

**Determinants of Student Performance on State-Mandated Competency Exams:
Evidence from Indiana Middle Schools**

by

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I. Introduction

The use of mandated, competency exams has increased over the past two decades because of increased emphasis on educational assessment and a heightened sentiment to increase the accountability of schools and their teachers. Using data from individual middle schools, this paper analyzes the factors that affect the performance of Indiana eighth-grade students on the competency exam known as ISTEP (Indiana Statewide Testing for Educational Progress). The paper determines the various factors that affected the percentage of eighth-grade students that passed the standardized math exam that was given state-wide during October of 2006. The results of an empirical model that explains the change in the exam pass rates that occurred between 2003 and 2006 are also reported.

The percentage of the students passing the mandated exam can be viewed as one of the many outputs of a school's educational production function. The inputs used in this production function include school specific characteristics and the socio-economic characteristics of the school's student body. Holding everything else constant, the empirical model described in this paper shows that percentage of the students that pass the exam are directly related to the school's attendance ratio and the average teacher's salary. Private schools have higher pass rates than public schools, *ceteris paribus*. Regression results also indicate that the percentage of eighth-graders that pass the ISTEP math scores is inversely related to the teachers' average age, the percentage of minority students, the percentage of students receiving a free or reduced-cost lunch, and the percentage of the school's students enrolled in special education programs. There is no strong statistical evidence that smaller class sizes lead to a greater number of students

passing the mandated exam. Finally, there is evidence that the exam pass rates and the percentage of male students are inverse related, although the relationship is not statistically significant.

One key result of the empirical model is that a conditional convergence phenomenon occurs as schools with relatively low pass rates on the exam will see larger improvement and their pass rates will converge to those of the more successful schools. This is good news for those who believe in policies such as “No Child Left Behind” which requires adequate, annual improvement in the student’s test scores. However, persistent and wide gaps in the socio-economic characteristics of the schools will lead to persistent and wide achievement gaps in terms of pass rates on the exams. This will be troubling to those who believe that 100 percent of the school’s students must pass the competency exam.

The outline of this paper is as follows. A brief review of the literature follows this introduction. The third section of the paper describes the empirical model used to determine the factors that affect the performance of a school’s student body on the ISTEP exam. Also included in this section is a description of the data and its sources. The empirical results are presented and interpreted in the paper’s fourth section. The final section of the paper offers concluding comments.

II. Review of the Literature

As the use of mandated competency exams has increased over time, the literature analyzing the determinants of the pass rates on these exams has also grown. Greenwald, Hedges, and Laine (1996) find that student test scores are directly related to the inputs used in the educational process. Inputs affecting student performance on these exams include per-pupil

expenditure, teacher ability, teacher education, teacher experience, the ratio of students to teachers and school size.

Student scores also depend on socio-economic factors and demographic variables. Grissmer, Flanagan, Kawata and Williamson (2000, p. 15) find “that attempts to explain the variance in test scores across populations of diverse groups of students shows that family and demographic variables explain the largest part of total explained variance.” Statistically significant family characteristics affecting test scores include the level of parental education, family income and ethnicity. After controlling for the influence of other variables, family size, family mobility, age of the mother when the student was born and whether the family had only a single parent living at home were also found to affect the pass rates on exams.

Using data at the school district level, Bremmer and Carlson (2005, 2006) analyzed the factors that determine the percentage of eighth-grade middle students that pass the ISTEP math exam. Their research found that the percentage of current eighth-grade students passing the exam was determined by past academic performance, as measured by the percentage of the school district’s sixth-graders who passed both the math and English ISTEP exams two years earlier. Their regression results indicate that the test scores were directly related to teachers’ salaries, the school district’s expenditure per student, the students’ attendance rate, the hours of instruction, and the percentage of the school district’s high school graduates that pursue higher education. On the other hand, their empirical model indicates that the odds of passing the ISTEP eighth-grade math exam were inversely related to the teachers’ average age, the percentage of minority students, the percentage of adults in the area who never attended high school, the percentage of single parent families and the percentage of special education students.

