indicators on both school-level and county-level factors. We would like to see if any changes compared to single level within school model. Likelihood Ratio test results show that two-level model is more favorable than single-level model in this study. In this hierarchical model, we include both within-group and between group effects. Math county mean, ELA county mean, and county-level control variables (the percentage adults holding a bachelor or higher degree, unemployment rate, and median household income) capture between county effects, which shows how these predictors affect indicators across counties, other predictors demonstrate within group effects, suggesting the changes within each county.

First off, fixed effect coefficients of math and ELA pass rates are all positively and significantly correlated with four college readiness indicators both ready, SAT/ACT above criteria, SAT/ACT taking rate and graduation rate. And the coefficients from two-level model are slightly bigger than single level model, which indicates that predictors have bigger effects at higher level model. This finding is also consistent with the highest level, between group, estimated coefficients. At single level model, SAT/ACT taking rate is not correlated with neither of pass rates, this finding suggests that countywide factors play a bigger weight role at SAT/ACT taking rate. A county with higher standardized testing passing rates, average teaching experience, teacher/student ratio, percentage of adults holding a bachelor degree, then this county has more students getting ready for college. Except for SAT/ACT taking rate, random effect coefficients of math and ELA positively affect other college readiness indicators. Meanwhile, at random effect part, we get variance of math and ELA coefficients to obtain reliability coefficient to account for county effects for the college readiness indicators. The results show that school level effects mostly account for college readiness indicators for coefficients of math and ELA pass rate. For example, with a unit increase of math pass rate, high school graduation rate will increase by 0.17 unit and 0.32 unit across counties.

Secondly, school demographics estimation results are similar to single level models'. Average teaching experience and teacher-student ratio have significantly positive effects on both ready and SAT/ACT above criteria rate within counties. No matter at single school level or accounting for county level, teacher quantity and quality are very important to students' college readiness preparation. The percentage of economically disadvantaged students are negatively with these four indicators. At a higher-level model, coefficients of this proxy variable are consistent for all four indicators, indicating that the percentage of economically disadvantaged students has a negative effect across schools within counties. Also, fixed effect of operating expense per student at county level are significant for all four indicators. Both of these two financial condition predictors consistently demonstrate that with better-off families and school districts, more students are better prepared for college. Meanwhile, the percentage of adults holding bachelor degree has a positive effect on both ready, SAT/ACT taking rate and performance across counties. However, it has a negative effect on high school graduation rate. We believe this is led by big portion of urban schools in our dataset. Urban high schools have the lowest graduation rate, however, urban area's rate of holding bachelor degree is the highest. Median household income positively affects both ready and SAT/ACT performance, a negative effect on SAT/ACT taking rate across counties. In this case, median household income's reliability coefficient is 0.18, indicating 18% of county effect account for high school graduation rate.

Thirdly, except for both ready, the introduction of STAAR has a positive effect on SAT/ACT above criteria and taking rate, and high school graduation rate in the hierarchical model.

Especially SAT/ACT taking rate at single-level model is not significant, indicating within county effect account for the SAT/ACT taking rate.

5.3 College enrollment and first-year GPA

Since we only have data from 2009 to 2015, we separately estimate enrollment rate and first year GPA models. Table 9 shows the estimation results of both single level within school model and hierarchical model of Texas public higher education institutions. Model 1 presents single level within school model estimation results. The estimation results show that ELA pass rate has a strong and positive effect on college enrollment rate, unlike to what we find before, math pass rate does not positively affect college readiness indicators within schools across years. Average teaching experience and teacher-student ratio do not show significant effects on college enrollment rate. Percentage of economically disadvantaged students and median household income have strong negative effects on college enrollment rate, indicating family income background is important to students' going to higher education institutions. The percentage of adults holding bachelor degree and household income have negative effects on college enrollment rate. Since our dataset only includes students going to Texas Public Higher Education Institutions, these confusing coefficients may indicate that counties with higher percentage of adulating holding bachelor degree and higher median household income, high school students probably go to private or out of state institutions.

Model 2 is two-level hierarchical model including county level fixed and random effects. The fixed effect coefficients of math pass rate and ELA pass rate are significantly positive, indicating standardized testing positively help more students enroll in higher education institutions within counties. However, the random coefficients do not show strongly significant impacts on enrollment rate across counties, suggesting the standardized testing at school levels has more powerful explanatory. Meanwhile, consistent with previous findings, teacher quality and quantity are positively correlated with college enrollment. The percentage of economically disadvantaged students is negatively correlated. Moreover, STAAR test works better than TAKS at county level to improve higher education institution enrollment rate. However, at school level, the coefficient is not significant.

Table 10 presents the results of higher education institution first year GPA performance under both within school fixed effect model and hierarchal model. The dependent variable we apply here is percentage of first year GPA greater than 3 for both two-year colleges and four-year universities. Math pass rate has positively significant effects under both four models, which suggests that if students are well performed at math standardized testing at high school level, they can also receive good academic performance at first year of higher education institutions. With more students scoring above math satisfactory standard, there are more students receiving GPA greater than 3 at first year of colleges and universities. The estimated regression coefficients of hierarchical model are higher than the corresponding single level coefficients, indicating math pass rate has a bigger explanatory power at higher level; ELA meeting satisfactory standard are positively correlated with GPA great than three both at college and university in the hierarchical regression estimated results. This finding shows a very good link between high school performance and higher education performance. Meanwhile, high school average teaching experience also has strong and positive effects on first yea GPA. Coefficients of teacher/student ratio are only significant at county-level estimations. High school percentage of economically within counties level has negatively affect first year performance. Operating expense per student are only positively correlated with first-year GPA at 2-year college. Median household income shows significant positive effects at within school model, suggesting that when median income increase over years, students better perform at postsecondary institutions.

