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**The Determinants of the High School Graduation Rate in Mclean County**

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## **Introduction**

During the last decade, schools and community organizations are using a rather new approach to improve education outcomes through the use of a collective impact model. A collective impact model joins together the community, schools, organizations and their resources to tackle one issue that could not be accomplished otherwise. Strive Together of Cincinnati was one of the first to use the collective impact model as a way to address the student achievement crisis within their community. Strive gathered over 300 local leaders from colleges, foundations, city government, school district representatives and more to participate in this movement. Despite the recent recession and budget cuts, Strive Together saw improvement in 34 out of 53 school indicators including high school graduation.

This year, organizations in Mclean County are using a model much like Strive where many aspects of the community are joining together to improve the graduation rate. The purpose of my research is to help schools and organizations better understand the factors that correlated with the high school graduation rate. I reports results for not only Mclean County, but also for the state of Illinois. To find the potential factors associated with the high school graduation rate, I use panel random effects and fixed effects multivariate regressions with data from Illinois State Board of Education. I examine the time period 2003-2014 and compare results for Mclean County, similar-sized counties, and Illinois (excluding Mclean County). To account for the change in the high school graduation definition, I then regress outputs based on time periods 2003-2010 and 2011-2014 to validate whether the results are consistent.

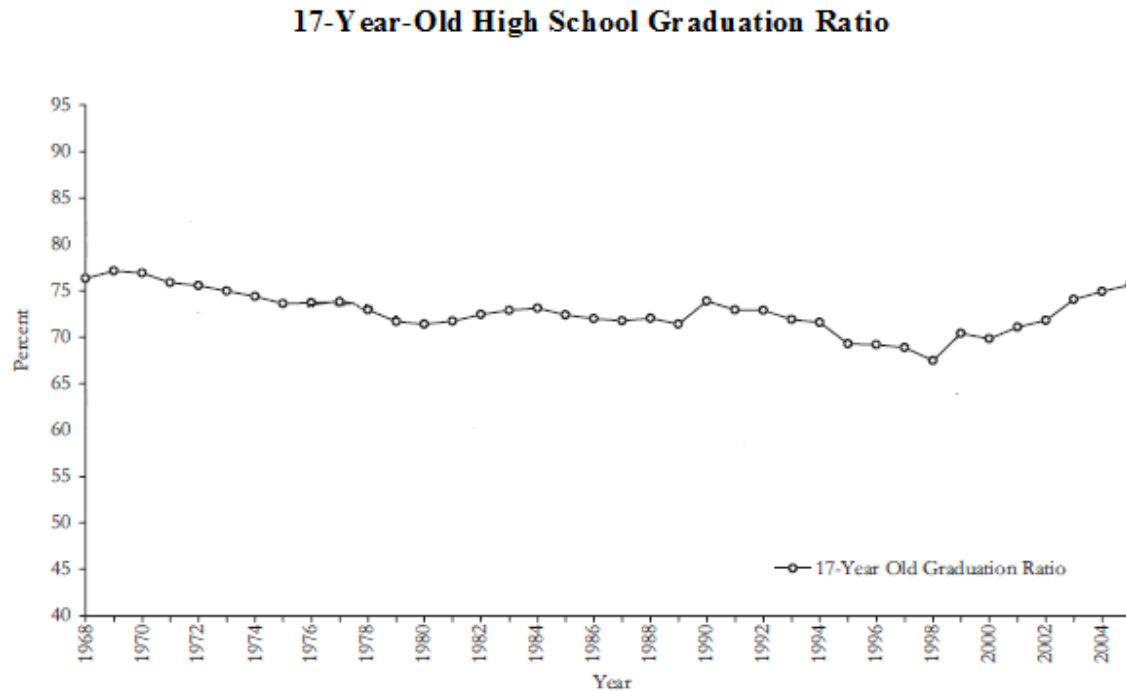
In Mclean County, the overall findings suggest that ACT scores is highly correlated with graduation rate which emphasizes the importance of student performance in the schooling process. A 1 point additional score on the average school's ACT score is correlated with a 1.681% increase in the graduation rate. Education policy can be implemented in order to improve student performance in both primary and secondary schooling as a way to benefit the high school graduation rate. I suggest that organizations and schools work together to offer students after school programs and resources such as tutoring so that students do not fall behind. Also, it would be beneficial if teachers spread awareness to parents that student performance is vital early on. Lastly, schools can monitor struggling students more closely so that they can direct students to the appropriate resources or programs. Others results indicate that average

class size, and average teacher salary are also positively correlated to the graduation rate though with minor significance.

### *Is the Graduation Rate a Problem?*

Recent concern in Mclean County has been voiced over improving the high school graduation rate due to the dramatic decrease it faced during 2011. For example, using data from Illinois State Board of Education Report Card in 2010, Bloomington district 87 had a graduation rate of 91.4% but the following year dropped to 76.4%. This not only happened in Bloomington district, but for the majority of schools in Illinois. The graduation rate for Illinois dropped 4% during the same time frame. Even though this may sound alarming, the decrease is attributed to the change in the high school graduation definition that occurred in 2011. The new definition, known as the 4-Year-Adjusted Cohort Graduation Rate is an estimator reported by all schools nationwide, whereas a uniform estimator was not reported previously. The most substantial change from previous definitions is that the new definition excludes unaccredited state equivalency diplomas which have been overestimating the graduation rate. The GED is not considered to be equivalent to a high school diploma, and in fact, shares social and economic characteristics closer to that of a high school dropout (Heckman 2010). Due to the change in definition, Mclean County schools along with schools nationwide have seen a sharp decline in their graduation rate. The change in definition has revealed a closer estimate to the true high school graduation rate which has been an issue for decades. Since the 1960's, the true graduation rate has remained stagnant until the 2000's, where it has seen a slight increase in recent years (Heckman 2010). Therefore, the graduation rate is an ongoing issue that needs to be addressed but not necessarily because of the decline in 2011. Figure 1 illustrates the 17-year-old ratio that Heckman (2010) used to estimate for the high school graduation rate.

Figure 1.



## Review of Literature

Literature on education attainment can be separated into two main categories: human capital theory, and education production functions. In Becker's *Human Capital* (1964), an individual views education as an investment that will yield future returns. An individual has a choice to work or forego work in response to the expected returns to education.

An early example of a human capital model is shown by Eckstein and Wolpin (1999). Eckstein and Wolpin estimate the utility of dropping out and find that youths who dropout have different traits than those who graduate. Dropouts have lower motivation, expectations about the rewards from graduating and lower consumption value of school attendance. Montmarquette et al. (2007), using a similar framework, find that females with educated parents and attending a private school have a strong preference of schooling. They also find that students are affected by a lower legal age to enter the market, higher minimum wages, and lower employment which increase the likelihood to dropout.