III. Model Specifications, A Priori Signs and Data

Student performance on state-mandated, competency exams is a function of several inputs. Scores are affected by the students' academic aptitude, the socio-economic characteristics of the students' households, and the characteristics of the students' schools. This paper reports the results of two sets of regressions. In the first set of regressions, the dependent variable is the percentage of students of an Indiana middle school that pass the 8th grade ISTEP math exam. The second set of regressions explains how these pass rates changed between 2003 and 2006. The dependent and independent variables are defined in Table 1. Table 1 also identifies whether the dependent variable has a direct or inverse relationship with a given explanatory variable and whether the slope coefficient associated with the explanatory variable is expected to be positive or negative.

Model specifications

The first set of regressions identifies those factors that influence the percentage of 8th graders that passed the math ISTEP exam in October 2006 and its general form is

$$\begin{aligned} \text{PASS06}_i = & \beta_0 + \beta_1 \text{MINORITY}_i + \beta_2 \text{FREE}_i + \beta_3 \text{MALE}_i + \beta_4 \text{SPECIALED}_i \\ & + \beta_5 \text{PRIVATE}_i + \beta_6 \text{AGE}_i + \beta_7 \text{SALARY}_i + \beta_8 \text{RATIO}_i + \beta_9 \text{ATTEND}_i + \varepsilon_i . \end{aligned} \quad (1)$$

The second set of regressions analyze the change in pass rates on the exam between 2003 and 2006 and it almost takes the general form as Equation (1) or

$$\begin{aligned} \text{CHANGE}_i = & \alpha_0 + \alpha_1 \text{MINORITY}_i + \alpha_2 \text{FREE}_i + \alpha_3 \text{MALE}_i + \alpha_4 \text{SPECIALED}_i + \alpha_5 \text{PRIVATE}_i \\ & + \alpha_6 \text{AGE}_i + \alpha_7 \text{SALARY}_i + \alpha_8 \text{RATIO}_i + \alpha_9 \text{ATTEND}_i + \alpha_{10} \text{PASS03}_i + \mu_i . \end{aligned} \quad (2)$$

The subscript i on each of the dependent and independent variables refer to the i^{th} middle school in the sample.

The dependent variables and a priori signs

In Equation (1), $PASS06_i$ is the percentage of students enrolled in the eighth grade at the i^{th} middle school in Indiana that passed the ISTEP math exam that was administered in the fall of 2006. For example, if 70.91 percent of the eighth graders at a given middle school passed this exam, $PASS06$ would equal 70.91.

The dependent variable in Equation (2) is $CHANGE_i$ and it equals the actual change in the pass rates between 2003 and 2006. If 77 percent of the eighth graders passed the math ISTEP exam in the fall of 2003 and 84 percent of the school's eighth grade students passed the math ISTEP exam in the fall of 2006, then $CHANGE$ equals 7.

The independent or explanatory variables

Independent variables that explain student performance on the state-mandated exams include socio-economic variables that proxy the students' likelihood of academic success and that measure the students' learning environment both at school and at home. Additional variables measure key characteristics at each school that may affect student success on the exams. These variables are discussed below and the key points are again summarized in Table 1.

The percentage of the students that are minorities

The first independent variable listed in Table 1 is $MINORITY$ or the percentage of the school's eighth graders that were classified as minority students. Everything else held constant, there should be an inverse relationship between the percentage of students that passed the eighth-grade and the percentage of the school's students that are minorities. There are several plausible theories for this inverse relationship. Some have argued that standardized exams have a cultural bias against minority students and they score lower on the exams. Minority families bear the cost of past discrimination and past inequities in educational opportunities. Students from

families with less educational backgrounds get less help at home, they receive less reinforcement at school, and their scores on standardized exams are lower. The percentage of minority students also serves as a proxy for the school's average family income. Lower income families have fewer educational opportunities. They live in areas with a smaller tax base and, consequently, their schools are of lower quality, resulting in lower scores on standardized exams.

As noted in the third column of Table 1, schools with a higher percentage of minority students are expected to see a smaller improvement in test scores. Therefore, CHANGE and MINORITY should be inversely related and the regression coefficient associated with MINORITY is expected to be negative.

