School Corporation Size & Student Performance:

Evidence from Indiana

This study addresses the question of whether or not the size of a school corporation affects the educational performance of its students.

Center for Business and Economic Research, Ball State University

- **Srikant Devaraj, PhD,** research assistant professor, CBER
- **Dagney Faulk, PhD,** director of research and research professor, CBER
- **Michael J. Hicks, PhD,** director, CBER; and the George & Frances Ball distinguished professor of economics

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About the Authors

Srikant Devaraj, PhD, is a research assistant professor at Ball State CBER. He holds master's degrees in business administration and information and communication sciences from Ball State and a doctorate in health economics from IUPUI.

Dagney Faulk, PhD, is director of research and a research professor at Ball State CBER. Her research focuses on state and local fiscal tax policy, local government structure, and regional economic development issues. She received her doctorate in economics from the Andrew Young School of Policy Studies at Georgia State University.

Michael J. Hicks, PhD, is director of Ball State CBER and the George & Frances Ball distinguished professor of economics in the Miller College of Business. His research interest is in state and local public finance and the effect of public policy on the location, composition, and size of economic activity. Hicks earned doctoral and master's degrees in economics from the University of Tennessee and a bachelor's degree in economics from Virginia Military Institute. He is a retired army reserve infantryman.

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Center for Business and Economic Research
2000 W. University Ave. (WB 149)
Muncie, IN 47306
765-285-5926 • cber@bsu.edu
www.bsu.edu/cber • www.cberdata.org
facebook.com/BallStateCBER
twitter.com/BallStateCBER

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Indiana Chamber of Commerce
115 West Washington St., Suite 850 S
Indianapolis, IN 46204
317-264-3110
indianachamber.com

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Ball State University
2000 W. University Ave. (WB 149)
Muncie, IN 47306
765-285-5926 • cber@bsu.edu
bsu.edu/cber • cberdata.org

Key Point

Students attending small school corporations (enrollment of < 2,000 students) face resource constraints that impede secondary school performance, as measured by standardized test scores and pass rates. These constraints are likely to restrict post-secondary educational opportunities and outcomes.

Executive Summary

This study addresses the question, "Does the size of a school corporation affect the educational performance of its students?" This question is important, not least because more than half of all Indiana school corporations are smaller than the minimum efficient scale of roughly 2,000 students as identified by earlier studies. This is important because secondary school performance often directly impacts post-secondary educational opportunities and success.

To answer this question, we use data on student performance and school corporation size and characteristics for Indiana's 289 public school corporations, analyzing the data using two separate approaches. Both approaches provide information about the impact of school corporation size on student performance including SAT and ACT scores, AP pass rates, end-of-course assessment (ECA) pass rates (English, algebra and biology), ISTEP+ scores (fourth and eighth grade) and honors diploma graduates. These measures are, in turn, likely to influence higher education access and performance.

We find that school corporation size impacts every measure of school corporation performance, except English ECA scores. Across the board, as school corporation enrollment increases, we observe better performance on these indicators, with the largest impacts occurring at roughly the 2,000 student enrollment threshold identified in earlier research that focused on per student costs.

This research clearly identifies statistically significant performance differences across school corporations that are directly attributable to size. Smaller corporations, especially those with fewer than 2,000 students, face resource limitations that affect student performance and potentially impede post-secondary educational opportunities. For example, **small school corporations that increase their size to around 2,000 students would experience an increase in the average student's performance on the SAT of 20.5 points, a 14.9 percentage point increase in share of students passing AP exams, an additional 4 percentage point increase on end-of-course assessment (ECA) pass rates in algebra and biology, and a 5 percentage point increase in the 8th grade ISTEP pass rate** *(Table 9, page 14)***.** The statistical modeling takes into account demographic and socioeconomic factors. For example, the average SAT score of 949.5 in the smallest corporations (between 240 and 999 students) compares to a 989.8 average in corporations with between 2,000 and 3,000 students (*Table 3, page 9*). That 40-point difference remains at 20.53 when incorporating the demographic and socioeconomic differences among corporations.

Because performance on college entrance examinations and high school science and mathematics performance are closely aligned with post-secondary success, attending small school corporations acts as a significant drag on the economic and career opportunities of students and the broader community. About 194,000 (19 percent) of public school students in the state were enrolled in school corporations with fewer than 2,000 students during 2014. The most recent Lumina Foundation (2017) report indicates that only 41 percent of Indiana's working age population has a college degree or other credential. Indiana ranks 42nd of the 50 states on this metric. In many counties with the smallest school corporations, the level of educational attainment is among the lowest in the state.

We recommend:

1. A continued focus on both cost savings and performance-related findings to motivate the merging of school corporations.
2. Funding feasibility studies for school corporations that are considering merger and continued funding for the implementation of mergers.
3. The creation of financial incentives for realized efficiency gains in district operations due to mergers or shared services.

In addition, we recommend:

4. A best practices "how-to" study to help guide smaller school districts interested in merging administrative functions or entire districts. This would also include a review of potential specific cost savings realized in districts already merged and a review of state and federal policy and financial barriers to merging.
5. A best practices study to understand opportunities to improve teaching and learning opportunities in smaller districts using technology to deliver content, specifically in the STEM areas. This would include a review of policy barriers, financial barriers, as well as technology barriers in rural areas.

To these we add the very clear conclusion that the combination of relatively higher cost and poorer outcomes for students attending small school corporations adds increased urgency to state-level policy initiatives.

Introduction

This study examines a straightforward public policy question—does the size of a school corporation[1] affect the educational outcomes of Indiana students? This question is important for two reasons. First, a significant body of research has identified that smaller school corporations (fewer than 2,000 students) are inefficient from a cost perspective (see Faulk and Hicks, 2011, 2014 and Zimmer, DeBoer, and Hirth, 2009 for studies of Indiana). Second, because inefficiencies of small school corporations are a matter of higher per student administrative/overhead cost, the smallest school corporations are not able to take advantage of the same economies of scale and scope as larger school corporations. Thus, small school corporations may suffer from higher per unit administrative/overhead costs and lower per unit quality measures (see Fox, 1981). As a result, small school corporations face resource constraints that can limit student performance, as measured by standardized test scores and pass rates, which in turn are likely to affect post-secondary educational opportunities and outcomes for students along with the level of educational attainment in the state. Lowering the administrative/overhead cost frees up more dollars for classroom instruction.

From a policy perspective, these questions matter to Indiana, because the state has an unusually high number of very small school corporations. In 2014, more than half of Indiana's 289 public school corporations were beneath the minimal efficient scale of roughly 2,000 students. Of these, more than half saw enrollment declines of more than 5 percent over the previous eight years. Moreover, there are 20 additional school corporations with more than 2,000 but fewer than 3,000 students that have experienced substantial enrollment declines over the same period and may be in danger of shrinking beneath the 2,000 student level in the coming years. Of the 157 school corporations with 2014 enrollment below 2,000 students, 94 percent are adjacent to another small school corporation.

The majority of Indiana's school corporations are inefficiently small from a pure cost perspective and could merge administrative functions with nearby corporations to secure cost savings. This study extends that policy question, evaluating whether or not these inefficiently small school corporations have lower academic outcomes. We reiterate at this juncture that we are examining school corporations, not individual schools.

To conduct this study, we test a model of student performance using 2011-2014 Indiana school corporation data. We also explain the transmission mechanism of higher per student administrative/overhead costs to lower student outcomes, which is a well-developed question in the economic analysis of school corporation cost and performance. We then test this model upon measures closely related to student performance. Factors such as college entrance exam performance, end-of-course assessment (ECA) performance, and advance placement (AP) exam performance are used as measures of student outcomes related to post-secondary opportunities and success. We then report the results and interpret these findings for Indiana's school corporations. We conclude with a brief summary and policy recommendations. We begin this analysis with a review of existing studies.

