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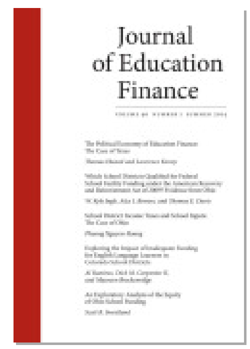
Journal of Education Finance, Volume 40, Number 1, Summer 2014, pp. 60-79 (Article)

Published by University of Illinois Press



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ABSTRACT

This study investigates the relationship between the academic achievement of all students and inadequate funding for English language learners in Colorado school districts. Several stochastic frontier analysis models were used in lieu of traditional production functions in order to achieve clearer estimates. The analyses detected only a few effects. Results suggest limited funding eventually has a small impact over time (i.e., districts with greater shortfalls will see declining achievement over time). These results may add insight to "the achievement gap"—in the face of inadequate resources for ELL students, school districts may be shortchanging other various targeted populations by using federal dollars to supplant state obligations and state dollars.

INTRODUCTION

This research investigates the funding and impact of populations of English language learners (ELLs) on student achievement and technical efficiency in Colorado school districts. Generally, technical efficiency is defined as the effectiveness with which a given set of inputs is used to produce an output, given certain "technologies" (Coelli, Prasada Rao, O'Donnell, and Battese 2005). In this study, inputs are generally funding variables, outputs are levels of student proficiency, and technologies include things like student-to-teacher ratios or years of personnel experience.

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The key question of the study asks: Are students in school districts with higher populations of ELL students adversely affected by the inadequate support for ELL programs? Based on prior research (Augenblik, Palaich and Associates 2011; Ramirez, Siegrist, Krumholz, and Rainey 2013), it is stipulated for the purposes of this study that funding for ELL students in Colorado is inadequate. Therefore, it was projected that as the percentage of ELL students increased, a school district would be more challenged to finance mandated ELL programs and be forced to take money away from other programs, such as those in the general fund, thereby affecting overall student achievement and efficiencies for affected school districts. The impetus for the study comes from adequacy studies conducted in Colorado and litigation regarding financial resources for school districts in the state. Using stochastic frontier analysis (SFA), the study set out to explore the effect of inadequate funding for ELL students on the overall student academic achievement in school districts in Colorado and the technical efficiency of these school districts.

THEORETICAL AND ANALYTICAL FRAMEWORK

The theoretical and analytical framework for this study is built around four areas: econometric modeling, education finance, school law, and academic achievement. Hanushek (1986) was an early pioneer who promoted economic analysis as a means to estimate education output. Monk (1989) offered strategies for applying production function models to policy development and analysis. Levin (1997) also advocated analytical techniques that used economic models to gauge education productivity and concepts of efficiency in the school environment.

This study used stochastic frontier analysis as its analytical method (Coelli et al. 2005; Kumbhakar and Knox-Lovell 2000), which builds on the education production functions literature (Grosskopf, Hayes, Taylor, and Weber 1997; Hall 2007). Historically, production function research has relied on multiple regression to examine the effects of various contextual and input variables on achievement (Alexander, Boyer, Brownson, Clark, Jennings, and Patrick 2000; Condron and Roscigno 2003; Crampton 1991; Hanushek 1986; Hummel-Rossi and Ashdown 2002; Monk 1981; Wenglinsky 1998). Recently, researchers have begun to apply more sophisticated econometric tools, such as SFA (Adkins and Moomaw 2005; Palardy and Nesbit 2007), to schools in an attempt to overcome the significant shortcomings of regression, most notably serious bias in estimated parameters (Adkins and Moomaw 2005). Conceptually, SFA estimates a maximum possible output (i.e., proficiency level) given a vector of inputs (i.e., different types of funding, or underfunding in the case of this study), similar to traditional production functions using regression or regression techniques, such as hierarchical linear modeling (HLM). In SFA, deviations from the maximum are then ascribed to inefficiencies. The latter is where SFA differs from and builds upon production functions. SFA facilitates an understanding of what variables, such as pupil-to-teacher ratios or mean years of personnel experience, contribute to a school district's deviation from the maximum. Although our description implies a two-stage process—which former efficiency modeling used—SFA uses simultaneous equations for the production and efficiency estimations, making for a significant improvement over former techniques (Adkins and Moomaw 2005).