The percentage of students receiving a reduced-cost lunch

As Table 1 indicates, one of the explanatory variables included in the model is FREE which measures the percentage of eighth graders that receive either a free or reduced-cost lunch. Like MINORITY, FREE proxies per capita income and it should be inversely related to the percentage of students that pass the ISTEP math exam. A higher percentage of students receiving reduced-cost lunches may also capture students in poorer health with less nutrition and they will also score lower on the standardized exam. The greater the percentage of students receiving subsidized lunches, the smaller the improvement on the students' exam scores. Therefore, as noted in the second column of Table 1, FREE and CHANGE are also inversely related.

The percentage of male students

Some claim that standardized exams have a built-in gender bias. To determine whether such a bias exists, the model specification includes MALE, the percentage of eighth graders taking the ISTEP math exam at a given school that were male. The expected sign on the

regression coefficient is not certain. Given the old mantra that “Boys are better at math,” one may expect a direct relationship and a positive regression coefficient. However, given recent concerns about the rising percent of “bad boys” in middle school, an inverse relationship with a negative coefficient is also plausible.

The percentage of the students in special education

In Indiana, students enrolled in special education classes take the same state-mandated exam. Holding everything else constant, if a school has a larger percentage of eighth graders in special education, its pass rate on the mandated competency exam should be lower. As reported in Table 1, since SPECIAL ED is the percentage of the school’s students placed in special education programs, then SPECIAL ED and PASS06 should be inversely related as are SPECIAL ED and CHANGE.

Whether the students attend a public or private school

The regression model includes a binary, dummy variable named PRIVATE that indicates whether the middle school is a public school (PRIVATE = 0) or a private school (PRIVATE = 1). The arguments about the relative merits of private or public education are well known. Private schools would cost more to attend, attracting a higher-income clientele. Higher income families have more educational opportunities, they place higher demands for academic success, and private middle schools should have a higher pass rate on the ISTEP math exam. There is also the argument that private schools can avoid the higher cost, special education students that have less chance of passing the mandated math exams. One would also expect that the improvement in the pass rates of the standardized exam would be larger in the case of a private rather than a public school.

The average teacher's age, years of experience and salary

Three explanatory variables are included to capture the quality of a school's teachers: the average age of the school's teachers (AGE), the average years of experience that of each school's teachers (EXPERIENCE), and the average salary of a school's teachers (SALARY). Regarding teacher longevity and its impact on student scores on standardized exams, there are several arguments. Both the average age and average years of experience proxy the learning by doing that occurs while a teacher is in class. The first argument is that the percentage of students passing the ISTEP exam would be greater the more experienced the teachers. Thus, PASS06 should be directly related to either EXPERIENCE or AGE.

On the other hand, experienced teachers may be more committed to teaching content and improving students' ability to learn, and they may resist teaching toward the exam. Exam pass rates may fall, but they may not be indicative of the ability of students to perform in the classroom in the future or in the workplace once they graduate. Unfortunately, the average years of experience may also capture the increased possibility of "teacher burn out" and lower exam pass rates reflect sub par teacher performance. In these cases, PASS06 would be inversely related to either EXPERIENCE or AGE. Past research results by Bremmer and Carlson (2005, 2006) indicates that the regression coefficient associated with either of these variables is indeed negative.

Clearly EXPERIENCE and AGE are collinear and they should not be included in the same regression to avoid problems with multicollinearity. Since the pass rates on the standardized exam and teacher experience are expected to exhibit an inverse relationship, if a given school's faculty has more years of experience, a smaller increase in test scores is expected

over time. In the second set of regressions which have CHANGE as dependent variable, the regression coefficient which accompanies either EXPERIENCE or AGE should be negative.

Schools that attract and retain better teachers with higher salaries should have better performance in the classroom and students should score higher scores on the eighth-grade ISTEP math exam. Since higher average salaries attract superior teachers and the percentage of students passing the eighth-grade ISTEP math exam should increase, there should be a direct relationship between PASS06 and SALARY. Given that labor is the largest cost that most schools incur, the average salary of teachers serves as a proxy for expenditures per students. The more money that schools spend per student, the more likely that standardized test scores will increase. Likewise, schools paying larger average salaries should see a larger increase in their test scores and CHANGE and SALARY should also be directly related, holding everything else constant.