(1) The terms "school district" and "school corporation" are used interchangeably in this analysis.

A Review of Previous Studies

Analysis of school or corporation size on student academic performance has long been part of efforts to evaluate the efficiency and quality of public services. Research related to educational outcomes focuses on two measures: first, those that concentrate on educational outputs, such as test scores, attendance rates, graduation and dropout rates, among others, and second, those that examine costs and address such issues as economies of scale. This literature review will focus on studies examining the effects of corporation size on schooling outputs, specifically student academic performance measures that are associated with educational opportunities at the post-secondary level.

While numerous studies have examined the relationship between school size and student academic performance, less research has focused on how corporation size affects student performance. Using data from California because of significant statewide heterogeneity in size, quality, and student demographics, Driscoll et al. (2003) examined the impact of the school district as well as school sizes on student academic performance. The authors evaluated 5,525 schools in 755 California districts. The advantage of this study is that it examines size effects at three levels: district, school, and class. The authors also include population density as a regressor because district size and density are correlated (Driscoll et al., 2003). They separately estimate regressions for elementary, middle, and high schools. Among major variables included in the analyses are district size, school size, class size, median household income, and population density.

Driscoll et al. use production function approach with the school level standardized test scores as the dependent variable in the regressions (Driscoll et al., 2003:196). They report that for school districts with more than 40,000 students "district size has a negative effect on student performance, as measured by standardized scores"[(2)] (Driscoll et al., 2003:199). The school size also has a significantly negative effect on student performance at the elementary school level, but no significant effect on the middle school and high school levels. Similarly, class size is negatively correlated with academic attainment only on the elementary school level, and not on the secondary level (Driscoll et al., 2003:199). Indiana's largest school corporations (Indianapolis and Fort Wayne) have enrollment of roughly 30,000 students, which is well under the problem threshold.

Andrews et. al. (2002)—the authors of "Revisiting Economies of Size in American Education: Are We Any Closer to a Consensus?"—take a close look at school mergers and attempt to come to a consensus on how school and district size affect costs and student performance (Andrews et al., 2002). They examine 15 cost function studies and 12 production function studies to answer the following questions: do school size and school district size matter, and are mergers generally an effective policy? They conclude,

> "[M]oderation in district and school size may provide the most efficient combination. Under some conditions, consolidation of very small rural districts may save money, as long as schools are kept at a moderate size and transportation times remain reasonable. – Andrews et al. (2002:256)

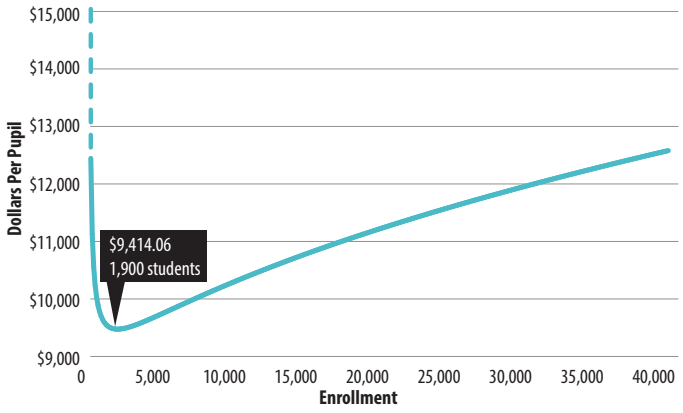
Cost functions used in the research, for the most part, lead to a conclusion that there is an opportunity to save significant administrative and instructional costs when moving from a small district with 500 or fewer students to a larger district with 2,000-4,000 students (Andrews et al, 2002). These authors note that per student costs may also continue to decline until the enrollment reaches approximately 6,000 students. That is the point where economies of scale are exhausted (Andrews et al., 2002).

These results are similar to two recent studies that examined costs in Indiana (Faulk and Hicks, 2011 and Zimmer, DeBoer, and Hirth, 2009). Both studies report a minimum efficient scale of roughly 2,000 students per corporation. Zimmer, DeBoer, and Hirth used a time series cross section (panel) model of school corporations with random cross-sectional effects to test a cost function. Because of endogeneity concerns with teacher salary and performance, the authors used a two-stage modeling approach (2SLS), which identified the second stage cost function. They then calculated the traditional U-shaped cost function, reporting that cost minimization occurred at a point estimate of 1,940 students, but a 5 percent confidence interval extended the range to 2,900 students. Importantly, the per unit cost function declined quickly to the 1,900 range and rose slowly thereafter.

Faulk and Hicks (2011) perform a similar, cross-sectional analysis of school corporation size and costs across Indiana, using a quadratic cost function to assess non-linear changes to the cost function. They also controlled for other conditions in the school corporation, such as the share of free and reduced lunch students, the reported at-risk mothers, education levels, and poverty and income levels. As with Zimmer, DeBoer and Hirth (2009) they report very rapid reductions in per unit cost for the smallest school corporations as they increase enrollment to 1,000 students. In this sample of small corporations, adding an additional 10 students would reduce the per unit costs by $83 per student across the entire corporation. At the enrollment level of less than 2,000 students, per unit costs drop by $33.85 per student with the addition of 10 pupils. The cost decline is statistically linear in the very small corporation sample, but flattens at the levels between 1,000 and 2,000 students.

(2) The coefficient for district size was negative and statistically significant at the 1 percent level for both elementary and middle school, but it was statistically insignificant for the high school regression.

Figure 1: Cost Curve for Education
Source: Author calculations from Zimmer, Deboer, and Hirth (2009)



As school corporations grow in size, the increase in savings slows, as shown in *Figure 1*. Faulk and Hicks followed up this study with a policy brief that outlined the possibilities for the merger of school corporations in Indiana due to the clustering of very small school corporations (Hicks and Faulk, 2014).

There are many additional studies of individual schools' size and performance that address these issues (see Andrews et al., 2002; Bradley and Taylor, 1998; Lee and Smith, 1995; Barnett et al. 2002; Lamdin, 1995; Eberts and Schwartz, 1990; Office of Instructional and Accountability Services, 2000; Stiefel et al., 2000). However, we again remind the reader that the current study is of school corporations and student outcomes that affect post-secondary opportunities. Any study of school size and performance must take into account transportation costs to include the impact of bus rides on student performance, which is outside the scope of this study.

Relationship Between Costs & Quality

However, the economies of scale and the duality issue are frequently tackled within the context of individual schools. Fox (1981) provided a theoretical explanation for the duality of cost and quality at the school level. This explanation is consistent with the well-known duality theory in production economics. Fox reviewed a number of studies and found optimal numbers of students at individual schools. Extrapolating the high school level results to school corporation size (with a single high school) yielded an optimal school corporation size of 2,700 students, which is 50 percent larger than the median school corporation in Indiana.

Individual school studies also offer insight into the transmission mechanism for scale economies and quality. For example:

> Smaller size implies lower specialization effects, lower performance, and hence less opportunities for the students. These findings suggest that, where possible, policy should be directed towards securing larger school size and thus better performance. – Barnett et al.(2002:308)

The literature cited here is mostly empirical and focused on offering insight on the impact of size upon quality or opportunity. However, other studies have also identified the transmission mechanism for scale benefits on quality that are applicable to school corporations. Dunscombe and Yinger (2007) identified five effects of scale that are relevant to this issue. Reprinted directly from Hicks and Faulk (2014), they are:

1. The quality of some education services does not diminish over a wide range of enrollment. For example, central administration – a superintendent and school board and associated staff – may be able to serve a large number of students.
2. Larger school corporations may be able to provide specialized services – science labs, computer labs, athletic facilities, etc. – at a lower average cost because they provide those services for more students.
3. Larger school corporations may be able to employ specialized labor, such as science, math, and technology instructors, and offer more specialized classes.
4. Larger school corporations may be able to negotiate price reductions for supplies and equipment by buying in bulk.
5. Larger school corporations may be able to implement innovations in curriculum or management at a lower cost.