As Kumbhakar and Knox-Lovell (2000) state:

> We call it *Stochastic Frontier Analysis* because we are concerned with estimation of frontiers, which envelop data, rather than functions, which intercept data. We associate proximity to estimated frontiers with the degree of efficiency with which producers pursue their objectives. Their objectives can be purely technical or economic in nature, and so we are concerned with the estimation of production frontiers and also with the estimation of cost and profit frontiers. Finally, the frontiers we estimate are stochastic, because we continue to maintain the traditional economic belief in the presence of external forces contributing to random statistical noise. (preface, x)

The theoretical perspective in these types of analytics parallels those found in microeconomics, for example, in which the efficient use of capital, labor, and other investments are calculated with input-output models. This approach is applied herein to examine the academic output and efficient use of resources given ELL funding shortfalls and the size of the ELL population served in school districts. These variables are manipulated in the models used for this study to explore the degree of influence they may have on student academic proficiency and the financial adeptness of school districts in Colorado.

Jimenez-Castellanos and Topper (2012) completed an extensive review of studies concerned with funding adequacy for ELL students. Seventy articles were included from more than two decades of literature. Their work organized the reviewed material into five general categories: multiple methods, professional judgment approach, successful school model, evidence-based model, and cost function analysis (CFA). Nineteen studies or 27% used cost function analysis, although it was not clear from the article whether any of these CFA studies used SFA. This investigation uses SFA in order to build upon the results of an earlier Colorado adequacy study (Ramirez et al. 2013) that used the professional judgment approach and a successful school model to make projections of weighted enrollments for ELL students.

The legal theory for the study rests on federal court rulings, statutes, and policies that mandate service for ELLs. Contemporary policies in the United

States require all states and school districts to function within a framework of academic standards, student assessments, and public accountability. This framework mandates that all students, including new learners of English, reach established academic standards of performance. Today, it is not enough that school districts serve these students; they are held accountable for their academic success. This pressure to meet academic benchmarks with ELL students requires school districts to allocate additional resources for their education.

Lau v. Nichols, an example of a landmark federal case, ruled in 1973 that limited English speaking students have a right to a differentiated education in order to gain sufficient English language proficiency to succeed in school. *Lau* ushered in an era of scholarship, training, program development, and professional practice that to this day strive to meet the needs of the ELL population. Another watershed case, *Keyes v. School District No. 1, Denver, Colorado, et al.*, is important to this study as well. *Keyes*, as a Colorado-focused case, underscores the complications of providing proper services to ELL students. Part of the legacy of *Keyes* in Colorado is a jaundiced view on the part of some in the academic and advocacy communities toward state and school district services for ELL students in Colorado. Services for ELL students remain controversial in the policy arena to this day. This study probes the effectiveness of current state policy.

A statutory example is the national government's adoption of the Equal Educational Opportunity Act of 1974, which states in part that a denial of equal educational opportunity exists when there is "failure by an educational agency to take *appropriate* action to overcome language barriers that impede equal participation by its students in its instructional programs" (emphasis added). This clause has been the nexus of much litigation regarding educational programing and funding. It continues to be an important issue today.

In Colorado, the English language acquisition needs of its ELL students are funded in part through a state categorical aid program known as the English Language Proficiency Act (ELPA). In fiscal year 2009, $8.6 million was distributed to school districts through the ELPA categorical aid program. The state estimates that the aid program covers only 20–25% of the actual expenditures for ELL students (Colorado Department of Education 2012). The calculations of the additional 75–80% that school districts spend for ELL services are derived from annual budget reports from school districts to the state.

An earlier study of funding issues concerning ELL students in Colorado (Ramirez et al. 2013) used weighted enrollment estimates to proffer that funding for ELL in Colorado was inadequate. The study showed that as the percentage of ELL students increased in a school district, the total amount of per-pupil funding for all students in the school district diminished. Furthermore, the study pointed to an accumulating effect that deteriorated over time because of the state's limitation on funding ELL students through the ELPA program for only two years.

Finally, as mentioned previously, the theoretical framework for this study also rests on the state's commitment to achieving academic proficiency for all students, regardless of their initial circumstance upon entering school. Colorado, like states across the country, has an extensive system of academic standards and assessments aimed at driving student achievement throughout the state. This model encompasses all students in the state and thus includes ELL students.

Education production function is used in this study at the nexus of these theories, through the application of SFA, to test the viability of the state's legal, educational, and financial commitments to students in Colorado public schools. The driving postulation in this study submits that inadequate funding for ELL students adversely affects the fiscal equity in the state's school funding mechanisms, which in turn adversely effects academic output overall. In other words, school districts in Colorado with higher concentrations of ELL students are unfairly burdened with mounting additional programs for which they are inadequately resourced. If this supposition is correct, the effect should be detected in those school districts with higher concentration of ELL students.

