

PHASE II - STUDENT SPENDING AND ACADEMIC OUTCOMES: SCHOOL-LEVEL ANALYSIS

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In the following document, we use data provided by the Delaware Department of Education to find potential relationships between per student spending and mathematics proficiency on the Delaware Comprehensive Assessment System (DCAS), and reading proficiency on the DCAS for public schools in Delaware. This analysis builds on the Phase I report, which examined district-level outcomes.

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EXECUTIVE SUMMARY AND KEY FINDINGS

INTRODUCTION

In this report, Hanover Research presents the results of an analysis of financial expenditures and student proficiency for 163 public schools in the State of Delaware. First, we create predictions of spending per pupil and the proportions of proficient students in math and reading on the Delaware Comprehensive Assessment System (DCAS) for each school based on the proportions of disadvantaged students in each school's student population. Then we assess each school's performance relative to the other schools by comparing the actual spending and proficiency scores to the ones predicted based on the student population makeup. Finally, we compare schools' financial performance to their proficiency performance.

An accompanying data supplement describes the underlying data and the results of Hanover's analysis for each school.

This report consists of two sections:

- **Section I** outlines the data provided by the Delaware Department of Education (DDOE), the data processing conducted by Hanover Research, and the methodology employed in the analysis.
- **Section II** presents summaries of the proportions of schools classified as high and low expenditure and high and low achievement for the two outcome variables.

KEY FINDINGS

- For math achievement, **17 schools are classified as low expenditure with high achievement, while 10 schools are classified as high expenditure with low achievement.**
- For reading achievement, **16 schools are classified as low expenditure with high achievement, while 10 schools are classified as high expenditure with low achievement.**
- Although most schools categorized as low achievement have levels of achievement below the average for schools across the state,¹ **in a few cases schools outperform the average while underperforming their predicted level of achievement to an extent that they are categorized as low achievement.**
 - For example, Concord High School, Delmar Senior High School, and Maclary Elementary School each exceed the state average for reading proficiency, yet are categorized as low achievement because they underperform their expected outcome based on their students' demographic characteristics. In particular, all three have lower than average proportions of their student populations

¹ Note that the state average represents the average for schools included in this analysis. See Figure 1.1 for relevant summary statistics.

classified as low income and special education. Based on the models, lower proportions of such students result in higher predicted reading proficiency scores.

- By contrast, although most schools categorized as high achievement have levels of achievement above the average for schools in the state, **in a few cases schools underperform the average while outperforming their predicted proficiency level so substantially that they are categorized as high achievement.**
 - For example, 64.6 percent of Brown (W. Reily) Elementary School's students are proficient at math, compared with an average across the schools of 69.6 percent. This school is categorized as high achievement because it serves very high proportions of low income and special education students. Based on the models, higher proportions of such students result in lower predicted math scores.

SECTION I: DATA AND METHODOLOGY

In this section, Hanover Research discusses the data analyzed in this report and presents our methodological approach to the analysis.

DATA

The Delaware DOE presented Hanover Research with three data sources used in this analysis, including a file with pro-rated cost per pupil data for 179 schools in the state, an Excel spreadsheet with a sheet including DCAS outcome data and a sheet including enrollment data for each school. Hanover evaluates the most recent year of data, the 2013-2014 school year.²

In all, 164 schools have data for both outcomes and inputs, with one school (Dover Air Force Base Middle School) missing enrollment data. Thus we evaluate spending, demographics, and outcomes for 163 elementary, middle, and high schools in Delaware.

INPUT VARIABLES

The input variable of interest in the report is adjusted per pupil expenditure (PPE). We construct this variable by modifying the pro-rated cost per pupil figures provided by Delaware DOE to account for cost-of-living differences. To perform this adjustment, we divide each district's expenditures by a region-specific figure derived by the National Center for Education Statistics, then multiply the resulting figure by the national mean.³ This calculation is formalized in the Methodology subsection below – see equation (2). Figure 1.1 describes this variable and the other variables Hanover employs in the analysis.

OUTCOME VARIABLES

In this report, we examine two outcomes at the school-level: the proportion of students proficient in math and reading according to the DCAS. Figure 1.1 describes these variables.

² Note that the Delaware DOE also provided outcomes data on dropout and graduation rates. However, upon reviewing these data, Hanover chose to analyze DCAS reading and math outcomes due to the considerably larger sample size available for analysis (163 schools with complete DCAS, finance, and enrollment data, compared to only 35 with graduation rate data and 41 with dropout data).