Each of these transmission mechanisms for cost savings has a dual effect on performance. Lower overhead costs increase per student spending on other activities so that larger school corporations may have better facilities and equipment due to lower per student

Legislation Passed During the 2017 Indiana General Assembly to Help Smaller School Districts

Two provisions passed to encourage right-sizing school districts.

The opportunity to reduce administrative costs by merging administrative services in smaller school districts will, in turn, reduce the duplication of programs or services, increase cost efficiencies relating to the use of school facilities, plus reduce debt and provide for establishing other cost-cutting measures.

- SEA 248 allows small school corporations situated in the same county or adjoining counties to consolidate services if 20 percent of legal voters in both school districts petition the trustees of their respective school corporation.
- HEA 1001, Section 160 (budget bill) includes a provision to help offset consolidation expenses involving two or more districts. A one-time small school district efficiency incentive consolidation grant is available in the amount of $250 x ADM ($250 times the number of students in the districts as determined by the Average Daily Membership).

One provision passed to assist smaller school districts in providing improved/additional course access:

- HEA 1007 allows school districts the ability to provide additional options for courses online to give more students access to classes delivered with quality instruction when approved by the Indiana Department of Education. This expands course access to students in smaller school districts and could be a significant cost-saving measure, which could redirect more dollars into the classroom.

cost. Specialization and shared personnel are possible in larger corporations, but face distinct difficulties in smaller ones. Per unit cost savings in contract services, ranging from health care to paper and office supplies, are likely in larger facilities, and larger facilities have less per unit overhead; therefore, larger facilities may be able to allocate more resources to innovation.

Examples may be helpful to illustrate this. In a smaller school corporation, there may not be a sufficient demand for an AP calculus teacher, who would typically demand more compensation and require additional education or training to meet AP requirements (see Hicks, 2015). Thus, students within a smaller corporation may not have the option to take this class. In larger corporations, with several schools, sharing a teacher across two or more schools may be possible. Sharing a teacher across two corporations is far less likely due to differences in pay structure, scheduling, retirement, or other factors. So, a larger corporation is more likely to have specialized staff than a smaller one, even if individual schools are the same size. We believe these examples exist across the five scaled economy arguments listed earlier and may pertain to many different facets of administration that devolve to school quality and opportunity for students.

These issues motivate a separate analysis for Indiana, which identifies and isolates the effect of school corporation size on measures of student performance.

> "A larger corporation is more likely to have specialized staff than a smaller one, even if individual schools are the same size."

Geographic Distribution & Educational Performance

During 2014, Indiana had 289 school corporations with widely varying levels of enrollment.[3] The number of school corporations by enrollment level in the state is shown in *Table 1*.[4] In 2014, 18.3 percent of school corporations had enrollment lower than 1,000 students and 54.3 percent of corporations had enrollment under 2,000 students.[5] About 19 percent of public school students were enrolled in school corporations with fewer than 2,000 students. Of the 157 school corporations with enrollment lower than 2,000 students, 85 (54.1 percent) had enrollment declines of 100 or more students between 2006 and 2014 indicating that these school corporations are becoming smaller. Of the 289 school corporations in the state, 139 (48 percent) had enrollment declines over this period. See *Appendix Table A1* for details on enrollment for each public school corporation in the state. *Figure 2* provides a map of school corporations in Indiana by enrollment size.

The number of school corporations in a county varies widely, ranging from one to 16. Of the 92 counties in Indiana, 21 contain one school corporation *(Table 2)*. Lake and Marion counties contain the most school corporations with 16 and 11, respectively. *Figure 3* shows the geographic distribution of school corporations by county. *Appendix Table A2* provides details about the number of public school corporations in each county.

Table 1: Indiana School Corporations by Enrollment Level

Source: Indiana Department of Education

2014 Student Enrollment	# of Corporations	% of Total	Enrollment Sum	% of Total Enrollment
240 to 499	7	2.42	2,511	0.25
500 to 999	46	15.92	38,155	3.80
1,000 to 1,499	60	20.76	76,410	7.61
1,500 to 1,999	44	15.22	76,943	7.66
2,000 to 2,999	40	13.84	97,284	9.69
3,000 to 4,999	35	12.11	133,567	13.30
5,000 to 9,999	35	12.11	240,083	23.91
10,000 to 19,999	18	6.23	235,520	23.45
20,000+	4	1.38	103,825	10.34
Total	*289*	*100*	*1,004,298*	*100*

Table 2: Distribution of School Corporations by County

Source: Indiana Department of Education

Corporations per County, 2014	# of Affected Counties	Corporations per County, 2014	# of Affected Counties
1	21	6	4
2	19	7	3
3	22	11	1
4	13	16	1
5	8	*Total*	*92*

Figure 2: Corporation-Level Public School Enrollment, 2014

Source: Indiana Department of Education

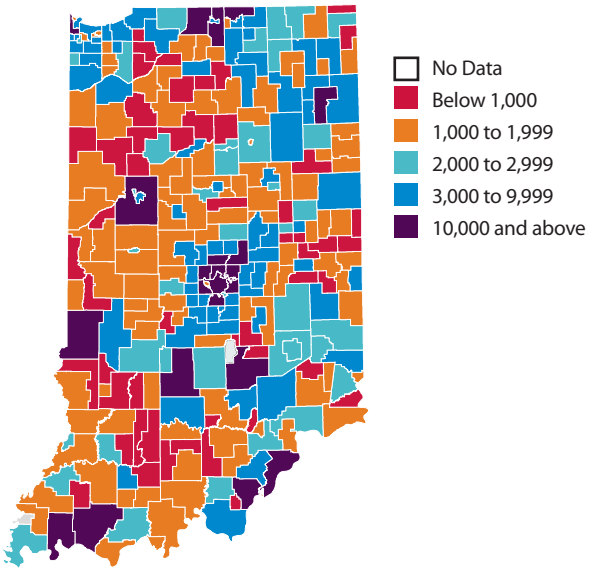
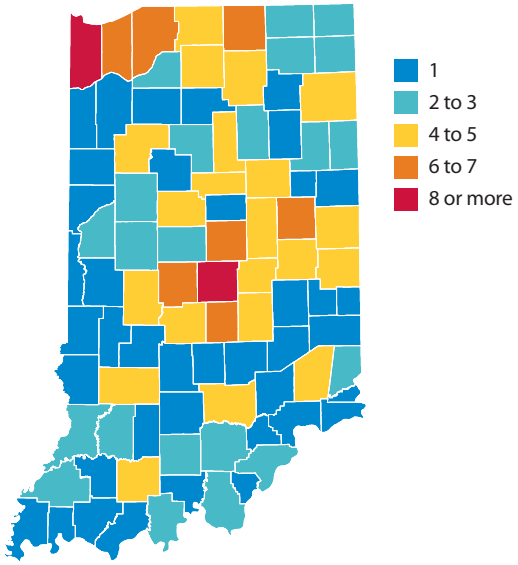


Figure 3: Number of School Corporations per County, 2014

Source: Indiana Department of Education



(3) *LaPorte County* – Dewey, Prairie, and Cass Township school corporations merged to form the Tri-Township Consolidated School Corporation during 2010 and 2011. *Posey County* – New Harmony closed at the end of the 2011-2012 school year. *Parke County* – Rockville and Turkey Run school corporations merged at the end of the 2012-2013 school year to form North Central Parke School Corporation. For more details on the consolidation in Parke County, see the info box on page 9.