METHODS

Research Questions

The key question of the study asks: Is there a significant relationship between state underfunding of ELL student education and achievement among all students? Secondarily, the study considers two other questions: Is there a significant relationship between the percentage of ELL students in a district and school district technical efficiency; and is there a significant relationship between the percentage of ELL students in a district and academic achievement among all students?

Sample, Data, and Variables

These questions are examined by studying school districts in Colorado over an eight-year period—2003 to 2010. Colorado educates more than 800,000 students across 178 school districts. On average, the ELL population in the state is more than 8%, ranging from 0% in some districts to almost 55% in others. During the study period, the ELL population grew in Colorado, from 6.9% in 2003 to 8.9% in 2010.

As described in greater detail later, the study uses stochastic frontier analysis to explore academic and efficiency effects associated with ELL populations and underfunding after controlling for a multitude of variables. To facilitate this analysis, we gathered district-level finance and demographic data from the Colorado Department of Education for all school districts. Table 1 includes the variables used in the analysis.

Most variables in Table 1 are self-evident, but one—ELL shortfall—requires some explanation, particularly because it is one of the primary variables of

Table 1. Variables Used in the Models

Variables	Measurement
Inputs	
Instruction: salary/benefits	Dollars per student
Instruction: services	Dollars per student
Instruction: supplies and materials	Dollars per student
Instruction: other	Dollars per student
Support: pupils	Dollars per student
Support: instruction staff	Dollars per student
Support: general administration	Dollars per student
Support: school administration	Dollars per student
Support: operations and maintenance	Dollars per student
Support: transportation	Dollars per student
Support: food services	Dollars per student
Support: other	Dollars per student
Community services	Dollars per student
ELL funding shortfall	Dollars per student
Time period	Continuous (0, 1, 2…, n)
Efficiency	
Family socioeconomic status	Percentage free and reduced lunch (FRL)
Student race/ethnicity	Percentage minority
Total district enrollment	Continuous (0, 1, 2…, n)
Gifted and talented	Percentage gifted and talented
Special populations	Percentage in special education (SPED)
Homeless	Percentage homeless
ELL	Percentage English language learners
Migrant	Percentage migrant
Immigrant	Percentage immigrant
Title I	Percentage Title I
Disciplinary rate	Percentage of students suspended
Level of superintendent education	Percentage of superintendents with MA or more
Average years superintendent experience	Continuous (0, 1, 2…, n)
Level of principal education	Percentage of principals with MA or more
Average years principal experience	Continuous (0, 1, 2…, n)
Level of teacher education	Percentage of teachers with MA or more
Average years teacher experience	Continuous (0, 1, 2…, n)
Student-to-teacher ratio	Continuous (0, 1, 2…, n)
Time period	Continuous (0, 1, 2…, n)

interest. As described in Ramirez et al. (2013), Colorado provides categorical funding to school districts based on the number of ELL students they educate each year. By the state's own acknowledgement, however, that funding fails to cover the total costs associated with educating ELL students, requiring districts to make up the difference through other sources, such as the general fund. The state estimates they provide only up to approximately 25% of ELL costs in the form of annual funding allocations to the districts. To capture this shortfall for each district and estimate its effects on overall student achievement, we first multiplied the ELL funding allocation each district receives from the state times four to calculate total ELL expenditures required by each district. We then calculated the difference between total cost and allocation amount, producing a negative dollar amount. Finally, this total was divided by number of students to create a per-student shortfall. Note that this variable is measuring a funding *shortfall*, not the dollars per student districts receive for ELL programs, similar to other funding variables included in this analysis. Therefore, we are not measuring the relationship between ELL spending and achievement, but rather the relationship between a funding deficit (i.e., ELL shortfall) and achievement.

As is often the case in studies like this, data available from the state were not complete. Missing data were a function of prohibitively small cell sizes for public reporting. That is, for some variables, the number of individuals associated with a given metric was so small as to potentially compromise privacy. This "missingness" took two forms. The first was random cells throughout the data file. The second was small districts with no data whatsoever. Because the software used for this analysis (Frontier 4.1; Coelli 1996) does not allow for missing data, districts with no data at all were deleted from the file. This left 155 districts (87% of the state's districts), as the final sample size. To retain districts with sporadic missing data, missing values were imputed using the expectation maximization (EM) method (Baraldi and Enders 2010).