The drawback from using the human capital model approach is that it ignores schooling environment that may affect the decision to drop out. For example, a student may choose to dropout not necessarily due to the quality of schooling but rather due to bullying from other

students. In contrast to the theoretical human capital model, empirical studies using the education production function do consider the schooling environment but do not consider the individual's choice.

As described in Hanushek (1986) the education production function examines the relationship among the different inputs into and outcomes of the educational process. Education production functions vary from study to study, but typically contain inputs such as family, peers, school, and teacher characteristics. Studies also use different measurements of output such as student performance, years of education, dropout rate, or graduation rate as their output.

Connelly and Zheng (2003) use individual level data (Census Data from China) and logistic regression to study the determinants of high school enrollment and completion. They use logistic regression and community fixed-effects logit for five education milestones: (1) having ever attended primary school, (2) having graduated from primary school, (3) having attended middle school, (4) having graduated from middle school, and (5) having attended high school. Community fixed-effects allows for the differences in villages and controls for potential correlations between unobserved school quality and household variables. They find parental education and level of income are important factors for high school completion. However, their study finds the area of residence, gender and their interactions are most important.

Rivkin et al. (2005) use an extended specification of the education production function that includes a value-added measure in student's test scores depending on family background, teacher characteristics, school characteristics, and inherent student abilities. The value-added of student test scores allows for the influence a student's test taking history. Using individual level panel data on UTD Texas School Project, their study suggests a costly reduction of class size by ten students yields a smaller benefit compared to moving up one standard deviation up the teacher quality distribution. This finding reveals the importance of teacher quality which can be much less costly than reducing the classroom size.

The limitation to education production functions is that it is unknown to both the researcher and decision maker. Furthermore, the entire process of family, community, and school histories is rarely accessible. Also nonrandom sampling tends to be an issue because families choose where to live and which schools to place their children, while administrators choose which classes to place students (Rivkin, 2005).

Although education research is diverged between human capital theory and education production function, literature exists that use both types. Wilson's (2001) structural model recognizes that individuals make decisions in response to expected returns to education while allowing for the schooling process to effect the expected returns to education and therefore education attainment. Using neighborhood, school data and Panel Study of Income Dynamics, she finds that youths do respond to economic incentives when making education choices. However, most of the change in utility is from the process of being schooled (family, neighborhood and school characteristics) rather than the changing returns of schooling.

For the purpose of my paper, I will use the education production function as my empirical model. The education production function explained in Hanushek (1986) examines the different inputs and outcomes of the educational process. Hedges, Greenwald, and Laine (1994) further explain that relationship between these inputs and education attainment is determined by the level of technology and of the other inputs. Therefore, the student is not the decision maker who chooses a level of education. Many of the inputs examined by the literature will also be used in this paper, along with the output being the 4-year adjusted high school cohort graduation rate. There are a few limitations associated with my analysis. The data is limited to the school level; therefore I am unable to observe important characteristics of the students and their families such as number of siblings, parental education level, gender, etc. There are also important characteristics before high school that I am unable to observe (e.g. middle, elementary, pre-k). For example, a student's ability to read at a 3<sup>rd</sup> grade reading level will affect their progress later on in secondary school. Due to the lack of individualistic data, I use school level proxies to capture the inputs related to the schooling process.

## **Methodology**

To estimate the determinants of the graduation rate, the education production function will be used with inputs from students, school, family, and teachers as shown below.

$$4 \text{ year high school graduation rate} = f(\text{students, school, family, teachers inputs}) (1)$$

The model will be estimated using panel random effects and panel fixed effects. Random effects treat unobservable characteristics as random and not correlated with the dependent variables. Whereas fixed-effects treats the unobservable school specific characteristics as fixed

over time, varying across schools, and correlated with dependent variables. Panel random and fixed models are illustrated as:

$$4 \text{ year adjusted cohort graduation rate}_{st} = \beta' x_{st} + \partial_t + \epsilon_{st} \quad \begin{matrix} \epsilon_{st} \sim (0, \sigma^2) \\ \epsilon_{st} = u_s + u_{st} \end{matrix} \quad (3)$$

Where subscript “s” represents the schools observed and “t” represents years.  $x_{st}$  is a vector inputs of the education production function including the intercept [1,  $X_{1i}$ ,  $X_{2i}$ ,  $X_{3i}$ ,  $X_{4i}$  ...] and the 4 year cohort high school graduation rate as the output.  $\beta'$  is a vector of coefficients [ $1, \beta_1, \beta_2, \beta_3, \beta_4$ ] attached to their respective X variable.  $\partial_t$  is a year dummy variable that controls for variation due to time.  $\epsilon_{st}$  represents a composite error term composed of unobservable school-specific characteristics that remain constant over time ( $u_s$ ) and the stochastic error term ( $u_{st}$ ). In Random Effects,  $u_s$  is treated as random and uncorrelated with the right-hand side variables. In Fixed Effects,  $u_s$  may be correlated with the right-hand side variables in which the model is transformed as:

$$4 \text{ year adjusted cohort } \widetilde{\text{graduation rate}}_{st} = \beta' \tilde{x}_{st} + \tilde{u}_{st} \quad \begin{matrix} \tilde{u}_{st} \sim (0, \sigma^2) \end{matrix} \quad (4)$$

Where  $\tilde{x}_{st} = x_{st} - x_{st-1}$ ,  $\tilde{u}_{st} = u_{st} - u_{st-1}$ , and  $\widetilde{4 \text{ year adjusted cohort graduation rate}}_{st} = 4 \text{ year adjusted cohort graduation rate}_{st} - 4 \text{ year adjusted cohort graduation rate}_{st-1}$

In this specification, the 4 year adjusted cohort graduation rate,  $\tilde{x}_{st}$  and  $\tilde{u}_{st}$  have been time demeaned.

## Data and Descriptive Statistics

Table 1.