(4) The totals used here do not include charter schools, lab schools, vocational schools, and other single schools that the Indiana Department of Education counts as being their own school corporation. These represent approximately 130 schools in 2015.

(5) These statistics show an increasing proportion of small school corporations. By comparison in 2012, 17.5 percent of school corporations had enrollment lower than 1,000 students and 52.9 percent had enrollment lower than 2,000 students.

Table 3: Educational Outcomes in Indiana School Corporations by Enrollment Level, 2014
Source: Author's calculations from Indiana Commission on Higher Education's Indiana College Readiness Reports and Indiana Department of Education datasets

2014 Student Enrollment	# of Corporations	Average SAT Score	Average ACT Score	2014 % Students w/ Honors Diploma	2014 % Students Passing...					
					ISTEP (4th grade)	ISTEP (8th grade)	AP Exam	Algebra ECA	English ECA	Biology ECA
240 to 999	53	949.50	21.49†	30.90	54.85	39.65	22.62‡	71.18	82.38	34.22
1,000 to 1,499	60	963.37	22.73	28.97	57.49	46.46	34.71	74.78	82.60	41.04
1,500 to 1,999	44	973.84	22.26	31.28	57.11	45.71	38.28	69.97	80.00	39.41
2,000 to 2,999	40	989.82	22.85	33.77	60.89	48.78	35.34	73.96	80.19	45.93
3,000 to 4,999	35	972.49	22.22	33.92	58.96	48.77	46.57	75.92	80.89	44.60
5,000 to 9,999	35	986.84	22.73	34.31	61.48	50.00	54.80	73.87	80.14	47.37
10,000 to 20,000+	22	982.57	22.01	31.43	54.47	47.65	51.18	61.46	73.70	41.46
Total	*289*	*971.56*	*22.36*	*31.77*	*57.85*	*46.22*	*38.75*	*72.29*	*80.65*	*41.45*

† Sample size was 45 instead of 53. Corporations not reporting ACT scores are not included in calculations.

‡ Sample size was 43 instead of 53. Corporations not reporting AP pass rates are not included in the calculations. We assume that no students took AP exams in these school corporations.

Descriptive statistics for various student outcomes are presented in *Table 3*. These outcomes include scores on various standardized tests and the awarding of honors diplomas. We consider these the strongest indicators. Other educational outcome measures are shown in *Appendix Table A3.* There is variation in student outcomes for school corporations of different sizes *(Table 3).* Average SAT and ACT scores are lowest for students attending the smallest school corporations and are highest for students attending school corporations with enrollment between 2,000 and 2,999 students. The percentage of students with honors diplomas generally increases with enrollment and then decreases for the largest school corporations (10,000+ students).

The percentage of students passing the 4th and 8th grade 2014 ISTEP exams is lowest in the smallest school corporations, indicating that school corporation size affects not only outcome indicators for high school students but also primary school students. A more detailed breakdown of math and language arts scores is shown in *Appendix Table A3.* The smallest school corporations have the lowest passing rates for the 8th grade ISTEP tests, while the smallest and largest school corporations have the lowest passing rates for the 4th grade ISTEP tests.

The percentage of students passing AP exams is lowest in the smallest school corporations at 22.6 percent, and the passing rate increases to more than 50 percent in the largest school corporations. This likely indicates resource differences in small and large school corporations.

The end-of-course assessment measures vary by subject. The end-of-course assessment (ECA) data show that as corporation enrollment increases, the percentage of students passing the English ECA decreases. The algebra ECA results don't show a clear pattern, but the smallest school corporations have among the lowest pass rates. The share of students passing the biology ECA is lowest in the smallest school corporations. We note here that regardless of school corporation size, the pass rate for the biology

A Recent Case of School Corporation Consolidation

The North Central Parke Community School Corporation was created in 2013 by the merger of the Rockville and Turkey Run districts. Superintendent Tom Rohr points to administrative cost savings that have been realized since the two districts merged in multiple areas. This includes reducing duplication of programs and services and increasing cost efficiencies, e.g. school board costs, superintendent costs, transportation costs, insurance costs, accounting and bookkeeping costs, academic management costs, food service costs, maintenance costs, legal fees, vocational education costs, special education costs, and extracurricular costs.

In response to continued declining enrollment, the school board voted in April 2017 to consolidate Rockville Jr./Sr. High School and Turkey Run Jr./Sr. High School into one grade 9-12 high school to be located at Rockville and one grade 6-8 middle school to be located at Turkey Run starting in the fall of the 2018-2019 academic year. Superintendent Rohr explained that it is difficult to offer comprehensive academic programs in such small schools.

Table 4: Educational Outcomes for School Corporations in Metro and Non-Metro Counties
Source: Author's calculations from Indiana Commission on Higher Education's Indiana College Readiness Reports and Indiana Department of Education datasets

County	# of Corporations	2014 Average Enrollment	2014 Total Enrollment	Average SAT Score	Average ACT Score	2014 % Students w/ Honors Diploma	2014 % Students Passing...					
							ISTEP (4th grade)	ISTEP (8th grade)	AP Exam	Algebra ECA	English ECA	Biology ECA
Metro	158	4,900	774,161	976.51	22.26	32.61	58.79	47.39	38.75	72.25	80.94	43.86
Non-metro	131	1,757	230,137	965.55	22.48	30.77	56.71	44.80	32.44	72.34	80.30	38.54
Total	*289*	*3,475*	*1,004,298*	*971.56*	*22.36*	*31.77*	*57.85*	*46.22*	*43.71*	*72.29*	*80.65*	*41.45*

ECA is the lowest of the three types of end of course assessments reported in the ICHE data. While this may be due to the unusual requirement for students to take biology but not necessarily to pass it to graduate from high school, it likely affects the choice of college major and would seem to conflict with the goal of encouraging more students to pursue STEM careers.

Additional measures are shown in *Appendix Table A3.* The percentage of high school graduates planning to enroll in college tends to increase with the size of the school corporations. High school graduates in larger school corporations are more likely to take AP exams, SAT/ACT college entrance exams, and meet the ACT/SAT college readiness benchmarks. We do not have information about differences in college graduation rates or time to degree completion. The information on type of degree is limited to students who attend Indiana public universities and is therefore not reported because students attending private and out-of-state college and universities are not included. We would be interested in knowing if students from smaller school corporations are less likely to pursue traditional STEM degrees. The lower portion of students in small school corporations who pass the biology ECA would suggest that students from these corporations may not have the same level of science preparation as students from large corporations, which may affect their choice of college major or other certification.

We also provide descriptive statistics for school corporations in metro and non-metro counties. School corporations in non-metro areas tend to be smaller, as indicated by average enrollment in *Table 4*. The average SAT composite score and pass rates for the 4th and 8th grade ISTEP exams, along with high school AP exams and the biology ECA, are lower in school corporations located in non-metro counties.

> The largest school corporations offer substantially more AP courses with a much larger share of students enrolling.

Course Offerings & School Corporation Size

Next, we examine difference in course offerings by school corporation size for advanced placement courses and for advanced math and science.

AP Course Offerings

Advanced placement (AP) courses are one predictor of preparation for higher education. Academic studies have shown that AP coursework positively influences SAT scores (McKillip and Rawls, 2013) and ACT composite scores, with AP mathematics courses especially having an influence (Mo et al., 2011) on college admission decisions and the first-year grade point average during college (Shaw et al. 2012). AP mathematics courses are also associated with higher likelihood of college enrollment (Chajewski et al., 2011) and somewhat higher college science grades (Sadler and Tai, 2007). Ackerman et al. (2013) found that students with more AP-based course credits from high school had higher college graduation rates and completed their college degrees in fewer semesters of study.