Another interesting finding is with the increase difficulty level of STAAR test, students' performance better at higher education institutions. First year GPA is considered as the best predictor of college readiness indicators, our findings are consistent with prior works and also show that STAAR and TAKS testing can help students to well prepare for the first year at higher education institutions.

5.2 College Readiness in Rural High Schools

In order to find out the urban-rural differences in college readiness for Texas public high schools, we used hierarchical model to estimate which we believe higher level demographic characteristics may contribute more on students' academic results. This part only covers rural highs schools.

Overall, we observe a less significant regression panel for rural areas compared to overall estimation results. School demographics variables like teacher experience, pupil/teacher ratio, and operating expense per student are not correlated with any of the college readiness indicators. But school level economically disadvantaged rate has a consistent negative effect on college readiness indicators, demonstrating family financial background is negatively correlated with students' college readiness.

In terms of standardized passing rate, both school level and county level mathematics standardized testing pass rates show significant positive effects on both ready and graduation rate; county level math pass rate positively affects college enrollment rate and school level math pass rate has a positive impact on 2-year college first year GPA; similarly, school and county level ELA pass rate positively affect both ready, county level ELA affects college enrollment rate and school level is positively correlated with SAT/ACT above criterial rate.

A very interesting finding is that a rural county's unemployment rate is significantly and negatively correlated with this county's college enrollment rate, which is not observed from overall regression results. With lowering unemployment rate, there will be more rural high school graduates going to college. From this perspective, the development of Texas rural economics affects high school students' going to college rate.

6 Conclusions

In this study, we examine the role of standardized testing on Texas public high school students' college readiness and also compare the differences between urban and rural communities. The results from using an 8-year large panel data set from Texas public high schools show that Texas' standardized STAAR testing program helps more students get ready for college compared to its previous standardized testing program TAKS. Gaps in education between urban and rural schools are also found in this paper.

Given on Texas' demographic features of high student population and diversity, standardized testing programs which are designed to improve students' academic performance are especially important in Texas. STAAR have been criticized after its launch for being difficult, it did have a positive effect on students' college readiness.

In addition to standardized testing passing rates, school demographics and teacher characteristics also play an important role in students' college readiness. Teacher's quality and quantity, schools' operating expense per student all positively impact college readiness indicators. These effects are more significant in higher level models. Social demographic characters can significantly affect educational outcomes. We found that high school students were more readily prepared for colleges if there were more adults within this county who had earned a bachelor degree or higher.

Urban-rural education gap was another focus of this paper. Compared to other states, Texas has the highest number of rural students. With respect to standardized testing ratings, we did not observe big differences between urban and rural schools, with rural schools perform slightly better than urban schools. We found notable differences between urban and rural schools with respect to SAT/ACT scores, college enrollment rate, and high school graduation rate. Consistent with previous studies, rural high schools rank highest on high school graduation rate, but college enrollment rate is a little lower than urban areas.

Figures and Tables

Figure 1 Standardized Test Math Pass Rate (2009~2016)

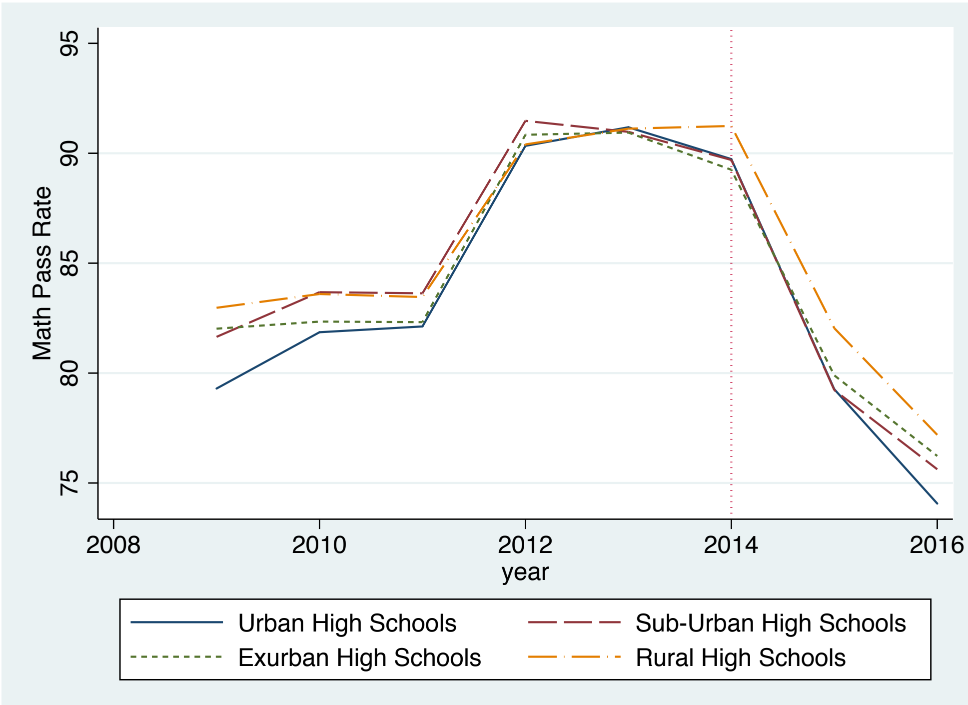

Figure 2 Standardized Test English Pass Rate (2009~2016)