The ratio of students to teachers

Another one of the explanatory variables reported in Table 1 is the ratio of the school's enrollment to their faculty (RATIO). The fewer students per teacher, the higher the pass rates on the ISTEP math exam. Smaller classes allow more individual attention, more intensive directed instruction, a better learning environment and should result in more students passing the state-mandated exams. As a school's student-teacher ratio declines, a larger percentage of students should pass the mandated state exams and there should be a larger improvement on previous test scores. RATIO should be inversely related to both PASS06 and CHANGE.

The attendance ratio

The percentage of a middle school's eight graders passing the ISTEP math exam should also be a function of the school's attendance rate (ATTEND). Higher attendance rates imply

more frequent reinforcement of the material and higher scores on the standardized exams. This variable may also capture additional socio-economic characteristics. A higher attendance rate may reflect families that place relatively more emphasis on the educational experience and demand higher levels of student productivity, both in the classroom and on standardized exams. As reported in Table 1, ATTEND should be directly related to both PASS06 and CHANGE.

The percentage of students that passed the ISTEP math exam in 2003

In specifying the second set of regressions that explain the change in test scores between 2003 and 2006, the last explanatory variable to discuss is the percentage of the school's eighth-grade students that passed the exam in 2003. The change in test scores will be smaller the larger the percentage of students who passed in the past. If a relatively larger number of students passed the exam three years ago, there is less room for improvement as the pass rate has an upper bound of one hundred percent. This argument is similar to the conditional convergence in economic growth models. A key prediction of neoclassical growth models, conditional convergence stipulates that, everything else held constant, poorer countries will grow a faster rate of growth than rich countries and that the income levels of poorer countries will converge to the income levels of richer countries. In a similar fashion, schools with relatively low pass rates on the eighth-grade ISTEP math exam will see relatively larger changes in the percentage of students who pass the exam. As indicated in the last row and the last column of Table 1, there should be an inverse relationship between CHANGE and PASS03. The regression coefficient associated with PASS03 should be negative.

Data sources

Data on Indiana middle schools was obtained from Indiana's Department of Education website.¹ The ISTEP math exam was administered to eighth-grade students during October of 2006 in 460 public schools and in 165 private schools. After deleting missing variables, the set of regression models describing the ISTEP pass rate in 2006 had 495 observations, while the set of regressions explaining the change in ISTEP pass rates between 2003 and 2006 had 474 observations.

IV. Regression Results

The results from six different regressions are reported in Table 2. The columns labeled (1), (2), and (3) contain the estimation results for those regression models whose dependent variable was the percentage of eighth graders of a given middle school that passed the math ISTEP exam in the fall of 2006. For those regressions reported in the columns labeled as (4), (5) and (6), the dependent variable was the change in the pass rates on the ISTEP eighth-grade math exam between 2003 and 2006. The regression in column (1) includes AGE and excludes EXPERIENCE, the model in column (2) does just the opposite; it includes EXPERIENCE and excludes AGE. The model in column (3) includes both of these variables and suffers from the resulting multicollinearity. Regarding the inclusion or exclusion of the variables AGE and EXPERIENCE, the models in columns (4), (5), and (6) follow the same pattern as the other model. The regression models in columns (4), (5) and (6) include the explanatory variable PASS03 while the regressions models in columns (1), (2) and (3) do not. As indicated in Table 2, all six of the regressions reject the hypothesis of homoscedasticity using White's (1980)

¹ See the following three websites: <http://www.doe.state.in.us/istep/2006/welcome.html>, <http://mustang.doe.state.in.us/SEARCH/search.cfm>, and <http://mustang.doe.state.in.us/SAS/sas1.cfm>.

heteroscedasticity test and the standard errors reported in Table 2 have been corrected for heteroscedasticity using White's (1980) methodology.

The regression results are encouraging. The regression results in columns (1) thru (3) have an R^2 of almost 80 percent. While estimation of the change in pass rates will be more problematic, the regressions in columns (4) thru (6) have an R^2 of 36 percent. In all six regressions the F-test strongly rejects the hypothesis that all the slope coefficients in each model are simultaneously equal to zero, adding further credibility to the models performance and validity.