Variable	Mclean		Similar-Sized		Non-Similar Sized		Non-Mclean	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
4 Year Adjusted Cohort Graduation Rate	90.371	6.728	90.106	8.864	87.655**	11.244	87.843**	11.098
African American Enrollment (%)	5.346	7.588	11.537***	19.428	14.182***	27.429	13.979***	26.908
Hispanic/Latino Enrollment (%)	2.347	2.256	2.886	3.963	10.394***	18.288	9.819***	17.721
LEP Enrollment (%)	0.367	0.646	0.509	1.124	1.709***	3.99	1.617***	3.86
Low Income Enrollment (%)	19.874	10.831	25.71***	19.837	35.637***	26.125	34.876***	25.832
Chronic Truancy Rate	2.134	3.054	3.843**	6.937	6.021***	12.354	5.855***	12.039
Mobility Rate	9.869	5.717	14.867***	12.076	13.594***	12.629	13.691***	12.591
Attendance Rate	93.928	1.258	92.89***	3.257	92.124***	4.922	92.183***	4.819
ACT Scores	21.17	1.138	20.441***	1.762	19.694***	2.298	19.751***	2.27
Overall Performance	63.035	9.973	55.893***	13.778	50.857***	17.845	51.243***	17.616
Parent Involvement Rate	96.041	5.652	96.038	6.431	93.006***	10.592	93.238***	10.364
Average Class Size	17.626	3.891	17.373	3.682	17.557	4.495	17.543	4.438
Teachers Emergency/Provisional Certification (%)	0.266	0.988	0.65***	1.323	0.896***	2.235	0.877***	2.179
Total Enrollment	735.204	639.511	779.695	546.832	969.539**	955.157	954.989**	931.569
Instructional Expenditure Per Pupil (District)	4.702	0.611	4.352***	0.811	5.06***	1.283	5.006**	1.267
Total Expenditures (District)	347.784	423.854	362.815	486.754	6072.221***	14554.73	5634.651***	14068.67
Teachers with Master's Degree (%) (District)	37.731	10.861	40.37*	13.121	47.374***	19.339	46.837***	19.026
Pupil Teacher Ratio (District)	15.297	3.357	16.671***	3.405	16.672***	4.12	16.672***	4.069
Average Teacher Salary (District)	45.138	3.9	43.547***	5.692	49.444***	12.547	48.992***	12.26
Observations	103		521		6277		6798	

The asterisks represents Mean T-Test P-values where diff != 0. Where \*=10% \*\*=5% and \*\*\*=1% significance levels. Significant mean test denotes the variable within the subsample has a mean that is different than corresponding variable within the Mclean subsample. Similar Sized subset includes: Rock Island, Peoria, Sangamon, Champaign, and Tazewell counties. Non-Similar Sized represents all counties within Illinois excluding Mclean County and counties within Similar-Sized subset. Non-Mclean subset includes all counties within Illinois except Mclean County.

School-level data was obtained from the Illinois State Board of Education for all schools in the state of Illinois from a time period of 2003-2014. For definitions of each variable, please see appendix A1. From the data, four data subsets were used categorized by Mclean County, similar-sized, non-similar sized, and Non-Mclean counties. The similar-sized counties subset is determined by counties with a population size +/- 50,000 of Mclean County's population. A comparison based on population is useful because similar sized counties may share similar demographics and statistics such as crime rates, poverty rate, etc. Non-Similar Size Counties subset is determined by counties outside the +/- 50,000 population range. Another subset was chosen based on geographic proximity which is defined as all counties that geographically touch Mclean County. In the robustness analysis, I compare the outputs for both criteria and conclude that subsets are identical.

The 4-year-adjusted cohort graduation rate dependent variable and the chronic truancy rate independent variable contained a value greater than 100% which was restricted to a value of 100%, though there were only a few numbers of these observations. On the other hand, there were many observations for the mobility variable that range from 100 to 367.7%. This could have a couple of potential reasons. First, a large-scale merge of schools would reflect an extremely high mobility for that year. Secondly, there were charter schools with a very small number of students found

with a high mobility rate. It could be that these charter schools enroll a specific demographic of students that are apt to leave, change, or enter schools frequently.

A few variables have been transformed so that they provide a better interpretation when reporting the results. Total enrollment is reported in 1000 students per unit while instructional expenditures per pupil and average teacher salary are reported in \$1000 per unit. Total expenditures is reported in \$10,000 per unit. Since average teacher salary, instructional expenditures per pupil, and total expenditures are nominal values, these variables have been adjusted using the Consumer Price Index for all urban consumers acquired from FRED database. 2003 was chosen as the base year where nominal values were divided by the CPI ratio (current CPI/2003 CPI) to attain inflation adjusted variables. Instructional expenditure per pupil, total expenditures, teachers with master's degree, pupil teacher ratio, and average teacher salary did not have information at the school level, therefore district level data was used instead.

Next to each mean value are asterisks that represent the significance levels of the mean t-tests of the respective subset compared with the mean of the Mclean County subset. In Table 1, we notice Mclean County contains characteristics that are different than the other subsets. Mclean County on average has a high school graduation rate that is roughly 3% higher than non-similar sized and non-mclean subsets. Mclean County also compares favorably with certain school indicators such as chronic truancy, mobility, attendance, ACT scores, and overall performance. In Mclean County on average, students are more likely to attend class and perform better than all other subsets. Chronic Truancy is nearly half in Mclean County (2.1%) compared to similar sized counties and nearly three times less than non-similar sized and non-mclean subsets.

In terms of school quality, Mclean County has some favorable traits compared to the other subsets. Mclean County has on average 1 less student per teacher compared to all other subsets. More surprisingly, Mclean County has on average half the amount of emergency certified teachers compared to similar sized counties and approximately three times less compared to non-similar sized and non-mclean subsets. Demographically, Mclean is less ethnically diverse than all of the others subsets with only an average 5.3% African American, 2.3% Hispanic enrollment. Compared to the similar-sized subset, African American enrollment is less than half in Mclean County whereas Hispanic enrollment is are very similar. However, when we compare Mclean County to non-similar sized and non-mclean subsets, there is a dramatic difference in African American and Hispanic enrollment.

## **Expected Signs**

The expected signs for the independent variables are as follows: African American enrollment (+/-), Hispanic enrollment (+/-), LEP enrollment (-), low income enrollment (-), chronic truancy rate (-), mobility rate (-), attendance rate (+), act scores (+), overall performance (+), parent involvement rate (+), average class size (+/-), teachers with emergency certification (-), total enrollment (+/-), instructional expenditure per pupil (+), total expenditures (+), teachers with master's degree (+), pupil teacher ratio (+/-), average teacher salary (+).

Studies have found mixed results for African American and Hispanic enrollment depending on the model and the definition of the high school graduation rate used. Warren et al. (2006) finds that the percentage of African American ages 14-21 negatively effects completion rates while percentage of Hispanic 14-21 has a positive effect. Other studies have argued that once controlling for background characteristics, being African American has a positive effect on the graduation rate (see Havemen and Wolfe 1995). LEP enrollment is expected to carry a negative sign as students with limited English proficiency are at a disadvantage when classes are taught in predominantly English classrooms.