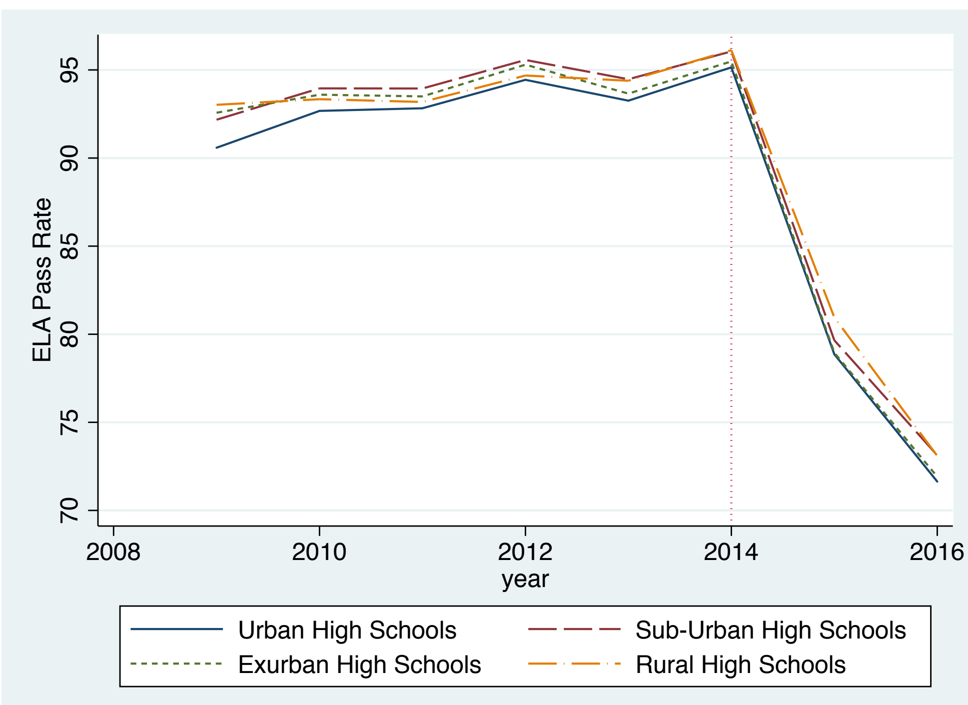

Figure 3 Both Math and ELA College Ready Rate (2009~2016)

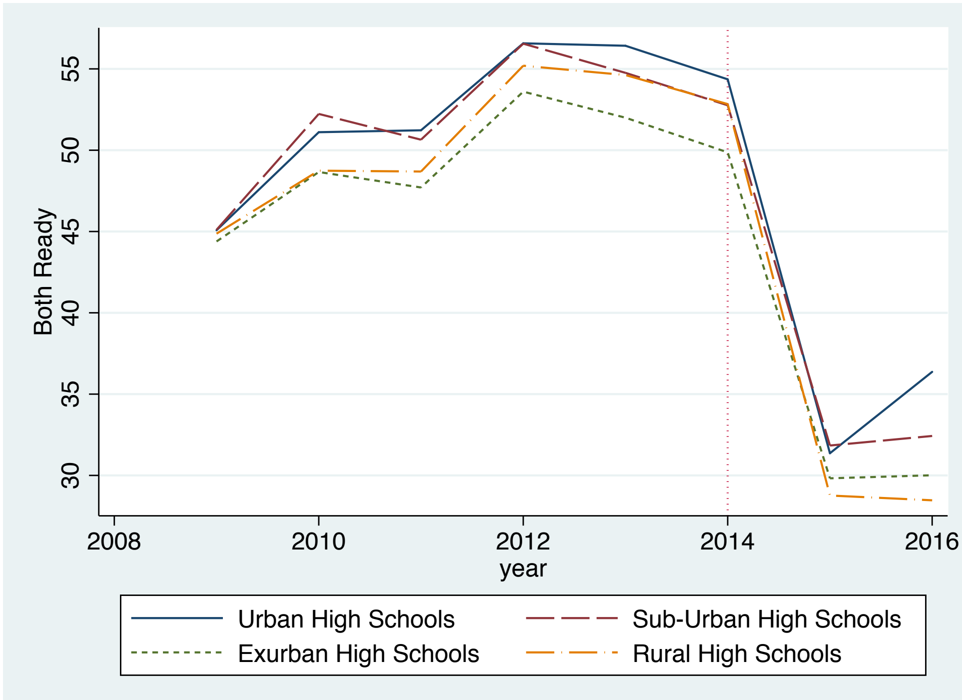

Figure 4 SAT/ACT Above Criteria Rate (2009~2016)