With the exception of two explanatory variables, MALE and RATIO, all the regression slope coefficients have the correct sign and are statistically significant. In all six regressions reported in Table 2, the regression coefficient associated with the explanatory variable RATIO has the anticipated negative sign, but none of them are statistically significant. In regressions describing the percentage of eighth-graders passing the ISTEP math exam, the regression coefficient associated with the percentage of male students is always negative, but never statistically different from zero. Hence, there is some weak statistical evidence that middle-school boys achieve lower scores on standardized math exams than female students. These results are also consistent with the positive coefficients on MALE in the regressions explaining CHANGE. Since schools with a higher percentage of males have lower scores on standardized math exams, there is more room for improvement. Again, the positive coefficients associated with MALE in columns (4), (5) and (6) are not statistically significant.

Testing for the presence of multicollinearity

The regression results in Table 2 show the problems of simultaneously including the GAE and EXPERIENCE variables in the same regression model. In models that only include

AGE in columns (1) and (4), the regression coefficients associated with AGE are both negative and statistically significant. In a similar fashion, the regression models in columns (2) and (5) include EXPERIENCE, exclude AGE, and the regression coefficients associated with EXPERIENCE are both negative and statistically significant. However, when the regression models include both variables one coefficient has an unanticipated sign and is insignificant in the case of column (3) and both coefficients are insignificant in the case of column (6).

The explanatory variables in Table 2 are closely related and some may suspect multicollinearity beyond the case of the AGE and EXPERIENCE variables. TABLE 3 reports the results of auxiliary regressions that were estimated to aid in the detection of multicollinearity. Auxiliary regressions regress one of the explanatory variables in the model on all the other remaining explanatory variables.

The auxiliary regressions in Table 3 were performed on the regression model reported in column (1) of Table 2. This regression had nine explanatory variables: MINORITY, FREE, MALE, SPECIAL ED, PRIVATE, AGE, SALARY, RATIO, and ATTEND. Table 3 reports the R^2 from nine separate regressions. For example, when MINORITY was regressed on a constant and the other remaining eight explanatory variables, the resulting R^2 was 52 percent. Klein's rule of thumb states that multicollinearity may be a problem if the R^2 obtained from one of the auxiliary regressions exceeds the R^2 of the initial model reported in column (1) of Table 2. The initial model has R^2 of 79 percent which is greater than the R^2 of any of the auxiliary regressions reported in Table 2, as the R^2 range from a low of 18 percent to a high of 66 percent. Since the vast majority of the initial model's regression coefficients have the expected sign, most of the coefficients are statistically significant and the auxiliary regressions show little evidence of

multicollinearity, the regression results reported in columns (1), (2), (4) and (5) appear to be free of this statistical problem.

The model's sensitivity to changes in the explanatory variables

Taking the estimation results for the regression reported in column (1) of Table 2, the model was first evaluated at the means of the independent variables. Then, one at a time, the model was evaluated to determine how the percentage of a middle school's eighth graders passing the ISTEP math exam would change given a shock to one of the explanatory variables. These "elasticities" are reported in Table 4. Note that if everything else is held constant, a private school will have a greater pass rate than a public school and the difference is almost 10 percentage points. If the percentage of students receiving a free lunch increases five percentage points, the pass rate on the standardized exam will fall by 1.45 percentage points. Increasing the average teacher salary by 10 percent will increase the percentage of students passing the standardized exam by 2.42 percentage points.

Table 4 contains some policy implications. Reducing the student-teacher ratio in each class by five students will only increase the exam's pass rate by 0.45 percentage points, a small improvement for a costly step that would involve more classrooms and more teachers. An increase in the attendance rate of 1 percentage point will increase the pass rate on the exam by 1.55 percentage points.

V. Concluding Comments

The regression results offer both the best of news and the worst of news. The good news is that there is evidence of conditional convergence of the scores on standardized exams. Schools that have relatively low pass rates on state-mandated competency exams do see improvement over time. School resources may affect pass rates as increased teacher salaries lead

to higher pass rates on the standardized exams. The direct relationship between the attendance rates and the percentage of students that pass the exams provides a clear message to schools and parents: find ways to keep the kids in school and keep them engaged with the curriculum.