Low income enrollment is a proxy for low family income where studies have found that low family income is negatively correlated with the graduation rate (Wilson 2001). Chronic truancy rate is defined as students who have missed 18 or more days during the previous school year without valid cause. Students who are chronically truant may fall behind classwork and/or engage in risky behavior. I expect schools with a high chronic truancy rate to be negatively correlated with the graduation rate. Inversely, attendance rates should have a positive effect on the graduation rate. A high mobility rate reflects families that change location many times in which students have to adjust to new schools, teachers, friends, and different graduation requirements. Therefore, it is expected that schools with a high mobility rate will have a negative correlation with the graduation rate. ACT scores and overall performance proxy student ability where studies have found that high test scores have a positive effect on graduation (Scott et al. 2006).

Researchers have also found that better quality teachers and schools are linked to positive school outcomes. Hedges, Greenwald, and Laine (1994) find that expenditures are linked to positive school outcomes. Therefore, instructional expenditures per pupil and total expenditures

should have a positive effect on graduation rates because students have access to more resources to perform well. Small classrooms also have a positive effect on student performance, however Rivkin (2005) argues that teacher quality has a greater impact. Teachers with master's degrees and teachers with emergency certifications are proxies for teacher quality. A teacher with a master's degree are more qualified to teach than those with emergency certification. Therefore, a high percentage of teachers with master's degree should positively impact the high school graduation rate while a high percentage of emergency certified teacher should negatively impact the graduation rate. I expect pupil-teacher ratio and average classroom size to be positive or negative. Larger classrooms reduces one-on-one attention with the teacher, however, it can allow students to use each other as a resource (share notes, study together, etc.). Lastly, parental involvement is a proxy for parental characteristics that influence a student's education. Studies have found that students are more likely to graduate if their parents are highly educated and/or if students are under a strict household (Ensminger and Slusarcick 1992).

## **Results**

Based on the hausman test, fixed-effects regressions are more appropriate estimations reported in table 3. There are a few variables in table 3 that carry an unexpected sign. Mclean County (column 1) carries an unexpected sign for LEP enrollment while the other subsets carry the expected sign. Since Mclean County has such a low average LEP enrollment (.367%), it may be a unique case where LEP students are provided proficient language resources that allow them to excel. Nonetheless, when I account for the change in graduation rate definition in table 4 and 5, LEP enrollment no longer is significant. Chronic Truancy carries an unexpected sign in table 3 (column 3 and 4), however, this also corrects itself once I account for the change in graduation rate definition. Lastly, Parent involvement in column 4 also carries the wrong expected sign, however, this variable may not be capturing its intended purpose. Parental involvement is loosely defined as the percentage of parents who have had one or more personal contacts with the students' teacher during the year. Furthermore, we can see that parental involvement is insignificant in all cases except in column 4 (10% significance).

*Table 3.*

Variables	Mclean	Similar-Sized	Non-Similar Sized	Non-Mclean
	(1)	(2)	(3)	(4)
African American Enrollment (%)	-0.038 (0.621)	0.249 (0.228)	-0.133* (0.079)	-0.079 (0.077)
Hispanic/Latino Enrollment (%)	0.119 (0.754)	0.630** (0.269)	0.123** (0.054)	0.146*** (0.054)
LEP Enrollment (%)	4.704** (1.78)	-0.262 (0.42)	-0.047 (0.079)	-0.050 (0.077)
Low Income Enrollment (%)	0.162 (0.186)	0.080 (0.074)	-0.071*** (0.021)	-0.064*** (0.021)
Chronic Truancy Rate	0.163 (0.219)	-0.298*** (0.065)	0.043** (0.018)	0.037** (0.018)
Mobility Rate	-0.088 (0.162)	0.031 (0.058)	0.034 (0.026)	0.034 (0.024)
Attendance Rate	-0.065 (0.758)	0.053 (0.213)	0.562*** (0.076)	0.562*** (0.074)
ACT Scores	1.681*** (0.503)	-0.268 (0.375)	0.639*** (0.163)	0.601*** (0.155)
Overall Performance	0.090 (0.085)	0.056 (0.052)	-0.004 (0.019)	0.002 (0.018)
Parent Involvement Rate	-0.094 (0.136)	-0.022 (0.076)	-0.031 (0.02)	-0.032* (0.019)
Average Class Size	0.557** (0.217)	0.163 (0.107)	0.051 (0.045)	0.052 (0.043)
Emergency/Provisional Certification (%)	-1.061 (1.221)	-0.239 (0.146)	-0.027 (0.095)	-0.028 (0.091)
Total Enrollment	0.004 (0.008)	-0.004 (0.005)	-0.001 (0.002)	-0.001 (0.002)
Instructional Expenditure Per Pupil (District)	-0.730 (2.141)	-0.643 (1.306)	0.354 (0.338)	0.324 (0.334)
Total Expenditures (District)	0.006 (0.006)	-0.021** (0.009)	0.0003** (0.001)	0.0003** (0.001)
Teachers with Master's Degree (%) (District)	0.052 (0.147)	0.085 (0.053)	-0.026 (0.02)	-0.019 (0.019)
Pupil Teacher Ratio (District)	-0.263 (0.538)	0.196 (0.263)	0.232*** (0.057)	0.235*** (0.06)
Average Teacher Salary (District)	1.126* (0.644)	-0.104 (0.15)	0.046 (0.052)	0.045 (-0.051)
Observations	103	434	6364	6798
R <sup>2</sup>	0.009	0.133	0.128	0.083

\*\*\* significant at 1% level \*\* significant at 5% level \* significant at 10% level

The dependent variable is the 4 Year Adjusted Cohort Graduation Rate. Year Dummy Variables are included in the output but not shown below and standard errors have been clustered at the school-level.

### *Mclean County is a Unique Case*

When comparing across subsets, many variables that are significant in non-Mclean and non-similar sized counties are not significant for Mclean County. Hispanic, Low Income Enrollment, Chronic Truancy, Attendance, Total Expenditures, and Pupil teacher ratio are very significant factors when observing non-similar sized counties and non-mclean subsets, however,

are insignificant for Mclean County. This demonstrates the unique composition of Mclean County with very different factors affecting their graduation rate. A “one-size fits” all education policy for Illinois may not benefit Mclean County because Mclean County is much different than the rest of the state. For example, a 1% increase in attendance rate for the non-Mclean subset is correlated to a .562% increase in the graduation rate. Policy implemented to increase the attendance rate may benefit the state of Illinois, but will have no significant effect on the graduation rate for Mclean County. Moreover, school characteristics that are perceived to be an issue such as chronic truancy are not an issue for Mclean County. Organization sought out to decrease the chronic truancy rate in Mclean County may not see any benefit for high school graduation rate.