As shown in *Figure 4* and in *Table 5*, the average number of AP courses offered by small school corporations (enrollment below 1,000 students) is 2.69 AP courses, with some schools offering no AP courses and some offering up to seven.[6] In contrast, school corporations with enrollment of 2,000 to 2,999 students had an average of almost six AP course offerings during 2015. The largest school corporations offer substantially more AP courses with larger enrollment. When scaled for school corporation enrollment, 4.29 percent of students take AP courses in corporations with enrollment below 1,000 students, while 5.94 percent of students take AP courses in corporations with 2,000 to 2,999 students and 8.98 percent of students take AP courses in corporations with enrollment of 5,000 to 9,999. *(Table 6)*.

Calculus and Physics Courses

We examine course offerings for calculus and physics, which are the highest level math and science courses offered during high school. Many of the STEM majors in college require calculus as a prerequisite for upper-level courses. Math readiness has been shown to be a strong predictor of retention within undergraduate engineering programs

(6) This section on course offerings uses 2015 data. The previous sections of this report use 2014 data.

Figure 4: AP Course Offerings by School Corporation Size
Source: Author's calculations from Indiana Commission on Higher Education's Indiana College Readiness Reports and Indiana Department of Education

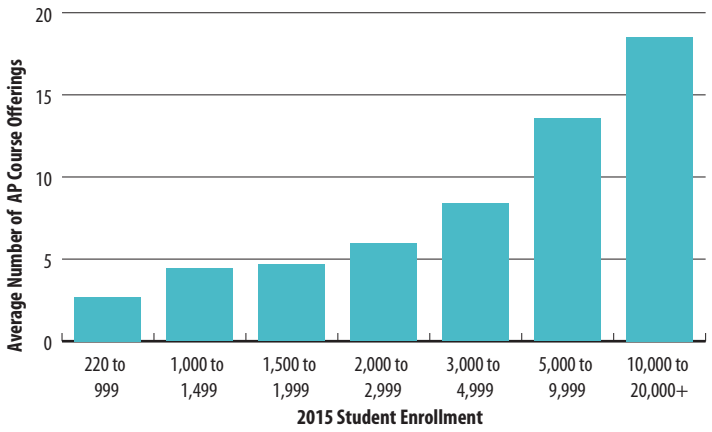


Table 5: AP Course Offerings by School Corporation Size
Source: Author's calculations from Indiana Commission on Higher Education's Indiana College Readiness Reports and Indiana Department of Education

2015 Student Enrollment	# of Corporations	Mean	Min	Max	Sum
220 to 999	54	2.69	0	7	145
1,000 to 1,499	58	4.43	0	12	257
1,500 to 1,999	44	4.66	1	12	205
2,000 to 2,999	41	5.95	1	14	244
3,000 to 4,999	36	8.39	2	15	302
5,000 to 9,999	33	13.55	0	25	447
10,000 to 20,000+	23	18.52	10	30	426
Total	*289*	*7.01*	*0*	*30*	*2,026*

Table 6: AP Enrollment Share as a Percent of Total School Corporation Enrollment, 2015
Source: Author's calculations from Indiana Commission on Higher Education's Indiana College Readiness Reports and Indiana Department of Education

2015 Student Enrollment	# of Corporations	Mean	Min	Max
220 to 999	54	4.29	0.19	19.94
1,000 to 1,499	58	5.34	0.08	14.37
1,500 to 1,999	44	4.87	0.27	15.40
2,000 to 2,999	41	5.94	0.31	23.64
3,000 to 4,999	36	6.67	1.24	24.67
5,000 to 9,999	33	8.98	2.43	20.79
10,000 to 20,000+	23	8.33	2.81	18.61
Total	*289*	*6.02*	*0.08*	*24.67*

(Moses et al., 2011). Taking advanced high school math and science courses influences the declaration of a STEM major and success in engineering programs (Robinson, 2003). Robinson (2003) notes that students who do not take advanced math and science courses during high school are more likely to experience difficulties in the engineering curricula. Tyson (2011) finds that high school calculus grades are the strongest predictor of grades in college physics and calculus courses. Ackerman et al. (2013) found that students receiving course credit for AP calculus were more likely to complete a STEM major in college. Math skills are also a strong predictor of success in economics principles courses, which are gateway courses to all business degrees (Ballard and Johnson, 2004).

High schools in Indiana can offer a general calculus course and/or two versions of advanced placement calculus—AP Calculus AB, which is equivalent to one semester of college calculus, and AP Calculus BC, which is equivalent to a full year of calculus at most colleges and universities *(Figure 5)*. The data presented in *Appendix Tables A4-A6* show that most high schools offer calculus through the AP track. Of the 289 school corporations considered in this analysis, only 24 (8.3 percent) offer a general calculus course, while 223 (77 percent) offer AP Calculus AB, and 55 (19 percent) offer AP Calculus BC. The likelihood of offering a calculus course tends to increase with the size of the school corporation. While almost 67 percent of corporations with enrollment below 1,000 offer AP Calculus AB, more than 75 percent of corporations with enrollment between 2,000 and 2,999 and 100 percent of the largest school corporations offer this course. No school corporations with enrollment below 1,000 offer the year-long equivalent calculus course (AP Calculus BC).

Physics is the most advanced science class offered during high school in Indiana. Two general physics courses (Physics I and II) and three AP physics courses (AP Physics 1, 2, and C) are on the state-approved course list. Physics I focuses on core topics, while Physics II is a laboratory, field, and literature-based course. AP Physics 1 and 2 are algebra-based and are equivalent to first- and second-semester introductory college courses, respectively. AP Physics C is calculus-based and consists of two half-year courses *(Table A9 Notes)*.

Physics I is offered by 55 percent of the smallest school corporations. This increases to almost 83 percent of school corporations with enrollment between 2,000 and 2,999 and 100 percent of the largest school corporations. A small number of school corporations offer Physics II *(Figure 6)*. Less than 10 percent of school corporations with enrollment below 1,000 students offer AP Physics 1, and none of the smallest school corporations offer the calculus-based physics courses. In contrast, 22 percent of school corporations with enrollment between 2,000 and 2,999 and 74 percent of the largest school corporations offer the algebra-based AP Physics 1 course *(Appendix Tables A7-A9)*.

Figure 5: Frequency Distribution for Calculus, 2015
Source: Author's calculations from Indiana Commission on Higher Education's Indiana College Readiness Reports and Indiana Department of Education

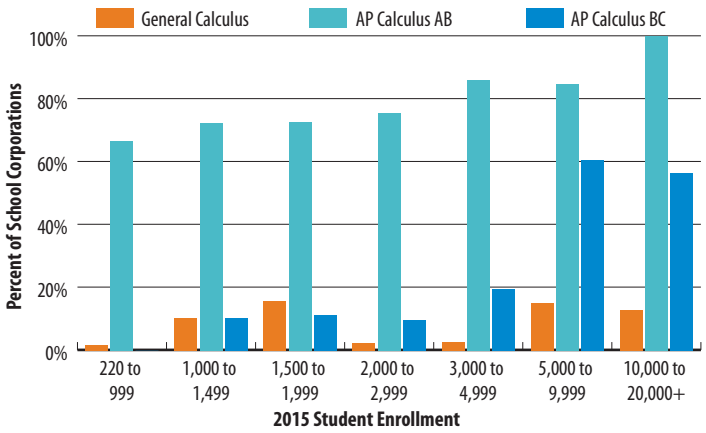
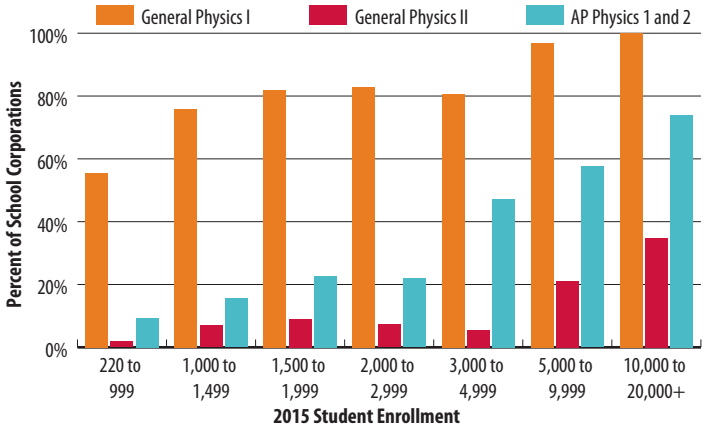