³ [1] Taylor et al., *Documentation for the NCES Comparable Wage Index Data Files*, p. 6, <http://nces.ed.gov/edfin/pdf/2007397.pdf>

[2] Note that in the previous analysis (Phase I – Student Spending and Academic Outcomes), Hanover used the most recent comparable wage index (CWI) figures published by the National Center for Education Statistics (NCES). However, faculty at the Bush School of Government & Public Service at Texas A&M University have updated the CWI data to reflect more recent years (2013 is the most recent). Hanover used these updated figures for the current analysis. For the state of Delaware, there are three labor market regions represented in the CWI data: Sussex County, Dover, and the Wilmington DE-MD-NJ Metropolitan Division. See: Taylor, L. and Fowler, W. "The National Center for Education Statistics Comparable Wage Index." Texas A&M University. http://bush.tamu.edu/research/faculty/Taylor_CWI/

CONTROL VARIABLES

In order to determine whether a school is overperforming or underperforming expectations, we use three demographic control variables to create predictions of the outcome and input variables for each school. These variables are the proportion of the students who are classified as low income, the proportion of the students who are classified as limited English proficient (LEP), and the proportion of students who are classified as special education (SPED). Figure 1.1 describes these variables.

METHODOLOGY

RETURN ON INVESTMENT

The basic ROI measures the amount of academic achievement ‘produced’ per (thousand) dollar(s) spent. However, because it does cost more to educate students in special programs as well as those receiving subsidized lunches, we calculate an adjusted ROI for each location to account for differences in the student population served, and by adjusting the per pupil expenditure (PPE) for cost of living as described above. We compute the cost of living adjusted ROI as follows.

$$ROI_s^i = Y_s^i \div C_s \tag{1}$$

and

$$C_s = (PPE_s \div CWI_s) * CWI_n \tag{2}$$

ROI_s^i denotes the return on investment from outcome i in school s , calculated as the ratio of the outcome Y_s^i and C_s (the cost of living-adjusted per pupil expenditure at school s). Y_s^i denotes the outcomes of interest to this analysis and will include: the percentage of students meeting DCAS proficiency standards in mathematics and reading (separately). PPE_s is the per pupil expenditure in school s , while CWI_s is the comparable wage index for the region in which school s is located and CWI_n is the comparable wage index for the United States overall, allowing us to account for regional variation in the cost of living in the United States as described above.

Figure 1.1 describes the averages for the calculations of ROI, along with summary statistics for the other variables used in the analysis. Calculations for individual schools can be found in the accompanying data supplement.

Figure 1.1: Summary Statistics

VARIABLE	MEAN	SD	N
Adjusted Per Pupil Expenditure	\$14,555	\$3,786	164
Low Income	41.8%	18.4%	163
LEP	7.5%	10.4%	163
SPED	11.5%	4.4%	163
Math Proficiency	69.6%	15.5%	164

VARIABLE	MEAN	SD	N
Reading Proficiency	71.2%	13.9%	164
Math ROI (Proficiency/PPE)	5.1%	1.8%	164
Reading ROI (Proficiency/PPE)	5.2%	1.8%	164

Note: For the ROI measures, PPE is expressed in thousands of dollars.

DETERMINING ADEQUATE ROI

Figure 1.1 summarizes the ROI outcomes for math and reading proficiency described in equation (1) above. However, although we adjust the per pupil expenditures for cost of living, we still must determine whether a particular school or district is spending and producing a level of academic achievement that is more or less than what is expected. Since schools and districts serve different student populations, we expect differential outcomes and differential levels of expenditures. Therefore, to ensure comparability in schools’ returns relative to their expenditure levels, we employ a regression analysis framework to more accurately assess whether each school is spending more or less than other schools with a similar student population and whether each school’s achievement is above or below the average of similar schools. Thus, we estimate the following regression equation:

$$C_s = \beta_0 + \beta_1 * LowInc_s + \beta_2 * LEP_s + \beta_3 * SPED_s + \epsilon_s \tag{3}$$

where C_s denotes the cost of living adjusted PPE for school s . $LowInc$, LEP , and $SPED$ refer to the percentage of all students enrolled in school s who are of low income status, have limited English proficiency, and receive special education, respectively. Lastly, ϵ_s is the idiosyncratic residual term. A positive value of ϵ_s denotes that spending at school s was above the average of similar schools in the state, i.e., higher than expected.