There are a few factors in Mclean County that are correlated to the graduation rate with a 5-10% significance level. LEP enrollment is positively correlated with the high school graduation rate, however in the robustness analysis, I find that this correlation disappears. Teacher salary and average class size were also found to be positively correlated with the graduation rate. Adding an extra student in the classroom is correlated with a .557% increase in the graduation rate. This finding reveals that students may be benefiting from each other through the use of studying together and sharing notes. The result is also consistent with Warren et al. (2006) where one of his results found that average class size has a positive effect on the completion rate. Another finding suggests that paying teachers more is positively correlated with the graduation rate but with slight significance. A \$1,000 increase in the average teacher salary is correlated with a 1.126% increase in the graduation rate. The rationale behind this finding is that offering a premium in salary will make teachers more productive in the classroom and attribute to a better quality education offered to the students. Policies that simply increase teacher salary in Mclean County may potentially see benefit in increasing the graduation rate.

### *ACT Scores*

A significant result found for Mclean County is that ACT scores is highly correlated with the graduation rate. The finding was also consistent in sign and significance for non-Mclean and non-similar sized subsets showing that ACT scores are important for the state of Illinois as well. Scott et al. (2006), found similar results where test scores (SAT test) on the college level had a positive effect on the college graduation rate. A one point increase in average ACT scores is correlated with a 1.681% increase in the high school graduation rate. This finding suggests that

policies focused on improving student performance can vastly help students graduate on time. Most students take the ACT test during junior and senior year, however, efforts to improve test scores during those years may be too late. Literature has found that student performance in high school is linked to performance in earlier years. Ensminger and Slusrcick (1992) found that males who received As or Bs in first grade had twice the odds of graduating from high school than those with Cs or Ds and females were about 1.5 times likely with the same grades. Therefore, there should be an increased effort to improve student performance throughout primary and secondary education.

## **Robust Analysis**

### *Geographic Proximity*

Another output was done to see whether subsets based on similar-sized counties (counties with +/- 50,000 of Mclean) shared the same results as subsets based on geographic proximity. Geographic proximity is defined as all counties that geographically touch Mclean County. The summary statistics can be found in appendix B1 and regression output can be found in appendix B2. The output in table 3 and appendix B2 almost mirror each other with similar significance level and magnitudes. A few variables are significant in geographic proximity counties that are not significant in similar sized counties and vice versa. African American enrollment, low income enrollment, and teacher emergency certification are significant within geographic proximity but not for similar sized counties. Likewise, chronic truancy is significant for similar sized counties but not for geographic proximity counties. However, even with these slight differences in subsets, Mclean County is still very unique compared to either subset.

### *Change in Definition: 2003-2010 and 2011-2014 Outputs*

In order to account for the change in the high school graduation definition, I run two separate outputs from before the change in 2003-2010 and after the change in 2011-2014. The hausman test finds random effects more appropriate for Mclean County from 2003-2010 as reported in column 1 in table 4. All other outputs in table 4 and 5 are fixed effects estimation as found appropriate by the hausman test. The results from Table 3 are compared to Table 4 and 5 to make sure that the main findings are consistent. For Mclean County, the mobility rate, parent involvement, and teachers with a master's degree were excluded from table 4 and 5 due to

insufficient number of observations in the 2011-2014 time period. Removing these variables should have no effect on the results considering they were not significant nor jointly significant in the main findings.

Table 4

	Mclean	Similar-Sized	Non-Similar Sized	Non-Mclean
2003-2010	(1)	(2)	(3)	(4)
African American Enrollment (%)	0.508 (0.33)	0.141 (0.266)	0.12 (0.145)	0.154 (0.135)
Hispanic/Latino Enrollment (%)	-0.566 (1.169)	0.769 (0.562)	0.032 (0.086)	0.046 (0.085)
LEP Enrollment (%)	2.643 (1.97)	0.499 (0.706)	-0.064 (0.087)	-0.059 (0.084)
Low Income Enrollment (%)	-0.07 (0.14)	0.11 (0.077)	-0.045* (0.026)	-0.042* (0.025)
Chronic Truancy Rate	-0.036 (0.287)	-0.127 (0.098)	-0.044 (0.041)	-0.047 (0.04)
Mobility Rate	.	0.026 (0.06)	0.032 (0.033)	0.029 (0.03)
Attendance Rate	0.276 (0.788)	0.215 (0.25)	0.243** (0.105)	0.247** (0.102)
ACT Scores	2.176*** (0.776)	-0.408 (0.515)	0.545*** (0.191)	0.476*** (0.182)
Overall Performance	-0.079 (0.096)	0.019 (0.054)	-0.007 (0.02)	-0.003 (0.019)
Parent Involvement Rate	.	-0.047 (0.073)	-0.015 (0.023)	-0.016 (0.022)
Average Class Size	0.288 (0.218)	0.256* (0.135)	0.159*** (0.045)	0.167*** (0.043)
Emergency/Provisional Certification (%)	-2.076*** (0.65)	-0.31* (0.178)	0.034 (0.097)	0.029 (0.094)
Total Enrollment	-0.014 (0.01)	0.013* (0.007)	0.001 (0.002)	-0.001 (0.002)
Instructional Expenditure Per Pupil (District)	-6.926*** (2.307)	-0.664 (1.963)	0.152 (0.424)	0.061 (0.414)
Total Expenditures (District)	-0.003 (0.008)	0.003 (0.01)	-0.001* (0.001)	-0.001** (0.001)
Teachers with Master's Degree (%) (District)	.	0.142* (0.073)	-0.026 (0.025)	-0.016 (0.024)
Pupil Teacher Ratio (District)	-0.144 (0.625)	-0.185 (0.418)	0.248** (0.113)	0.233** (0.109)
Average Teacher Salary (District)	0.78** (0.35)	-0.007 (0.159)	-0.102 (0.072)	-0.1 (0.069)
Observations	76	382	4529	4911
R <sup>2</sup>	0.623	0.169	0.2009	0.066
*** significant at 1% level ** significant at 5% level * significant at 10% level				



The dependent variable is the 4 Year Adjusted Cohort Graduation Rate. Year Dummy Variables are included in the output but not shown below and standard errors have been clustered at the school-level.