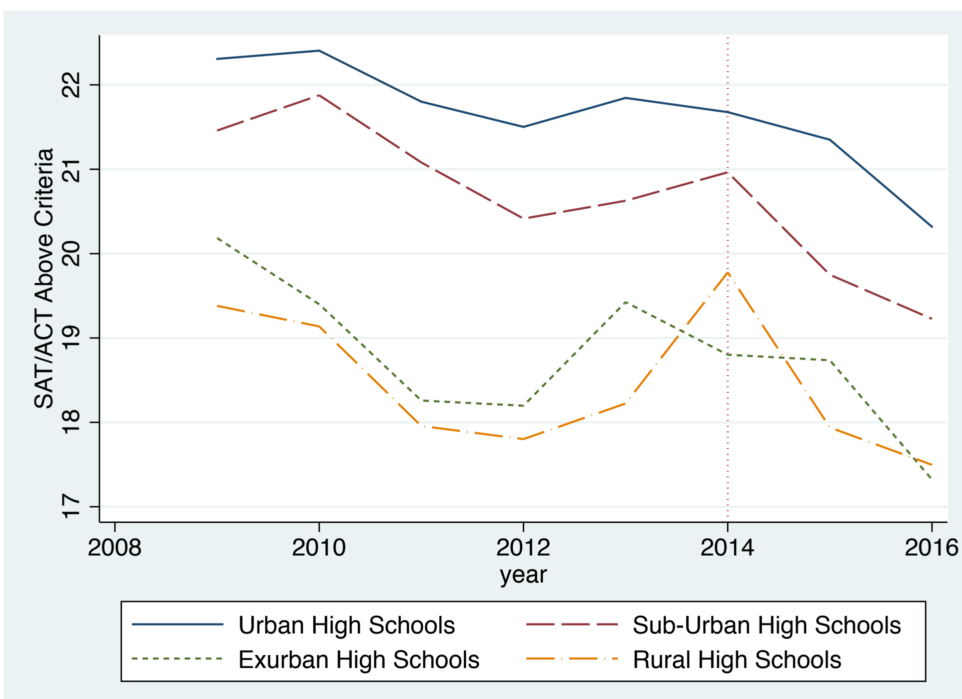

Figure 5 SAT/ACT Participation Rate (2009~2016)

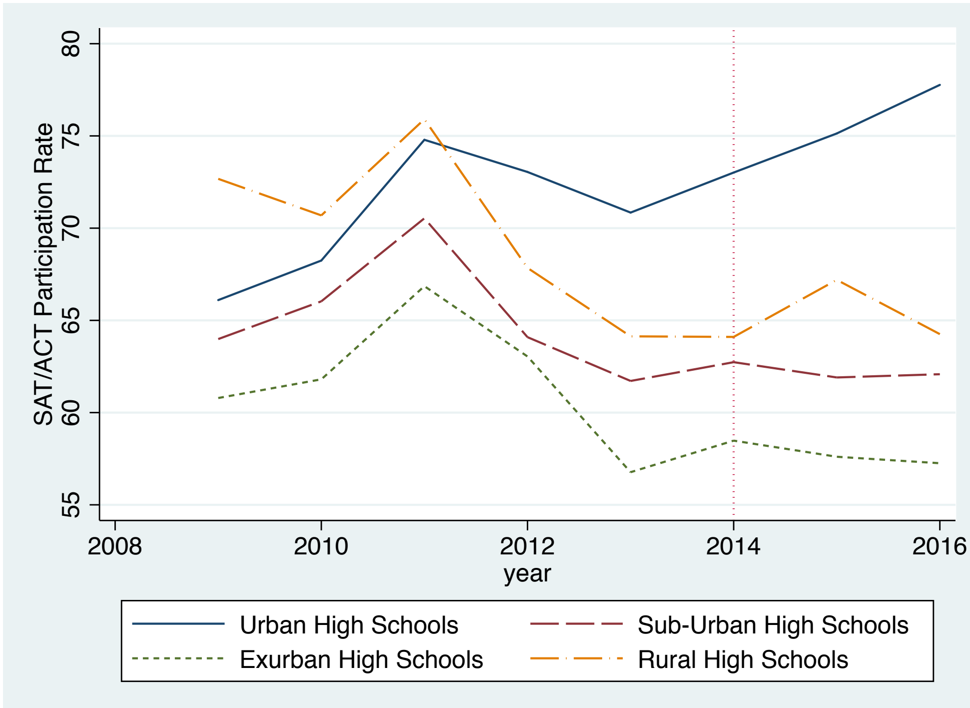

Figure 6 High School Graduation Rate (2009~2016)