Figure 6: Frequency Distribution for Physics, 2015
Source: Author's calculations from Indiana Commission on Higher Education's Indiana College Readiness Reports and Indiana Department of Education



> "Taking advanced high school math and science courses influences the declaration of a STEM major and success in engineering programs (Robinson, 2003)."

Table 7: Average Share of 2015 Graduates, by Diploma Type, 2015
Source: Author's calculations from Indiana Commission on Higher Education's Indiana College Readiness Reports and Indiana Department of Education

2015 Student Enrollment	# of Corporations	Core 40 %	General %	Core 40 Academic Honors %	Core 40 Technical Honors %	Core 40 Academic & Technical Honors %	International Baccalaureate %
220 to 999	54	49.63	14.50	28.77	3.12	3.97	0
1,000 to 1,499	58	48.36	15.49	28.39	4.06	3.71	0
1,500 to 1,999	44	48.44	15.04	30.32	2.52	3.68	0
2,000 to 2,999	41	45.78	15.34	32.72	1.92	4.25	0
3,000 to 4,999	36	49.04	15.38	28.70	1.89	5.00	0
5,000 to 9,999	33	51.74	11.59	32.12	1.49	2.99	0.07
10,000 to 20,000+	23	52.07	12.03	30.03	1.93	3.43	0.51
Total	*289*	*49.01*	*14.48*	*29.96*	*2.61*	*3.89*	*0.05*

Analysis of Diploma Types

Since fall 2012, four types of high school diplomas have been offered in Indiana: General, Core 40, Core 40 with academic honors, and Core 40 with technical honors.[7] As *Table 7* shows, there is also a hybrid Core 40 with academic and technical honors. A limited number of schools offer the international baccalaureate program and associated diploma, which is also expected to meet the requirements of Indiana's Core 40 diploma. In all school corporation enrollment categories, the largest shares of students receive the Core 40 diploma. School corporations with enrollment of 2,000 to 2,999 have the largest share of academic honors diplomas.

> "School corporations with enrollment of 2,000 to 2,999 students have the largest share of academic honors diplomas."

Dual Enrollment Credit

The proportion of graduating seniors earning dual enrollment credits during 2014 is shown in *Table 8*. Dual credit courses are recognized by both the high school and Indiana public colleges. In the smallest school corporations, 57.1 percent of graduating seniors earned dual credits. This increases to 58.6 percent of graduating seniors in school corporations with enrollment between 3,000 and 4,999. The largest school corporations have the lowest shares of students earning dual credits.

Table 8: Share of High School Graduates Earning Dual Credit Hours, by School Corporation Enrollment, 2014
Source: Author's calculations from Indiana Commission on Higher Education's Indiana College Readiness Reports and Indiana Department of Education

2014 Student Enrollment	# of Corporations	Mean	Min	Max
220 to 999	53	0.571	0.082	0.973
1,000 to 1,499	60	0.545	0.012	0.884
1,500 to 1,999	44	0.574	0.253	0.879
2,000 to 2,999	40	0.579	0.206	0.863
3,000 to 4,999	35	0.586	0.344	0.889
5,000 to 9,999	35	0.492	0.168	0.733
10,000 to 20,000+	22	0.501	0.242	0.826
Total	*289*	*0.501*	*0.012*	*0.973*

(7) Details on the Core 40 and general diploma requirements are available at **http://www.doe.in.gov/ccr/indianas-diploma-requirements**. Details on the international baccalaureate program are available at **http://www.doe.in.gov/ib**.

Empirical Modeling of Student Performance & School Corporation Size

The descriptive statistics presented in *Table 3* (see page 9) do not take into account demographic and economic differences among school corporations. Performance or quality differences between the smallest and largest school corporations may be attributed to demographic and socioeconomic differences that exist between the state's most urban and rural places. To account for this, we turn to a more rigorous statistical analysis of the relationship between school corporation enrollment and educational outcomes, controlling for demographic and socioeconomic differences among school corporations. We examine the effect of school corporation size on educational outcomes in Indiana, employing time series, cross-sectional (panel) data from 2011-2014. These data are compiled by the Indiana Department of Education (IDOE) and the Indiana Commission on Higher Education (ICHE) and are available through their respective websites. To evaluate the post-secondary opportunity, we examine performance measures associated with college preparation and attendance. To control for non-size-related performance in schools, we include demographic heterogeneity measures and share of students receiving free or reduced lunch. Descriptive statistics for the data used in the analysis appear in *Appendix Table B1.*

Appendix B contains technical details on the modeling approach and the entirety of the modeling results, which provide five alternative models *(Appendix Tables B2-B10).* In each, we use the natural logarithm of school corporation enrollment as the size measure. We first measure the overall marginal impact across all school corporations. We then examine marginal effects with increasingly larger enrollment sizes (under 1,000 students, under 2,000 students, under 4,000 students, and under 8,000 students).

Figure 7 and Table 9 summarize the overall and increasingly larger marginal effects from these models. Those estimates not meeting the 10 percent level of statistical significance are denoted by zero, while

Figure 7: Model Results—Impact of Increasing School Corporation Enrollment, 2015

Source: Author's calculations from Indiana Commission on Higher Education's Indiana College Readiness Reports and Indiana Department of Education