Table 5

	Mclean	Similar-Sized	Non-Similar Sized	Non-Mclean
2011-2014	(1)	(2)	(3)	(4)
African American Enrollment (%)	-2.358 (0.896)	0.415 (0.454)	-0.178 (0.211)	-0.001 (0.023)
Hispanic/Latino Enrollment (%)	3.196 -0.881 (2.119)	0.127 (0.632)	0.049 (0.111)	0.033 (0.032)
LEP Enrollment (%)	-3.011 (2.119)	-0.774 (1.219)	0.563** (0.278)	-0.353* (0.203)
Low Income Enrollment (%)	1.137 (0.239)	0.097 (0.163)	0.079* (0.045)	-0.062** (0.03)
Chronic Truancy Rate	1.919 (0.477)	-0.233** (0.113)	-0.075*** (0.025)	-0.025 (0.018)
Mobility Rate	.	0.078 (0.098)	0.012 (0.03)	-0.081*** (0.021)
Attendance Rate	-2.616 (0.773)	0.269 (0.645)	0.732*** (0.135)	0.875*** (0.112)
ACT Scores	-1.23 (0.454)	-0.317 (0.721)	-0.08 (0.397)	0.801*** (0.222)
Overall Performance	-0.031 (0.049)	-0.043 (0.107)	-0.057 (0.044)	-0.009 (0.034)
Parent Involvement Rate	.	-0.138 (0.165)	-0.023 (0.033)	-0.013 (0.029)
Average Class Size	1.048* (0.125)	-0.245 (0.23)	0.117 (0.141)	0.099 (0.1)
Emergency/Provisional Certification (%)	2.432 (0.59)	-0.255 (0.39)	0.317* (0.163)	-0.022 (0.154)
Total Enrollment	-0.017 (0.02)	-0.004 (0.014)	0.005 (0.006)	-0.001** (0.001)
Instructional Expenditure Per Pupil (District)	-20.378* (2.324)	-0.881 (2.161)	0.041 (0.805)	0.065 (0.319)
Total Expenditures (District)	-0.004 (0.007)	-0.013 (0.014)	-0.002** (0.001)	0.001*** (0.001)
Teachers with Master's Degree (%) (District)	.	-0.007 (0.08)	-0.042 (0.032)	-0.012 (0.02)
Pupil Teacher Ratio (District)	-1.623 (0.644)	0.187 (0.455)	0.243 (0.155)	-0.053 (0.107)
Average Teacher Salary (District)	3.031 (0.637)	-0.272 (0.292)	0.033 (0.069)	0.072 (0.042)
Observations	27	139	1748	1887
R <sup>2</sup>	0.019	0.035	0.082	0.078
*** significant at 1% level ** significant at 5% level * significant at 10% level				

The dependent variable is the 4 Year Adjusted Cohort Graduation Rate. Year Dummy Variables are included in the output but not shown below and standard errors have been clustered at the school-level.

### *Consistent Results for Illinois*

Although there are many significant variables in table 3, the results slightly change when I account for the change in the graduation rate in table 4 and 5. I find that low income enrollment, attendance rate, and act scores are very consistent and therefore, should be the focus for education policy for the state of Illinois. Low income enrollment is consistently negative with the exception of the non-similar sized subset during the time period of 2011-2014 (column 3, table 5). Also the significance level of low income enrollment drops when adjusting for the change in definition. Nonetheless, low income enrollment has consistently shown a negative impact on the graduation rate. This finding is consistent with most literature that find high income family households have a positive effect on the graduation rate (see Wilson 2001, Connelly and Zheng 2003; Warren et al 2006). My finding suggests that low family income is negatively correlated with the graduation rate. The most substantial findings for Illinois involve attendance rate and act scores. Across all tables for the non-mclean subset, attendance rate and act scores maintain the correct sign and high significant levels. This result outlines the importance of student performance and participation. With the most recent data in table 5 (time period 2011-2014), a 1% increase in attendance rate is positively correlated with a .875% in the graduation rate. Illinois can improve their graduation rate by getting students to attend class. One way to improve attendance starts at home; parents need make sure their kids are attending class. ACT scores are also very important, showing that an average point increase is correlated with a .875% increase in the graduation rate. As discussed earlier, policy should be implemented to improve student performance during both primary and secondary schooling.

### *Consistent Results for Mclean County*

After accounting for the change in the graduation definition for Mclean County (see table 4 and 5, column 1), the significant variables in table 3 maintained the correct sign in table 4 and 5 but were not significant across both time periods. LEP enrollment is the only variable to completely drop significance when accounting for the change in graduation definition. ACT scores and average teacher salary were significant within the time period 2003-2010 but not 2011-2014 while average class size is significant in 2011-2014 but not 2003-2010. It is possible that without adjusting for the change in definition, table 3 is capturing both of these results. One interpretation

is that ACT scores and average teacher salary were relevantly correlated to the graduation rate prior to the change in definition, but are no longer correlated with the new definition. Likewise, average class size is more relevant for the recent change in definition. However, the low number of observations from the time period 2011-2014 may be altering the results. This is further explained by the instructional expenditures per pupil containing the wrong sign at a high significance level and large magnitude in table 4 and 5. In table 5, a \$1,000 increase in instruction expenditures per pupil is negatively correlated with a 20.378% decrease in the graduation rate. However, this result is very unrealistic and contains no consistency with other results. Nonetheless, there is consistent proof that act scores is positively correlated with the graduation rate and is highly significant. There are also consistent results for average class size and average teacher salary but these variables have less of an impact.

## **Conclusion**

The focus of this paper is to see the determinants affecting the 4-year cohort graduation rate. Using the education production function as my empirical model, I use a variety of school, student, teacher, and family characteristics as inputs in the production of a student's education (high school graduation rate). I estimate using panel fixed effects and find that Mclean County is very unique compared to the rest of the state. Illinois results consistently show that ACT scores, low income enrollment, and attendance rate are important factors correlated to the graduation rate. However, Mclean County results consistently show that ACT Scores are highly correlated with the graduation rate while average class size, and average teacher salary have some correlation. The positive sign and minor significance of average class size indicates that schools with larger classrooms may be beneficial because students are more apt to share knowledge and resources. An increase in teacher salary has a minor significance and positive correlation with the graduation rate which may indicate that higher wages are linked to more productivity.

The ACT score variable is a measure of a student's ability, therefore, emphasis should be placed on student performance in order to improve the graduation rate. Merely increasing ACT scores may see no effect on the graduation rate considering students who take the ACT test are already approaching the graduation date. I recommend that the community, schools, and organizations focused on improving the graduation rate direct their efforts to improve student performance in both primary and secondary education. I suggest that attention and resources

should be given to struggling students to make sure that they do well early on in their education. More specifically, a program dedicated to tutoring students at little or no cost would see much benefit for student performance. Moreover, monitoring students more closely would help reassure that students do not fall behind. Monitoring students should also be used as a way to direct them to the proper resources or programs they need. As data becomes more readily available for the new high school graduation definition, future research should be focused on observing individuals from pre-k throughout secondary school in order to capture many important milestones throughout students' lives. Individual data is key in order to capture many important family/neighborhood background characteristics such as parent's education, number of siblings, etc. By understanding the student's schooling process, their teachers, schools, and family background, finding the factors correlated to the graduation rate will be more accurately defined.