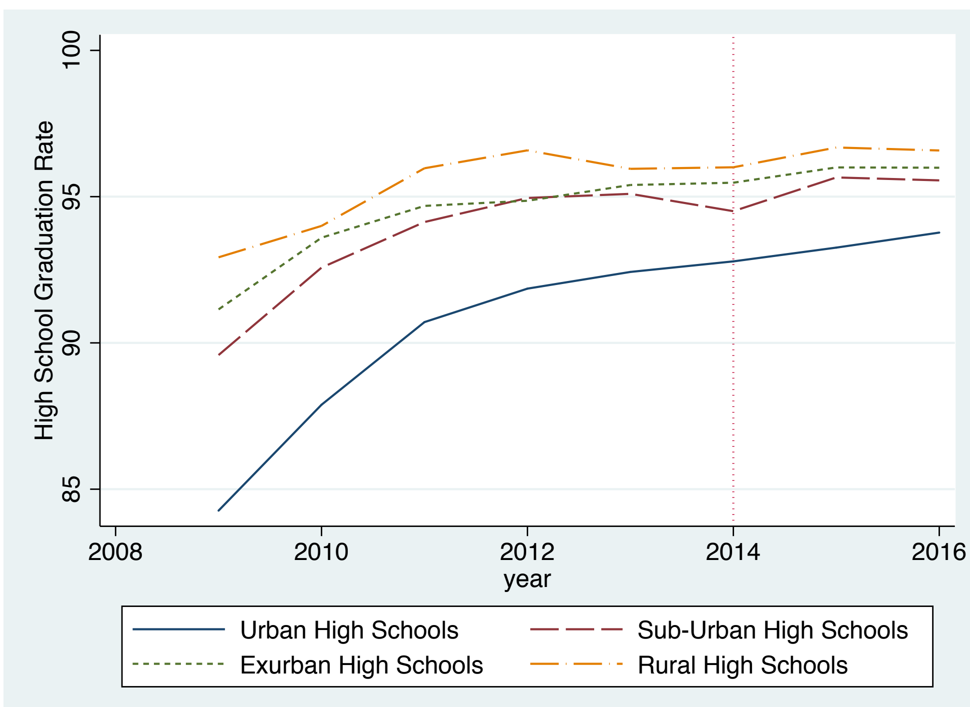

Figure 7 Texas Public Higher Education Institutions Enrollment Rate (2009~2015)

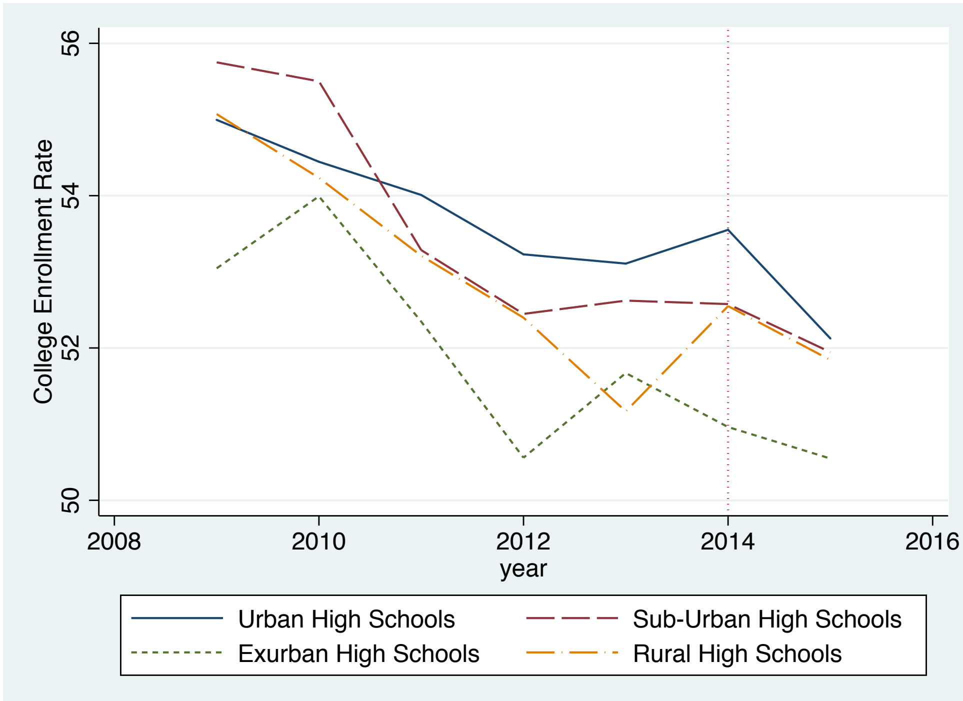

Table 1 Summary of School Demographic Information (2009~2016)

Variable	Urban		Sub-Urban		Exurban		Rural	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
School Demographics								
# of Students	1606.40	976.15	711.07	700.64	393.61	327.81	256.57	292.53
# of grade12 Students	357.40	235.39	150.27	158.13	79.07	77.40	47.99	65.11
% of Econ disadvantaged	53.38	25.70	48.29	18.26	50.40	15.72	51.39	17.18
Operating Expense per Student	9038.95	2170.39	9657.69	2079.13	9926.04	1739.99	12089.61	3496.18
Teacher Information								
Average Teaching Experience	11.81	2.36	12.84	2.38	12.95	2.52	13.89	2.61
Number of Students per Teacher	14.97	2.92	11.96	2.78	10.70	2.18	9.29	2.14
Observations	4674		2121		2468		968	

Table 2 TAKS&STAAR Test Performance: % Meeting Satisfactory Level (2009~2016)