Similarly, we estimate the same regression equation, but with Y_s^i as the academic outcome of interest. In this case, the regression estimates will determine whether each school’s achievement is above or below the average achievement among similar schools in the state. We estimate the following regression equation:

$$Y_s^i = \delta_0 + \delta_1 * LowInc_s + \delta_2 * LEP_s + \delta_3 * SPED_s + v_s \tag{4}$$

After estimating equations (3) and (4), we determine whether each school’s expenditures and outcomes were above or below similar schools’ average expenditures and outcomes by computing the values of the residual terms ϵ_s and v_s . Next, we group each school’s results into three categories of high spending, average spending, and low spending; and high achievement, average achievement, and low achievement. We place approximately one-third of the schools in each category. Instead of taking exactly thirds, however, we create the middle group (referred to as “average”) by identifying all observations within 0.43 standard deviations of the mean. If the distributions of these variables were completely normal, those falling within 0.43 standard deviations of the mean would comprise the middle third. As the distribution is not completely normal, this approach results in a somewhat larger proportion of schools placing in the “average” category than the low or high categories. We consider this method fairer than strictly dividing the sample into thirds,

in the sense that it is less likely that schools with residuals close to the mean will be assigned to the low or high categories.

The grouping of the residuals enables us to determine the schools that were most efficient in terms of achievement per spending level, while adjusting for both the cost of living as well as the student population served.

SECTION II: SCHOOL-LEVEL FINANCIAL AND ACADEMIC PERFORMANCE

This section presents the results of Hanover’s analysis of school PPE and reading and math proficiency outcomes. The full results for each school are available in the data supplement accompanying this report.

FINANCIAL PERFORMANCE AND MATH ACHIEVEMENT

In this subsection, we describe the distribution of schools across expenditure and math achievement categories and list notable schools.

Per our methodology, individual schools are assigned to each achievement category as well as to each expenditure category. For both achievement and expenditure, more schools are considered average than high or low.

Figure 2.1: Financial Performance and Math Achievement

Financial Level	Math Level			Total
	Low Achievement	Average Achievement	High Achievement	
Low Expenditures	14	26	17	57
Average Expenditures	27	31	13	71
High Expenditures	10	8	17	35
Total	51	65	47	163

LOW EXPENDITURE - HIGH ACHIEVEMENT SCHOOLS

Figure 2.2 describes the 17 schools that were categorized as low expenditure and high achievement. These schools both spent less than the model predicts and exhibited a higher proportion of students attaining math proficiency than the model predicts based on the demographic characteristics of the students at the school.

Because these categories are created by comparing actual school data with the data we predict based on the student characteristics, not all schools assigned, for example, to the high proficiency category have above-average proficiency. For example, 64.6 percent of Brown (W. Reily) Elementary School’s students are proficient at math, compared with an average across the schools of 69.6 percent. Yet 58.0 percent of this school’s students are classified as low income and 32.6 percent are classified as special education. Both of these figures are far above the average of schools, 41.8 percent and 11.5 percent, respectively, leading to the finding that the school is experiencing higher than predicted math achievement.⁴

⁴ In other words, based on the model, we would expect schools with larger low income and special education populations to achieve lower levels of math proficiency than schools with smaller low income and special education populations. Though underperforming the state average, Brown (W. Reily) Elementary School outperforms its own expected (predicted) level of math proficiency.