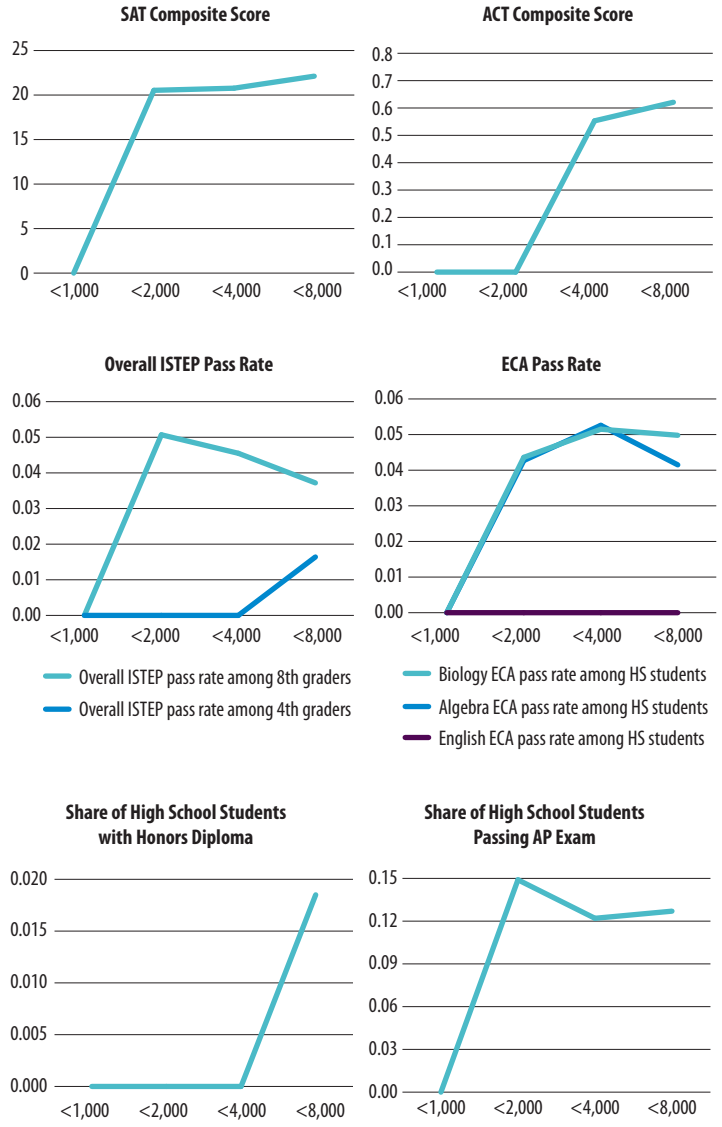


Table 9: Model Results—Impact of Increasing School Corporation Enrollment, 2015

Source: Author's calculations from Indiana Commission on Higher Education's Indiana College Readiness Reports and Indiana Department of Education

	Overall	< 1,000 Students	< 2,000 Students	< 4,000 Students	< 8,000 Students
SAT composite score for HS students	22.68	0	20.53	20.77	22.12
ACT composite score	0.516	0	0	0.553	0.621
Share of passing AP exam among AP students	0.113	0	0.149	0.122	0.127
English ECA pass rate among HS students	0	0	0	0	0
Algebra ECA pass rate among HS students	0.0264	0	0.0427	0.0526	0.0415
Biology ECA pass rate among HS students	0.0437	0	0.0436	0.0515	0.0498
Share of HS students with honors diploma	0.0197	0	0	0	0.0185
Overall ISTEP pass rate among 4th graders	0.0126	0	0	0	0.0164
Overall ISTEP pass rate among 8th graders	0.0335	0	0.0507	0.0455	0.0372
Overall average	*2.927*	*0*	*2.598*	*2.696*	*2.875*

all reported values are statistically significant at the 10 percent level or better using asymptotic t-statistics.

These results suggest that there are potential benefits from increasing the size of small school corporations. Indicators like SAT score and pass rates, end-of-course assessments (ECA) and advanced placement (AP) tests provide standardized measures of performance.[8] Interpreting these results is fairly straightforward. Our specification of the model allows us to interpret these results as the numeric change on a measure (test score points or share of students) as the size of a school corporation increases. The results in *Table 9* should be interpreted as the impact of increasing the size of the school corporation from the minimum observed level (240 students) to the enrollment level noted in the top row.

For the smallest schools (enrollment < 1,000), the impact of increasing enrollment to 1,000 students is near zero. This means that increasing enrollment from the smallest observed level to 1,000 students is not sufficient to generate statistically reliable impacts on SAT or ACT test scores or take rates, ECA pass rates at the corporation level, share of students graduating with an honors diploma or ISTEP+ pass rates.

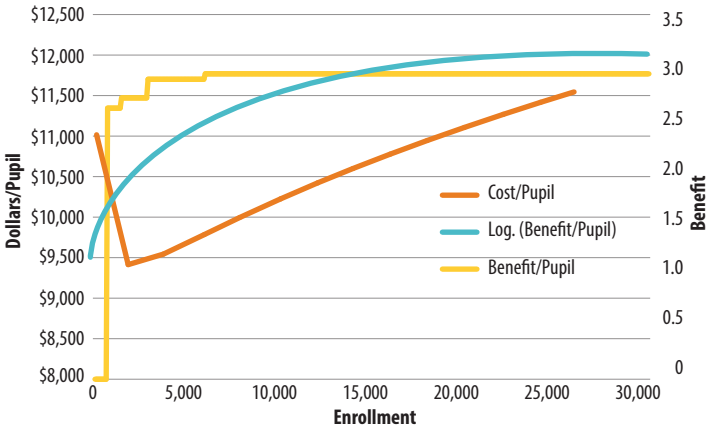
Significant impacts on educational outcomes occur as school corporations approach an enrollment level of 2,000 students. For school corporations of this size, average SAT composite scores are 20 points higher.[9] There is a 15 percentage point increase in the number of AP students passing AP exams, a 4 percentage point increase in students passing the algebra and biology ECA, and a 5 percentage point increase in students passing the 8th grade ISTEP+ exam.

The largest effects impacted by enrollment growth (through mergers or outright population growth) would be the AP exam pass rates and SAT composite test scores. However, the growth of these effects quickly dissipates as enrollment continues to increase. So, increased enrollment from 2,000 to 4,000 students would only add an additional 0.24 points on the composite SAT score, a result that is statistically significant but not meaningfully different. The increase in the share of students passing the algebra and biology ECA is small for all enrollment levels. As school corporations approach an enrollment level of 4,000 students, there is a significant increase in ACT scores, and as school corporations approach 8,000 students, there is a small but significant increase in the share of students earning honors diplomas and the pass rate for the 4th grade ISTEP exam. *See Appendix Tables B2-B10* for the full model results.

Importantly, the positive impacts of enrollment on performance mimic the cost savings discussed in the literature review (Zimmer, DeBoer, and Hirth). In their model, these authors calculate the cost per student of economies of scale of schools. *Figure 8* shows the incremental cost savings of enrollment changes along with our model's estimates of the incremental improvement in test scores (average of tests) as a proxy for opportunity. Combining these two concepts (as in Fox, 1981) highlights the inverse relationship between the performance measure and the cost measure. A non-technical way to think about this is that the performance (benefit) function should take the inverse shape of the cost function.

To depict this duality, we show the average of the incremental change in test scores from our models that depict the increase in scores from increasing enrollment at a school corporation. These are an imperfect measure (we don't have a single quality or performance measure), but the functional growth of performance clearly occurs when increasing corporation size from the lowest level of enrollment. The biggest gains come between 1,000 and 2,000 students within a corporation. We then plot this against the per

Figure 8: Average Student Benefit and Cost Functions of Corporation Size
Source: Author calculations using Zimmer, Deboer, and Hirth, 2009.



> "Improvements in both costs and benefits per student occur quickly as small school corporations experience enrollment growth."

(8) The ICHE data also reports metrics on the intent to major in a STEM degree and the intent to attend a four-year college. These measures are less precise, and reflect intent rather than actual outcomes; therefore they are not included in this analysis. The metrics have an additional problem that the definition of STEM involves a wide range of majors across a wide variety of schools of differing quality; however, college quality is not the only factor determining student success or choice of schools. Cost, proximity, and desired mix of majors also influence choice. The ICHE dataset can address some of these questions, but that element is better left to the research of actual, not intended, post-secondary outcomes. The ICHE dataset does not contain information on college graduation rates, time to degree completion, or type of degree completed to determine if there are differences in these variables for students from small versus large school corporations.

(9) During this sample period, the SAT was scored out of 2,400 points and the ACT was out of 36 points. Both of these tests reflect the most critical external assessment of college readiness available to high school students.

unit costs of school corporations drawn from Zimmer, DeBoer, and Hirth to illustrate how the large change in per student costs occurs at the very lowest levels of enrollment. The discrete changes in our benefit estimation result from sample size limitations in our approach. However, in this depiction, we include a simple logarithmic trend line, to illustrate the benefit change per student from very low to average-sized enrollment.