But with the good news also comes some sobering facts. There is no statistically significant evidence that smaller classes lead to more students passing the standardized exams. Socio-economic factors do affect the percentage of students who pass the mandated exams. If the gap in income differences across families continues to persist, relatively lower pass rates will also continue to persist. Wide gaps in the various socio-economic characteristics of a school's student body will generate a larger achievement gap and it is doubtful that the disadvantage can achieve academic proficiency as measured by a standardized exam. If states continue to rely on evidence from standardized exams as proof of accountability and academic success, the perverse, inverse relationship between years of teacher experience and the percentage of students passing the exam needs to be addressed. Maximizing society welfare requires equating the marginal social benefit and the marginal social cost. Setting a benefit-based goal such as 100 percent of the students passing a mandated competency exam ignores the cost of achieving such a goal. If some pollution is optimal, if some level of shoplifting is optimal, some students should probably fail a state-mandated competency exam.

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TABLE 1

**A Priori Expected Signs of the Regression Coefficients:
Relationship between Explanatory Variable and Dependent Variable**

Independent Variables	Dependent Variables	
	PASS06 ISTEP pass rate in 2006 (%)	CHANGE Δ in pass rates between 2003 & 2006
MINORITY Minority students (%)	Inverse Relationship (-)	Inverse Relationship (-)
FREE Students with reduced-cost lunch (%)	Inverse Relationship (-)	Inverse Relationship (-)
MALE Male students (%)	Uncertain (+ or -)	Uncertain (+ or -)
SPECIAL ED Special education students (%)	Inverse Relationship (-)	Inverse Relationship (-)
PRIVATE 1 if private school, 0 if public school	Direct Relationship (+)	Direct Relationship (+)
AGE Average teacher age (years)	Inverse Relationship (-)	Inverse Relationship (-)
EXPERIENCE Average teacher experience (years)	Inverse Relationship (-)	Inverse Relationship (-)
SALARY Average teacher salary (in \$1,000)	Direct Relationship (+)	Direct Relationship (+)
RATIO Ratio of all students to all teachers	Inverse Relationship (-)	Inverse Relationship (-)
ATTEND Attendance Rate (%)	Direct Relationship (+)	Direct Relationship (+)
PASS03 ISTEP pass rate in 2003 (%)		Inverse Relationship (-)

TABLE 2

Regression Results: Determinants of the Percentage of Students Passing the 8th Grade ISTEP Math Exam and the Change in the Exam Pass Rates between 2003 and 2006

Independent Variables	Dependent Variables					
	PASS06			CHANGE		
	ISTEP pass rate in 2006 (%)			Δ in pass rates between 2003 & 2006		
	(1)	(2)	(3)	(4)	(5)	(6)
CONSTANT	-58.20 (-1.46)	-69.08 (-1.76)	-56.52 (-1.51)	-1.78 (-0.06)	-10.65 (-0.37)	-9.04 (-0.32)
MINORITY Minority students (%)	-0.23* (-8.44)	-0.24* (-7.67)	-0.23* (-7.27)	-0.15* (-6.19)	-0.16* (-5.95)	-0.16* (-5.68)
FREE Students with free lunch (%)	-0.29* (-8.80)	-0.30* (-9.05)	-0.29* (-8.74)	-0.12* (-3.60)	-0.13* (-3.61)	-0.12* (-3.57)
MALE Male students (%)	-0.08 (-1.15)	-0.08 (-1.11)	-0.08 (-1.15)	0.04 (0.59)	0.04 (0.60)	0.04 (0.60)
SPECIAL ED Special education students (%)	-0.53* (-10.32)	-0.54* (-10.39)	-0.53* (-10.16)	-0.42* (-7.78)	-0.42* (-7.98)	-0.42* (-7.94)
PRIVATE 1 if private school, 0 otherwise	10.53* (4.70)	9.63* (4.50)	10.54* (4.68)	4.85* (2.58)	4.71* (2.60)	4.82* (2.59)
AGE Average teacher age (years)	-0.37* (-2.61)		-0.42*** (-1.36)	-0.25** (-1.93)		-0.06 (-0.22)
EXPERIENCE Average teacher experience (years)		-0.31*** (-1.65)	0.06 (0.15)		-0.29** (-1.89)	-0.24 (-0.83)
SALARY Average salary (in \$1,000)	0.55* (5.75)	0.53* (4.69)	0.54* (4.80)	0.35* (3.64)	0.38* (3.61)	0.38* (3.58)
RATIO Ratio of all students to all teachers	-0.09 (-0.93)	-0.07 (-0.68)	-0.09 (-0.93)	-0.12 (-0.83)	-0.13 (-0.85)	-0.13 (-0.85)
ATTEND Attendance Rate (%)	1.55* (3.84)	1.55* (3.77)	1.54* (3.90)	0.49** (1.72)	0.50** (1.78)	0.50** (1.77)
PASS03 ISTEP pass rate in 2003 (%)				-0.52* (-10.68)	-0.52* (-10.57)	-0.52* (-10.80)
Number of Observations	495	495	495	474	474	474
White Heteroscedasticity Test	264.84†	293.17†	292.89†	230.14†	239.42†	245.70†
R ²	0.79	0.79	0.79	0.36	0.36	0.36
Adjusted R ²	0.79	0.79	0.79	0.34	0.35	0.34
F-statistic	205.64‡	203.79‡	184.73‡	25.77‡	25.98‡	23.58‡