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## Appendix

### **A1. Variable Definitions<sup>1</sup>**

**4-Year Adjusted Cohort Graduation rate** is calculated based on the federal guidance of NCLB High School Graduation Rate, <http://www2.ed.gov/policy/elsec/guid/hsgrguidance.pdf>.

According to 2008 Regulations, states are required to calculate a four-year adjusted-cohort graduation rate in school year 2010-2011. Starting school year 2011-2012, Illinois reports both four-year and five-year adjusted-cohort graduation rate.

$$\frac{\text{Number of cohort members who earned a regular high school diploma through summer 2014}}{\text{Number of first – time 9th graders in fall 2010 (starting cohort) plus students who transfer in, minus students who transfer out, emigrate, or die during school years 2010 – 2011, 2011 – 2012, 2012 – 2013, 2013 – 2014, and through summer 2014}}$$

**Graduation rate (2003-2010)** is the number of 2009-10 high school graduates, divided by the 2006 first-time grade 9 fall enrollment (not including students transferred out), plus students transferred in, multiplied by 100. [Numerator = number of graduates, denominator = (grade 9 enrollment – transfers out) + transfers in]. “Transfers out” include students from the freshman class who transferred to another school or died prior to graduation. “Transfers in” encompass 2009-10 graduates who were not counted in the 2006 first-time grade 9 fall enrollment; transfers in may include students who transferred from another school, students with or without disabilities, and students who graduated in fewer or more than four years.

**Ethnic Enrollment** The percentage of students for each racial-ethnic group (White, Black, Hispanic, Asian, Hawaiian Pacific Islander, American Indian-Alaskan Native, and Multiracial/Ethnic) is the count of students belonging to a particular racial/ethnic group, divided by the total fall enrollment, multiplied by 100.

**Limited English Proficient Students (LEP)** are students who have been found to be eligible for bilingual education. The percentage of limited-English-proficient students is the count of limited-English-proficient students, divided by the total fall enrollment, multiplied by 100.

**Low Income Students** are pupils age 3 to 17, inclusive, from families receiving public aid, living in institutions for neglected or delinquent children, being supported in foster homes with public funds, or eligible to receive free or reduced-price lunches. The percentage of low-income students is the count of low-income students, divided by the total fall enrollment, multiplied by 100.

**Chronic truancy Rate** is the number of chronic truants, divided by the average daily enrollment, multiplied by 100. Chronic truants include students subject to compulsory attendance who have been absent without valid cause from such attendance for 10 percent or more of the previous 180 regular attendance days.

**Student Mobility (turnover)** reflects any enrollment change between the first school day in October and the last day of the school year. It is the sum of the students who transferred out and

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<sup>1</sup> Definitions taken from Illinois State Board of Education: [http://www.isbe.net/ASSESSMENT/pdfs/report\\_card/2014/rc14-definition.pdf](http://www.isbe.net/ASSESSMENT/pdfs/report_card/2014/rc14-definition.pdf)

the students who transferred in, divided by the average daily enrollment, multiplied by 100. Students are counted each time they transfer out or in during the reporting year. Thus, individual students may be counted more than once.

**Student attendance rate** is the aggregate days of student attendance, divided by the sum of the aggregate days of student attendance and aggregate days of student absence, multiplied by 100.

**ACT Scores** is an achievement test, measuring what a student has learned in school. The ACT has up to 5 components: English, Mathematics, Reading, Science, and an optional Writing Test. The SAT has only 3 components: Critical Reading, Mathematics, and a required Writing Test.

**Overall student performance** shows the percentage of student scores meeting or exceeding *Illinois Learning Standards* in all state assessments for the most recent two years, in compliance with NCLB legislation.

**Average class size** is the sum of specified class enrollments from kindergarten through grade 8 for schools having grades below grade 9 and in all subject areas in high school, divided by the number of classes. For high schools, and optionally for grades 6 and 8, an average for the 2nd and 5th class periods is used.

**Percentage of teachers with emergency or provisional credentials** is the number of full-time equivalent teachers teaching with emergency or provisional credentials, divided by the total number full-time equivalent teachers, multiplied by 100.

**Total Enrollment** is the total student enrollment in the school and district in the fall of the school year.

**Instructional expenditure per pupil** is instructional expenditures divided by the nine-month average daily attendance. "Instruction" includes activities dealing with the teaching of pupils or the interaction between teachers and pupils. Teaching may be provided for pupils in a school classroom or in another location, such as a home or hospital and may include other learning activities. It may also be provided through some other approved form of communication, such as television, radio, telephone, or correspondence. Included here are the activities of aides or assistants of any type (clerks, graders, teaching machines, etc.), who assist in the instruction process. (Capital Outlay expenditures, which are reported separately, are excluded.)

**District expenditure by fund** is the total expenditure from each of the eight funds: educational, operations and maintenance, transportation, debt service, tort, municipal retirement/social security, fire prevention and safety, and capital projects.

**Parent Involvement** includes the percentage of students whose parents or guardians have had one or more personal contacts with the students' teachers during the school year concerning the students' education

**Percentage of teachers with a master’s degree and above** is the sum of all full-time equivalent classroom teachers with master’s degrees and above in the district, divided by the total number of full-time equivalent classroom teachers, multiplied by 100.

**Pupil-teacher ratio** is the fall enrollment for the school year divided by the number of full-time equivalent classroom teachers in the district. Teachers classified as special education teachers are excluded.

**Average teacher salary** is the sum of the salaries for all classroom teachers divided by the number of full-time equivalent classroom teachers.