Figure 2.2: Low Expenditure – High Math Achievement Schools

SCHOOL NAME	DISTRICT ID	MATH PROFICIENCY	LOW INCOME	LEP	SPED	ADJUSTED SPENDING
Banneker (Benjamin) Elementary School	18	89.0%	56.2%	10.5%	12.2%	\$11,722
Brown (W. Reily) Elementary School	10	64.6%	58.0%	1.3%	32.6%	\$13,277
Chipman (W.T.) Middle School	15	77.0%	41.8%	0.5%	16.5%	\$11,839
Clayton Elementary School	24	90.8%	30.0%	1.0%	9.2%	\$12,223
Frear (Allen) Elementary School	10	81.4%	35.3%	1.8%	8.4%	\$10,131
Lake Forest Central Elementary School	15	79.9%	48.2%	1.2%	13.5%	\$12,415
Lake Forest North Elementary School	15	91.2%	46.5%	1.0%	14.9%	\$13,439
Lake Forest South Elementary School	15	80.0%	57.4%	2.0%	9.9%	\$13,286
Mispillion Elementary	18	75.5%	56.0%	10.5%	9.1%	\$10,435
North Smyrna Elementary School	24	64.4%	47.8%	2.5%	30.1%	\$14,066
Ross (Lulu M.) Elementary School	18	78.3%	50.8%	12.3%	9.5%	\$10,968
Simpson (W.B.) Elementary School	10	84.6%	38.8%	1.6%	7.7%	\$10,436
South Dover Elementary School	13	66.0%	63.6%	6.4%	10.9%	\$13,441
Star Hill Elementary School	10	87.2%	25.8%	2.7%	8.4%	\$10,781
Stokes (Nellie Hughes) Elementary School	10	87.6%	49.6%	8.7%	16.0%	\$13,763
Sunnyside Elementary School	24	93.4%	25.3%	1.5%	8.5%	\$11,350
Towne Point Elementary School	13	65.9%	66.3%	5.1%	10.9%	\$14,517

HIGH EXPENDITURE - LOW ACHIEVEMENT SCHOOLS

Figure 2.3 describes the 10 schools that were categorized as high expenditure and low achievement. These schools both spent more than the model predicts and exhibited a lower proportion of students attaining math proficiency than the model predicts.

Notably, although Delmar Senior High School outperforms the average math proficiency of all schools (69.6 percent) with 70.9 percent of students proficient, the school has lower than average proportions of its student population classified as low income (17.1 percent), LEP (0.3 percent), and special education (9.0 percent). Based on its student body, the school significantly underperforms the model’s prediction, and is thus categorized as low achievement.⁵ A similar relationship is observed for Calloway School of the Arts.

Figure 2.3: High Expenditure – Low Math Achievement Schools

SCHOOL NAME	DISTRICT ID	MATH PROFICIENCY	LOW INCOME	LEP	SPED	ADJUSTED SPENDING
Bancroft Elementary School	33	27.5%	79.0%	2.7%	14.7%	\$19,728
Brandywine High School	31	59.5%	29.9%	1.8%	12.2%	\$16,298
Calloway (Cab) School Of The Arts	32	85.1%	7.2%	0.2%	2.5%	\$14,836
Christiana High School	33	46.3%	35.3%	4.4%	10.8%	\$17,668
Concord High School	31	67.2%	16.6%	1.2%	7.3%	\$14,438
Delmar Senior High School	37	70.9%	17.1%	0.3%	9.0%	\$16,015

⁵ Based on the model, we would expect schools with smaller low income and special education populations to achieve higher levels of math proficiency. Though outperforming the state average, Delmar Senior High School underperforms its own expected (predicted) level of math proficiency.

SCHOOL NAME	DISTRICT ID	MATH PROFICIENCY	LOW INCOME	LEP	SPED	ADJUSTED SPENDING
Glasgow High School	33	48.3%	37.2%	4.1%	9.5%	\$16,048
Laurel Senior High School	16	56.4%	46.6%	4.2%	17.1%	\$21,734
Seaford Senior High School	23	41.2%	53.4%	6.0%	13.3%	\$27,783
Woodbridge High School	35	56.1%	45.3%	2.5%	15.4%	\$30,112

FINANCIAL PERFORMANCE AND READING ACHIEVEMENT

In this final subsection, we describe the distribution of schools across expenditure and reading achievement categories and list notable schools.

Individual schools are assigned to each achievement category as well as to each expenditure category. Once again, for both achievement and expenditure, more schools are considered average than high or low.

Figure 2.4: Financial Performance and Reading Achievement

Financial Level	Reading Level			Total
	Low Achievement	Average Achievement	High Achievement	
Low Expenditures	16	25	16	57
Average Expenditures	26	28	17	71
High Expenditures	10	9	16	35
Total	52	62	49	163

LOW EXPENDITURE - HIGH ACHIEVEMENT SCHOOLS

Figure 2.5 describes the 16 schools that were categorized as low expenditure and high achievement. These schools both spent less than the model predicts and exhibited a higher proportion of students attaining reading proficiency than the model predicts.