t-statistics are in parentheses. *, **, and *** indicate the coefficient is statistically different from zero and has the correct a priori sign at the 1, 5, or 10 percent level, respectively, using a 1-tail t test. ‡ indicates the null hypothesis that all the slope coefficients are simultaneous equal to zero is rejected using an F test at the 1 percent level. † means the null hypothesis of homoscedasticity is rejected using a chi-squared test at the 1 percent level.

TABLE 3

No Evidence of Multicollinearity: R² from Auxiliary Regressions

<i>Initial Model Specification: Column (1) in Table 2</i>			
Dependent Variable		R²	
PASS06 ISTEP pass rate in 2006 (%)		0.79	
<i>R² from Auxiliary Regressions</i>			
Dependent Variable	R²	Dependent Variable	R²
MINORITY Minority students (%)	0.52	AGE Average teacher age (years)	0.35
FREE Students with free lunch (%)	0.66	SALARY Average salary (in \$1,000)	0.66
MALE Male students (%)	0.18	RATIO Ratio of all students to all teachers	0.20
SPECIAL ED Special education students (%)	0.38	ATTEND Attendance Rate (%)	0.22
PRIVATE 1 if private school, 0 otherwise	0.65		

TABLE 4

**Comparative Statics: The Response of the 8th Grade Pass Rate on the ISTEP Math Exam
Given a Change in an Independent Variable (Holding Everything Else Constant)**

Change in Independent Variable		Change in Dependent Variable = PASS06 ISTEP pass rate in 2006 (%)
MINORITY Minority students (%)	↑ percentage of minority students by 5 percentage points (from 18.90% to 23.90%)	↓ by 1.17 percentage points (from 70.91% to 69.74%)
FREE Students with free lunch (%)	↑ percentage of students with free lunches by 5 percentage points (from 35.35% to 40.35%)	↓ by 1.45 percentage points (from 70.91% to 69.46%)
MALE Male students (%)	↑ percentage of male students by 5 percentage points (from 52.06% to 57.06%)	↓ by 0.42 percentage points (from 70.91% to 70.49%)
SPECIAL ED Special education students (%)	↑ percentage of special ed students by 5 percentage points (from 14.94% to 19.94%)	↓ by 2.65 percentage points (from 70.91% to 68.25%)
PRIVATE 1 if private school, 0 otherwise	Assume school is private rather than public (holding everything else constant)	↑ by 10.53 percentage points
AGE Average teacher age (years)	↑ average age of teachers by 10% (from 42.76 years to 47.04 years)	↓ by 1.60 percentage points (from 70.91% to 69.31%)
SALARY Average salary (in \$1,000)	↑ average salary of teachers by 10% (from \$44,448 to \$48,892)	↑ by 2.42 percentage points (from 70.91% to 73.33%)
RATIO Ratio of all students to all teacher	↑ student-teacher ratio by 5 students (from 17.12 students to 22.12 students)	↓ by -0.45 percentage points (from 70.91% to 70.46%)
ATTEND Attendance Rate (%)	↑ attendance rate by 1 percentage point (from 96.03% to 97.03%)	↑ by 1.55 percentage points (from 70.91% to 72.45%)

In calculating the response of the dependent variable, PASS06, to a shock in one of the independent variables, the model is evaluated at the means of the independent variables.