Analysis

As Kumbhakar and Knox-Lovell (2000) explain, SFA measures the distance between some stochastic frontier and actual production (i.e., academic achievement) and is assumed to be a function of a set of variables. SFA also measures how efficiently firms use resources (i.e., technical efficiency). When applied to education, this means an inefficiency term containing school related variables, such as percentage of ELL students in a school district, is added to the typical education production function containing inputs (i.e., expenditures) and outputs (i.e., state assessment results). Specifically, the efficiency term is included in the traditional error term of a regression equation. A stochastic production frontier model is generally represented by

$$y_i = f(x_i, \beta) + v_i - u_i$$

where y_i is the output for school district i, x_i is the vector of inputs for school district i, β is a vector of parameters, v_i is an independent and identically distributed random variable typically assumed to be normally distributed, $f(*)$ is the transformation of inputs into the outputs, and u_i is a measure of technical efficiency. For the latter, let

$$u_i = g(z_i, \gamma) + e_i$$

where z_i is a vector of exogenous variables affecting efficiency, γ is a vector of parameters, g is a linear function, and e_i is an independent and identically distributed random variable typically assumed to a truncated normal distribution. In this model, the parameter vector can be estimated via maximum likelihood.

The output indicator is student achievement, as measured by the percentage of students achieving at proficient or advanced on Colorado's state assessment (CSAP). As required by state statute, third- through tenth-grade students in the state are tested annually on a standardized assessment that measures student knowledge of reading and math. Based on scale scores, each student's performance is classified as unsatisfactory, partially proficient, proficient, or advanced. These ratings are aggregated for each school and district and reported annually to the public. For this study, reading and math were outcome variables.

In the production function part of the model, inputs are represented by expenditures from district general fund appropriations and the aforementioned ELL shortfall, and efficiency variables are represented by school demographic indicators. The general model takes the form:

$$\text{Outcome variable} = \beta_0 + \beta_1(\text{InstrSalBene}) + \beta_2(\text{InstrSvcs}) + \beta_3(\text{InstrSuppMat}) + \beta_4(\text{InstrOther}) + \beta_5(\text{SupPupils}) + \beta_6(\text{InstrStaff}) + \beta_7(\text{SupAdmin}) + \beta_8(\text{SchAdmin}) + \beta_9(\text{SupO\&M}) + \beta_{10}(\text{SupPupilTrans}) + \beta_{11}(\text{SupFoodSvc}) + \beta_{12}(\text{SupOtherSup}) + \beta_{13}(\text{CommSvc}) + \beta_{14}(\text{ELLshortfall}) + \beta_{15}(\text{Year}) + v_i - u_i$$

where

$$u_i = \delta_0 + \delta_1(\text{SES}) + \delta_2(\text{Ethnicity}) + \delta_3(\text{TotalEnroll}) + \delta_4(\text{GiftedTalented}) + \delta_5(\text{SPED}) + \delta_6(\text{Homeless}) + \delta_7(\text{ELL}) + \delta_8(\text{Migrant}) + \delta_9(\text{Immigrant}) + \delta_{10}(\text{Title I}) + \delta_{11}(\text{Discipline}) + \delta_{12}(\text{SuperEdu}) + \delta_{13}(\text{SuperExp}) + \delta_{14}(\text{PrincipalEdu}) + \delta_{15}(\text{PrincipalExp}) + \delta_{16}(\text{TeacherEdu}) + \delta_{17}(\text{TeacherExp}) + \delta_{18}(\text{StuTchRatio}) + \delta_{19}(\text{Year})$$

Consistent with previous studies (Carpenter 2012; Carpenter and Medina 2011; Carpenter and Noller 2010; Palardy and Nesbit 2007), this analysis tested multiple models. The first was the model presented previously. In the second, the ELL percentage was moved from the efficiency part of the model into the production part. This treats the variable as an input and facilitates an examination of the relationship between ELL percentage and student achievement. The third model moves ELL percentage back to the efficiency part of the model and adds an interaction term between ELL shortfall and year. The interaction enables us to examine the effect of shortfall over time. The final model retains the interaction term and moves ELL percentage back into the production part of the model. Finally, prior to running the variables through Frontier 4.1, collinearity tests were conducted, resulting in the deletion of one variable, "teacher FTE."