Variable	Urban		Sub-Urban		Exurban		Rural	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
TAKS (2009~2014)								
Mathematics	85.97	10.09	86.93	9.17	86.32	9.70	86.97	11.08
ELA	93.22	5.50	94.39	5.49	94.02	5.27	94.08	5.96
Obs	3431		1579		1857		734	
STAAR (2015~2016)								
Mathematics	76.62	15.01	77.44	14.07	78.06	12.59	79.66	14.05
ELA	75.18	15.31	76.43	12.40	75.43	11.95	77.09	12.50
Obs	1243		542		611		234	

Table 3 Summary of College Readiness Indicators (2009~2016)

Variable	Urban		Sub-Urban		Exurban		Rural	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
% Meeting college-ready criterion for Math or ELA								
Both Ready	47.65	19.86	46.98	16.65	44.57	16.74	45.32	18.78
Math Ready	59.63	20.65	59.33	18.75	57.99	19.32	58.22	20.40
ELA Ready	59.66	18.75	59.95	16.57	57.73	16.83	58.00	18.62
SAT/ACT Performance								
Above Criteria Rate	21.62	17.82	20.66	12.18	18.79	11.92	18.48	12.12
Taking Rate	72.52	17.99	64.11	16.37	60.33	15.70	68.49	18.40
Four-year Graduation/Drop Rate								
Graduation Rate	91.03	8.01	94.05	5.93	94.64	5.58	95.53	5.37
Drop Rate	5.01	5.23	3.24	4.05	2.90	3.84	2.47	3.72
Obs	4674		2121		2468		968	
Enrollment Rate at Texas Public Higher Education Institutions (2009~2015)								
Rate	53.60	11.28	53.40	10.20	51.90	10.08	53.02	10.02
Obs	3917		1545		1697		477	

Table 4 Graduates' First Year GPA in Texas Public Higher Education Institutions (2009~2015)

Variable	Urban		Sub-Urban		Exurban		Rural	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Two-Year Public Colleges								
GPA<2.0	33.03	10.55	33.16	11.14	31.39	12.13	31.62	14.85
2.0<=GPA<2.50	15.14	5.57	15.10	7.12	15.31	8.38	15.10	10.10
2.5<=GPA<3.0	13.64	5.52	14.64	6.97	15.32	8.26	15.10	9.80
3.0<=GPA<3.50	16.53	6.39	17.29	8.02	17.94	9.15	17.36	10.73
GPA>3.5	13.14	8.23	13.69	8.38	14.14	8.77	13.99	10.60
Unknow	8.52	6.72	6.13	5.53	5.89	5.88	6.83	7.49
Obs	3884		1529		1686		462	
Four-Year Public Universities								
GPA<2.0	25.26	13.38	22.71	13.08	22.52	13.88	23.01	14.68
2.0<=GPA<2.50	16.04	6.70	16.06	9.35	16.14	10.74	16.29	11.19
2.5<=GPA<3.0	19.36	6.87	19.78	10.14	19.50	11.56	20.00	11.59
3.0<=GPA<3.50	20.88	8.41	21.92	11.30	22.12	12.82	21.30	13.59
GPA>3.5	17.56	11.10	18.61	11.86	18.82	12.99	18.47	12.84
Unknow	0.90	1.64	0.93	2.54	0.89	2.81	0.93	2.90
Obs	3886		1446		1432		427	

Table 5 County-level Demographics Summary Statistics (2009~2015)

Variable	Urban		Sub-Urban		Exurban		Rural	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
% holding high school or higher degree	76.84	11.28	75.09	12.58	76.62	11.40	75.94	11.58
% Holding Bachelor or higher Degree	27.19	8.99	18.32	6.51	15.36	3.93	16.86	5.81
Unemployment Rate	7.41	1.46	7.05	2.10	7.38	2.17	6.34	3.36
Median Household Income	52247.57	12881.11	46720.09	11108.64	44098.99	7441.78	43890.38	9826.78
Obs	4674		2121		2468		968	

Table 6 Summary of College Ready on Both Subjects (2009~2016)

year	State	African American	Hispanic	White	Asian	Special Education	Economically Disadvantaged	English language learner
2015-16	39%	22%	29%	55%	71%	6%	25%	9%
2014-15	35%	16%	22%	53%	65%	7%	19%	6%
2013-14	54%	38%	47%	67%	78%	8%	42%	8%
2012-13	56%	41%	48%	69%	77%	9%	45%	8%
2013-12	57%	41%	48%	69%	77%	8%	44%	8%
2012-11	52%	36%	42%	65%	75%	7%	38%	6%
2011-10	52%	36%	42%	65%	75%	7%	38%	6%
2010-09	52%	34%	42%	66%	74%	7%	38%	5%