The practical point of this analysis is that improvements in both per student costs and per student benefits occur quickly as small school corporations experience enrollment growth. This should be intuitive. Very small school corporations enjoy decreasing costs immediately, as additional students reduce per unit cost due to high fixed costs. We also observe that the benefits from these cost savings accrue quickly to students, and that the largest gains in test scores (from zero to nearly 20 points per student on the combined SAT, for example) occur as schools of smallest size increase enrollment to approach 2,000 students.

Overall, it remains difficult to construct a clear and unambiguous measure of quality that perfectly captures the opportunities for post-secondary educational or workforce opportunity.

In *Appendix B* we also provide model results for other educational outcome measures—the share of students taking SAT, ACT, AP tests, share of students meeting the ACT/SAT college readiness benchmark, share of students planning to attend college and ISTEP+ scores by subject area and grade *(Appendix Tables B11-B20)*.

Three measures (the share of students taking AP exams, the pass rates for 8th grade English/language arts ISTEP+, and the pass rates for 8th grade math ISTEP+) significantly increase as school corporation enrollment increases to around 2,000 students.

Other outcome measures are significant for larger school corporations. The pass rates for 4th grade English/language arts ISTEP+ and the share of students taking the SAT increase slightly in school corporations approaching 8,000 students, while the share of students meeting the ACT/SAT college readiness benchmark increases as the school corporation's enrollment approaches 4,000 students.

We find that school corporation size has no impact on self-reported student intention to attend college or on the share of students taking the ACT exam.

Across almost all our measures, and most importantly those that are most likely to be associated with post-secondary access and opportunities (such as SAT and ACT test scores, honors diploma and AP pass rates), school corporation size matters. In particular, growing enrollment from the smallest corporation to roughly 2,000 students is associated with significant gains across almost all our measured areas. Indeed, only English ECA pass rates are unaffected by scale. Across every other measure, performance increases with school corporation size. This is similar to results from other Indiana studies and motivates a restatement of our findings and a discussion of policy considerations.

For corporations with < 2,000 students...

2006 2014

81% of Indiana's small school corporations have seen enrollment declines in 2006-2014

54% have seen enrollment declines of more than 100 students

1 in 6

school corporations in Indiana serve less than 1,000 students each

94% of Indiana's school corporations under 2,000 students are contiguous with another small corporation.

If enrollment increased to ≥ 2,000 students...

14.9% increase
in share of students passing AP exams

4.3%
more students
passing the algebra end-of-course assessment in high school

20.5
point increase
in SAT composite score for the average student

Summary and Policy Recommendations

An earlier study (Hicks and Faulk, 2014) identified significant administrative/overhead per pupil cost savings were available from increasing school corporation size to around 2,000 students—savings could free up funds to use in classroom instruction. School corporations below this size comprise more than 150 out of Indiana's roughly 289 corporations. This study extends that research to evaluate the effect school corporation size plays in the educational outcomes that are likely to affect post-secondary opportunities available to students.

Using test scores (SAT, ACT, AP, and ECA) and other measures as proxies for student post-secondary preparation, we find that corporation size plays a significant role in educational outcomes. For example, small school corporations that increase their size to around 2,000 students would experience an increase in the average student's performance on the SAT of 20.5 points, a 14.9 percentage point increase in share of students passing AP exam, an additional 4 percentage point increase on end-of-course assessments (ECAs) in algebra and biology pass rates, and a 5 percentage point increase in the 8th grade ISTEP+ pass rate *(see Table 9 and Appendix Tables B2-B10)*. There was no statistically significant impact on ACT scores, ECA English pass rates or the share of students earning honors diplomas for school corporations of this size.

When combining costs and performance to evaluate economies of scale, we find a strong relationship. This should be intuitive, that the real cost savings and associated performance improvements are most readily gained by increasing the size of smaller school corporations. Another way to restate the findings of these studies is that more than half of all Indiana school corporations are of a size that experiences higher per unit costs due to inefficiently small scale. More disturbingly, the small size of half of Indiana's school corporations is likely to reduce post-secondary opportunity for students due to poor performance on standardized tests, college entrance tests, end of course evaluations in science and mathematics and passing AP examinations. These issues likely play a role in Indiana's low post-secondary educational attainment rates as compared to other states. Additional research is needed to examine actual post-secondary outcomes such as choice of major (STEM versus non-STEM), time to degree completion, college attendance, and college graduation rates for students from Indiana's smallest school corporations relative to larger corporations.

The findings presented in this report lead us to repeat, with some modification, our recommendations from Hicks and Faulk (2014). A majority of Indiana's school corporations are so small that they could increase efficiency (lower the cost of providing education services) and improve student performance by merging with one or more adjacent school corporations. A lengthy body of research, including studies of Indiana school corporations, found that small size increases the cost of K-12 education and reduces the availability of funds for other services and activities within corporations. Of those school corporations smaller than 2,000 students, 54 percent have seen enrollment declines of more than 100 students between 2006 and 2014. Thus, a majority of Indiana's small school corporations are shrinking. Among school corporations with fewer than 1,000 students, 81 percent had enrollment decreases between 2006 and 2014. Small school corporations are becoming more costly and are offering fewer opportunities to students. They are getting worse on both dimensions over time.

Also, more than one in six school corporations in the state serve less than 1,000 students each. The majority of Indiana's counties have three or more school corporations. A detailed examination of the geography of school corporations revealed few instances where a contiguous merger between corporations of fewer than 2,000 students could not occur with a similarly sized corporation. In fact, 94 percent of Indiana's small school corporations (fewer than 2,000 students) are contiguous with another small corporation.

The long-term fiscal viability of more than half of Indiana's school corporations argues for mergers as a tool to reduce overhead and management expenses. We believe the General Assembly should revisit those recommendations offered by Plucker et al. (2007). In particular, those recommendations from their conclusions are supported by this analysis.

To restate these recommendations briefly, they include:

1. A continued focus on both cost savings and performance-related findings to motivate the merging of school corporations.
2. Funding feasibility studies for school corporations that are considering merger and continued funding for the implementation of mergers.
3. The creation of financial incentives for realized efficiency gains in district operations due to mergers or shared services.

In addition, we recommend:

4. A best practices "how-to" study to help guide smaller school districts interested in merging administrative functions or entire districts. This would also include a review of potential specific cost savings realized in districts already merged and a review of state and federal policy and financial barriers to merging.
5. A best practices study to understand opportunities to improve teaching and learning opportunities in smaller districts using technology to deliver content, specifically in the STEM areas. This would include a review of policy barriers, financial barriers, as well as technology barriers in rural areas.

To these recommendations, we add the very clear conclusion that the combination of relatively higher cost and poorer outcomes for students adds increased urgency to state-level policy initiatives.

Credits

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Authors

Srikant Devaraj, PhD, research assistant professor, Center for Business and Economic Research, Ball State University.

Dagney Faulk, PhD, director of research and research professor, Center for Business and Economic Research, Ball State University.

Michael J. Hicks, PhD, director, Center for Business and Economic Research, Ball State University. George & Frances Ball distinguished professor of economics, Miller College of Business, Ball State University.

Research Assistance

Kera Fenimore, undergraduate research assistant, Center for Business and Economic Research, Ball State University.

Graphics and Design

Stephanie Davidsen, graduate research assistant, Center for Business and Economic Research, Ball State University.

Nathan Law, graduate research assistant, Center for Business and Economic Research, Ball State University.

Kaylie McKee, undergraduate design assistant, Center for Business and Economic Research, Ball State University.

Victoria Meldrum, manager of publications and web services, Center for Business and Economic Research, Ball State University.

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Center for Business and Economic Research
2000 W. University Ave. (WB 149)
Muncie, IN 47306

765-285-5926 • cber@bsu.edu
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