Of the schools categorized as low expenditure with high achievement, Brown (W. Reily) Elementary School, North Smyrna Elementary School, and Towne Point Elementary School underperform the average for all schools (71.2 percent), but outperform the model’s prediction. Each of these schools has exceptionally high proportions of students classified as low income, while Brown (W. Reily) Elementary School and North Smyrna Elementary School also have far above average proportions of special education students.⁶

Figure 2.5: Low Expenditure – High Reading Achievement Schools

SCHOOL NAME	DISTRICT ID	READING PROFICIENCY	LOW INCOME	LEP	SPED	ADJUSTED SPENDING
Banneker (Benjamin) Elementary School	18	88.7%	56.2%	10.5%	12.2%	\$11,722
Brown (W. Reily) Elementary School	10	64.8%	58.0%	1.3%	32.6%	\$13,277
Chipman (W.T.) Middle School	15	78.7%	41.8%	0.5%	16.5%	\$11,839

⁶ As with math outcomes, based on the model, we would expect schools with larger low income and special education populations to achieve lower levels of reading proficiency. These schools substantially outperform their predicted values.

SCHOOL NAME	DISTRICT ID	READING PROFICIENCY	LOW INCOME	LEP	SPED	ADJUSTED SPENDING
Clayton Elementary School	24	84.9%	30.0%	1.0%	9.2%	\$12,223
Clayton Intermediate School	24	84.9%	23.2%	0.0%	10.9%	\$11,372
Lake Forest Central Elementary School	15	80.1%	48.2%	1.2%	13.5%	\$12,415
Lake Forest North Elementary School	15	90.2%	46.5%	1.0%	14.9%	\$13,439
Lake Forest South Elementary School	15	74.1%	57.4%	2.0%	9.9%	\$13,286
Misphillion Elementary	18	81.2%	56.0%	10.5%	9.1%	\$10,435
North Smyrna Elementary School	24	65.9%	47.8%	2.5%	30.1%	\$14,066
Ross (Lulu M.) Elementary School	18	76.0%	50.8%	12.3%	9.5%	\$10,968
Simpson (W.B.) Elementary School	10	87.0%	38.8%	1.6%	7.7%	\$10,436
Skyline Middle School	32	81.4%	29.0%	2.5%	12.2%	\$10,552
Stokes (Nellie Hughes) Elementary School	10	89.6%	49.6%	8.7%	16.0%	\$13,763
Sunnyside Elementary School	24	90.9%	25.3%	1.5%	8.5%	\$11,350
Towne Point Elementary School	13	66.9%	66.3%	5.1%	10.9%	\$14,517

HIGH EXPENDITURE - LOW ACHIEVEMENT SCHOOLS

Figure 2.6 describes the 10 schools that were categorized as high expenditure and low achievement. These schools both spent more than the model predicts and exhibited a lower proportion of students attaining reading proficiency than the model predicts.

Concord High School, Delmar Senior High School, and Maclary Elementary School each outperform the average of all schools for reading proficiency. However, their relatively low proportions of low income students cause the models to predict substantially higher levels of proficiency in reading than the schools actually attain.⁷

Figure 2.6: High Expenditure – Low Reading Achievement Schools

SCHOOL NAME	DISTRICT ID	READING PROFICIENCY	LOW INCOME	LEP	SPED	ADJUSTED SPENDING
Bancroft Elementary School	33	29.3%	79.0%	2.7%	14.7%	\$19,728
Brandywine High School	31	64.9%	29.9%	1.8%	12.2%	\$16,298
Christiana High School	33	50.2%	35.3%	4.4%	10.8%	\$17,668
Concord High School	31	75.2%	16.6%	1.2%	7.3%	\$14,438
Delmar Senior High School	37	72.9%	17.1%	0.3%	9.0%	\$16,015
Dover High School	13	65.2%	42.5%	1.9%	13.2%	\$23,470
Glasgow High School	33	47.8%	37.2%	4.1%	9.5%	\$16,048
Maclary (R. Elisabeth) Elementary School	33	72.9%	31.3%	11.0%	8.6%	\$14,983
Seaford Senior High School	23	52.6%	53.4%	6.0%	13.3%	\$27,783
Woodbridge High School	35	51.2%	45.3%	2.5%	15.4%	\$30,112

⁷ Based on the model, we would expect schools with smaller low income and special education populations to achieve higher levels of reading proficiency.

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