**B1.**

Variable	Mclean		Neighboring		Non-Neighboring		Non-Mclean	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
HSGRAD	90.37087	6.727302	90.77028	8.457729	87.64268	11.22811	87.84235	11.09785
African American Enrollment (%)	5.345631	7.587603	3.775115	9.243043	14.67475	27.56839	13.97889	26.90784
Hispanic/Latino Enrollment (%)	2.346602	2.255269	1.793548	1.897794	10.36546	18.17925	9.818211	17.72017
LEP Enrollment (%)	0.3669903	0.645556	0.2442396	0.7509664	1.709711	3.9668	1.616152	3.859412
Low Income Enrollment (%)	19.87379	10.83061	22.86567	12.79685	35.695	26.28892	34.87595	25.83118
Chronic Truancy Rate	2.13301	3.053811	2.603687	3.786018	6.07566	12.37168	5.854001	12.03824
Mobility Rate	9.868932	5.716043	11.16866	5.755478	13.8627	12.90824	13.6907	12.59078
Attendance Rate	93.92718	1.257853	93.45876	1.809898	92.09508	4.945926	92.18214	4.818721
ACT Scores	21.1699	1.13732	20.70161	1.207395	19.68602	2.309834	19.75085	2.269182
AlltestsrecentSchool	63.03495	9.972302	59.00276	9.742481	50.71295	17.90645	51.24219	17.61596
Parent Involvement Rate	96.04078	5.651955	96.00184	6.909892	93.04918	10.53146	93.23769	10.36304
Average Class Size	17.62524	3.890277	16.27811	3.943557	17.62821	4.456215	17.54201	4.437292
Teachers Emergency/Provisional Certification (%)	0.2650485	0.987739	0.6080645	1.590954	0.8947046	2.212015	0.8764048	2.178702
Total Enrollment	735.2039	639.5108	554.4217	455.6116	982.3059	949.313	954.9888	931.5686
Intructional Expenditure Per Pupil (District)	4.701753	0.610044	4.683501	0.7585538	5.027247	1.291462	5.005301	1.266924
Total Expenditures (District)	347.7839	423.8535	135.4028	183.2038	6009.679	14464.5	5634.651	14068.67
Teachers with Master's Degree %)(District)	37.7301	10.86092	38.81267	13.19926	47.38408	19.23834	46.83686	19.02555
Pupil Teacher Ratio (District)	15.29612	3.356583	14.847	3.473556	16.79576	4.076597	16.67134	4.068557
Average Teacher Salary (District)	45.13715	3.899787	42.38832	5.605441	49.44212	12.4592	48.99179	12.25951
Observations	103		434		6364		6798	

Neighboring counties include: Woodford, Livingston, Ford, Champaign, Piatt, Dewitt, Logan, and Tazewell. Non-neighboring counties represents all counties within Illinois excluding Mclean County and neighboring counties subset. Non-Mclean subset includes all counties within Illinois except Mclean County.

**B2.**



Variables	Mclean	Mclean	Neighboring (Geo)	Neighboring (Geo)	Non-Neighboring (Geo)	Non-Neighboring (Geo)	Non-Mclean	Non-Mclean
	(1)	(2)	(3)	(4)	(5)	(6)	(6)	(8)
African American Enrollment (%)	0.358 (0.254)	-0.038 (0.621)	0.292** (0.145)	1.097** (0.47)	0.012 (0.014)	-0.109 (0.078)	0.017 (0.014)	-0.079 (0.077)
Hispanic/Latino Enrollment (%)	-0.241 (0.744)	0.119 (0.754)	0.272 (0.373)	0.996** (0.451)	0.027 (0.018)	0.122** (0.054)	0.032* (0.018)	0.146*** (0.054)
LEP Enrollment (%)	3.124 (1.49)	4.704** (1.78)	-0.401 (0.95)	-1.355 (1.315)	-0.166*** (0.072)	-0.047 (0.078)	-0.167** (0.071)	-0.050 (0.077)
Low Income Enrollment (%)	-0.099** (0.141)	0.162 (0.186)	-0.278*** (0.083)	-0.284* (0.154)	-0.094*** (0.017)	-0.058*** (0.021)	-0.098*** (0.016)	-0.064*** (0.021)
Chronic Truancy Rate	0.13 (0.16)	0.163 (0.219)	0.009 (0.118)	-0.037 (0.123)	0.051*** (0.017)	0.038** (0.018)	0.05*** (0.017)	0.037** (0.018)
Mobility Rate	-0.004 (0.157)	-0.088 (0.162)	0.082 (0.139)	0.132 (0.155)	-0.057*** (0.02)	0.033 (0.025)	-0.055*** (0.02)	0.034 (0.024)
Attendance Rate	0.01 (0.681)	-0.065 (0.758)	1.052** (0.524)	0.857 (0.471)	0.721*** (0.064)	0.558*** (0.075)	0.729*** (0.063)	0.562*** (0.074)
ACT Scores	1.586*** (0.615)	1.681*** (0.503)	0.227 (0.397)	0.029 (0.55)	0.878*** (0.122)	0.640*** (0.163)	0.852*** (0.116)	0.601*** (0.155)
Overall Performance	0.028 (0.055)	0.090 (0.085)	0.076 (0.059)	0.017 (0.066)	0.033** (0.016)	0.000 (0.019)	0.035** (0.015)	0.002 (0.018)
Parent Involvement Rate	0.015 (0.112)	-0.094 (0.136)	-0.039 (0.049)	-0.065 (0.048)	-0.013 (0.017)	-0.031 (0.02)	-0.014 (0.016)	-0.032* (0.019)
Average Class Size	0.263 (0.204)	0.557** (0.217)	0.075 (0.146)	0.033 (0.136)	0.072* (0.04)	0.054 (0.045)	0.071* (0.039)	0.052 (0.043)
Emergency/Provisional Certification (%)	-1.264** (0.64)	-1.061 (1.221)	-0.326** (0.158)	-0.407** (0.161)	-0.112 (0.085)	-0.012 (0.095)	-0.125 (0.081)	-0.028 (0.091)
Total Enrollment	-0.018*** (0.005)	0.004 (0.008)	0.001 (0.002)	0.004 (0.009)	-0.002*** (0.001)	-0.001 (0.002)	-0.002*** (0.001)	-0.001 (0.002)
Instructional Expenditure Per Pupil (District)	-4.883*** (0.893)	-0.730 (2.141)	-0.679 (0.896)	-1.225 (1.128)	0.652*** (0.196)	0.451 (0.347)	0.588*** (0.189)	0.324 (0.334)
Total Expenditures (District)	0.006 (0.005)	0.006 (0.006)	-0.003 (0.005)	-0.023** (0.012)	-0.001 (0.001)	0.0003** (0.001)	-0.001 (0.001)	0.0003** (0.001)
Teachers with Master's Degree %(District)	0.021 (0.119)	0.052 (0.147)	-0.059 (0.056)	-0.075 (0.054)	-0.017 (0.014)	-0.017 (0.02)	-0.018 (0.013)	-0.019 (0.019)
Pupil Teacher Ratio (District)	0.096 (0.449)	-0.263 (0.538)	-0.509** (0.243)	-0.359 (0.312)	0.035 (0.043)	0.250*** (0.065)	0.017 (0.04)	0.235*** (0.06)
Average Teacher Salary (District)	0.493 (0.321)	1.126* (0.644)	0.062 (0.161)	0.196 (0.241)	-0.054 (0.03)	0.042 (0.053)	-0.048 (0.029)	0.045 (-0.051)
Observations	103	103	521	521	6277	6277	6798	6798
R <sup>2</sup>	0.61	0.009	0.366	0.037	0.513	0.127	0.508	0.083

\*\*\* significant at 1% level \*\* significant at 5% level \* significant at 10% level