Table 7 Fixed-Effect Estimation Results of College Readiness Indicators

	Both Ready	SAT/ACT Above Criteria Rate	SAT/ACT Taking Rate	High School Graduation Rate
Math Pass Rate	0.24***	0.04***	-0.01	0.09***
	(0.01)	(0.01)	(0.02)	(0.01)
ELA Pass Rate	0.07***	0.06***	0.03	-0.00
	(0.02)	(0.01)	(0.02)	(0.01)
Average Teaching Experience	0.20**	0.22***	-0.00	-0.08*
	(0.08)	(0.06)	(0.10)	(0.04)
Teacher/student Ratio	0.11	0.11	-0.00	0.11*
	(0.10)	(0.08)	(0.14)	(0.05)
% Econ Disadvantaged	0.06**	-0.09***	0.03	0.07***
	(0.02)	(0.01)	(0.03)	(0.01)
Operating Expense per Student	0.00	-0.00	0.00**	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
% Holding Bachelor Degree	0.19*	0.04	0.39**	0.21***
	(0.10)	(0.07)	(0.13)	(0.04)
% Unemployment Rate	0.24**	-0.22**	-0.46***	0.23***
	(0.09)	(0.07)	(0.12)	(0.04)
Median Household Income	0.00***	-0.00**	0.00	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
Test Dummy	-17.79***	0.71*	-0.21	1.86***
	(0.39)	(0.30)	(0.52)	(0.18)
School Fixed Effect	-14.63***	18.28***	52.83***	55.61***
	(3.30)	(2.47)	(4.31)	(1.53)
Prob > F	0.00	0.00	0.00	0.00
N	10231	10231	10231	10231

* p<0.05, ** p<0.01, *** p<0.001

Table 8 Hierarchical Estimation Results of College Readiness Indicators

	Both Ready	SAT/ACT Above Criteria Rate	SAT/ACT Taking Rate	High School Graduation Rate
School-level Fixed Effect				
Math Pass Rate	0.43***	0.13***	0.13***	0.17***
	(0.01)	(0.01)	(0.02)	(0.01)
ELA Pass Rate	0.23***	0.12***	0.27***	0.10***
	(0.02)	(0.02)	(0.03)	(0.01)
Math County mean	0.48***	0.20*	0.06	0.23***
	(0.08)	(0.10)	(0.20)	(0.07)
ELA County mean	0.76***	0.71***	0.31	0.32**
	(0.12)	(0.15)	(0.30)	(0.10)
Average Teaching Experience	0.61***	0.59***	0.20**	-0.02
	(0.05)	(0.04)	(0.07)	(0.03)
Teacher/student Ratio	0.86***	0.67***	0.78***	0.10***
	(0.06)	(0.05)	(0.08)	(0.03)
% Econ Disadvantaged	-0.32***	-0.42***	-0.12***	-0.06***
	(0.01)	(0.01)	(0.01)	(0.00)
Operating Expense Per Student	0.00***	0.00**	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
% Holding Bachelor Degree	0.16**	0.21**	0.58***	-0.20***
	(0.06)	(0.06)	(0.15)	(0.04)
% Unemployment Rate	-0.17	-0.04	-0.46	-0.28*
	(0.13)	(0.17)	(0.34)	(0.11)
Median Household Income	0.00*	0.00**	-0.00***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Test dummy	-11.40***	2.49***	4.69***	6.02***
	(0.38)	(0.33)	(0.52)	(0.19)
Fixed Effect	-65.99***	-69.85***	42.32*	49.98***
	(7.71)	(9.66)	(19.29)	(6.55)
County-level Random Effects				
School Mean Effect	0.00	0.00	0.00	0.00
Math Pass Rate	0.00	0.00	0.01	0.00
ELA Pass Rate	0.01	0.01	0.13	0.00
% Holding Bachelor Degree	0.00	0.14	0.20	0.01
% Unemployment Rate	0.00	0.00	0.00	0.00
Median Household Income	0.00	0.00	0.00	6.18
Residual	120.25	89.30	221.84	29.08
LR Test	0.00	0.00	0.00	0.00
N	10231	10231	10231	10231

* p<0.05, ** p<0.01, *** p<0.001

Table 9 Estimation Results of College Enrollment Rate

	Model1	Model2
School-level Fixed Effect		
Math Pass Rate	0.01	0.07***
	(0.01)	(0.01)
ELA Pass Rate	0.12***	0.34***
	(0.02)	(0.02)
Math County Mean		0.31*
		(0.13)
ELA County Mean		0.31
		(0.19)
Average Teaching Experience	0.07	0.24***
	(0.06)	(0.05)
Teacher/student Ratio	-0.13	0.55***
	(0.08)	(0.05)
% Econ Disadvantaged	-0.14***	-0.19***
	(0.02)	(0.01)
Operating Expense per Student	0.00	0.00***
	(0.00)	(0.00)
% Holding Bachelor Degree	-0.32***	0.04
	(0.08)	(0.07)
% Unemployment Rate	-0.10	-0.17
	(0.08)	(0.21)
Median Household Income	-0.00***	-0.00
	(0.00)	(0.00)
Test Dummy	0.66	3.61***
	(0.34)	(0.37)
School Fixed Effect	65.25***	2.48
	(2.78)	(12.11)
County-level Random Effects		
School Mean Effect		0.00
Math Pass Rate		0.00
ELA Pass Rate		0.00
% Holding Bachelor Degree		0.28
% Unemployment Rate		0.00
Median Household Income		0.00
Residual		60.81
F test	0.00	
LR test		0.00
N	7636	7636

* p<0.05, ** p<0.01, *** p<0.001

Table 10 Estimation Results of First Year GPA

	One Level		Two Levels	
	2-year College GPA>=3	4-year University GPA>=3	2-year College GPA>=3	4-year University GPA>=3
Math Pass Rate	0.07***	0.13***	0.20***	0.29***
	(0.02)	(0.02)	(0.02)	(0.02)
ELA Pass Rate	-0.03	-0.05	0.05*	0.13***
	(0.03)	(0.04)	(0.03)	(0.03)
Math County Mean			0.17	0.32**
			(0.13)	(0.12)
ELA County Mean			0.28	0.37*
			(0.19)	(0.18)
Average Teaching Experience	0.33***	0.38**	0.47***	0.59***
	(0.10)	(0.13)	(0.06)	(0.08)
Teacher/student Ratio	0.05	0.10	0.16*	0.32***
	(0.13)	(0.16)	(0.06)	(0.08)
% Econ Disadvantaged	-0.05*	0.04	-0.19***	-0.32***
	(0.02)	(0.03)	(0.01)	(0.01)
Operating Expense Per Student	0.00*	-0.00*	0.00***	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
% Holding Bachelor Degree	-0.00	0.48**	-0.06	-0.01
	(0.13)	(0.17)	(0.07)	(0.06)
% Unemployment Rate	0.29*	0.06	-0.23	-0.33
	(0.12)	(0.16)	(0.20)	(0.19)
Median Household Income	0.00***	0.00***	0.00	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)
Test dummy	4.59***	4.57***	7.46***	10.38***
	(0.54)	(0.71)	(0.48)	(0.62)
Fixed Effect	2.66	-19.13***	-11.36	-26.08*
	(4.50)	(5.78)	(11.69)	(10.91)
County-level Random Effects				
School Mean Effect			0.00	0.00
Math Pass Rate			0.00	0.00
ELA Pass Rate			0.00	0.00
% Holding Bachelor Degree			0.01	0.00
% Unemployment Rate			0.00	0.00
Median Household Income			13.17	11.80
Residual			101.61	161.11
F test	0.00	0.00		
LR test			0.00	0.00
N	7561	7191	7561	7191

* p<0.05, ** p<0.01, *** p<0.001

Table 12 Summary of Excluded School Demographic Information (2009~2016)

Variable	Urban		Sub-Urban		Exurban		Rural	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
School Demographics								
# of Students	233.50	386.50	109.14	242.56	61.62	128.72	57.69	72.33
# of grade12 Students	23.30	57.00	13.01	31.99	7.09	21.70	6.17	11.07
% of Econ disadvantaged	61.60	30.17	60.68	28.53	61.47	29.90	67.40	31.38
Teacher Information								
Average Teaching Experience	9.84	5.99	11.77	6.10	14.23	6.91	12.47	4.29
Number of Students per Teacher	11.30	7.01	10.12	6.56	9.00	7.02	7.23	4.68
N	5255		1461		692		356	

Table 13 Data Source

Variables	Year	Data Source
School Demographics		
# of Students	2009-16	Texas Academic Performance Report (2009-12), Academic Excellence Indicator System (2012-16)
# of grade12 Students	2009-16	Texas Academic Performance Report (2009-12), Academic Excellence Indicator System (2012-16)
% of Econ disadvantaged	2009-16	Texas Academic Performance Report (2009-12), Academic Excellence Indicator System (2012-16)
Operating Expense per Student	2009-16	Texas Academic Performance Report (2009-12), Academic Excellence Indicator System (2012-16)
Average Teaching Experience	2009-16	Texas Academic Performance Report (2009-12), Academic Excellence Indicator System (2012-16)
Number of Students per Teacher	2009-16	Texas Academic Performance Report (2009-12), Academic Excellence Indicator System (2012-16)
TAKS&STAAR Test Performance		
Math Pass Rate	2008-16	Texas Academic Performance Report (2008-12), Academic Excellence Indicator System (2012-16)
ELA Pass Rate	2008-16	Texas Academic Performance Report (2008-12), Academic Excellence Indicator System (2012-16)
College Readiness Indicators		
Both Ready	2009-17	Texas Academic Performance Report (2008-12), Academic Excellence Indicator System (2012-17)
Math Ready	2009-17	Texas Academic Performance Report (2008-12), Academic Excellence Indicator System (2012-17)
ELA Ready	2009-17	Texas Academic Performance Report (2008-12), Academic Excellence Indicator System (2012-17)
SAT/ACT Above Criteria Rate	2009-17	Texas Academic Performance Report (2008-12), Academic Excellence Indicator System (2012-17)
SAT/ACT Taking Rate	2009-17	Texas Academic Performance Report (2008-12), Academic Excellence Indicator System (2012-17)
High School Graduation Rate	2009-17	Texas Academic Performance Report (2008-12), Academic Excellence Indicator System (2012-17)
High School Drop Rate	2009-17	Texas Academic Performance Report (2008-12), Academic Excellence Indicator System (2012-17)
Higher Education Institution Enrollment Rate	2009-15	Texas Higher Education Coordinating Board
First Year GPA	2009-15	Texas Higher Education Coordinating Board
County-Level demographics		
% Holding Bachelor Degree	2009-16	U.S. Census Bureau
% Unemployment Rate	2009-16	U.S. Census Bureau
Median Household Income	2009-16	U.S. Census Bureau

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