RESULTS

Table 2 includes descriptive statistics for all of the variables in the model, except for year. The first 13 variables indicate the mean amount school districts spent for each category throughout the eight years studied here. ELL shortfall shows that districts, on average, operate with a state funding deficit of approximately -$246 per student. Turning to demographic variables, the percentage of ELL students tends to be somewhat larger than other categories of students, such as percentage of immigrants, homeless, or Title 1, but it is noticeably smaller than the average percentage of students who qualify for free and reduced lunch and minority students. Finally, over the 2003 to 2010 period, approximately 60% of Colorado students read at or above proficiency, and 45% performed at the same level in math.

Turning to SFA results, Table 3 includes results for Model 1 in both reading and math. In this model, ELL shortfall appears to not be a significant predictor of student achievement. In fact, between math and reading, only two variables consistently appear significantly related to achievement—instructional spending on salaries and benefits and support spending for general administration. But the effects are small, as indicated by zeros in the coefficients out to the third place. Of the efficiency variables, percentage of ELL students has a significant effect on technical efficiency but only in reading. Note that this analysis is measuring the effects of the respective variables on inefficiency, which means positive coefficients show an increase in inefficiency, or a decrease in efficiency. Therefore, the positive coefficient in reading for ELL percentage indicates that as the percentage of ELL students increases, school districts operate less efficiently. Of the other variables, three consistently result in decreased efficiency: percentage of free and reduced lunch, percentage minority, and disciplinary rate. Only two variables appear to increase efficiency: the percentage of principals with a master's degree and the percentage of gifted and talented students in a district.

Table 2. Descriptive Statistics for Variables in Models, 2003–2010

	Minimum	Maximum	Mean	SD
Instruction: salary/benefits	480.00	8,665.00	4,326.56	927.52
Instruction: services	-251.00	4,524.00	421.21	327.05
Instruction: supplies and materials	83.00	3,910.00	413.99	256.15
Instruction: other	-124.00	1,202.00	169.45	204.60
Support: pupils	0.00	8,260.00	319.31	268.54
Support: instructional staff	10.00	1,878.00	347.20	221.71
Support: general administration	31.00	1,762.00	373.17	276.90
Support: school administration	105.00	1,632.00	576.86	183.36
Support: operations and maintenance	71.00	14,486.00	1,071.96	641.18
Support: transportation	22.00	1,536.00	427.44	208.57
Support: food services	0.00	1,167.00	364.14	134.36
Support: other	11.00	1,800.00	487.52	286.45
Community services	-1.00	903.00	33.16	86.24
Other expenditures	-243.00	43,391.00	2,591.22	4,015.03
ELL shortfall/student	-137,336.31	0.00	-246.05	3,909.11
Percentage FRL	0.00	0.90	0.35	0.21
Percentage minority	0.02	0.96	0.30	0.22
PK–12 pupil membership	101.00	87,925.00	5,052.04	12,082.85
Percentage gifted and talented	0.00	1.00	0.04	0.06
Percentage SPED	0.00	0.75	0.10	0.04
Percentage homeless	0.00	0.88	0.01	0.06
Percentage ELL	0.00	0.55	0.08	0.10
Percentage migrant	0.00	0.35	0.01	0.03
Percentage immigrant	0.00	0.14	0.01	0.02
Percentage Title 1	0.00	0.39	0.01	0.02
Disciplinary rate	0.00	0.96	0.12	0.11
Percentage of superintendents with MA or more	0.00	1.00	0.85	0.32
Percentage of principals with MA or more	0.00	1.00	0.90	0.21
Percentage of teachers with MA or more	0.01	1.00	0.40	0.13
Mean experience of principals	0.00	35.00	13.29	5.63
Mean experience of superintendents	0.00	50.00	12.09	9.30
Mean experience of teachers	0.93	26.00	11.51	2.39
Student-to-teacher ratio	5.02	329.00	14.70	10.17
PPA math	0.00	0.80	0.45	0.15
PPA reading	0.00	0.91	0.61	0.16

Table 3. SFA Results for Model 1

	Reading Coefficient	Math Coefficient
Production Variables		
Beta constant	0.833*	0.787*
Instruction: salary/benefits	0.000*	0.000*
Instruction: services	-0.000*	-0.000
Instruction: supplies and materials	-0.000	-0.000*
Instruction: other	0.000*	0.000
Support: pupils	0.000	0.000
Support: instructional staff	-0.000	-0.000
Support: general administration	-0.000*	-0.000*
Support: school administration	-0.000	-0.000*
Support: operations/maintenance	0.000	-0.000
Support: transportation	-0.000	-0.000*
Support: food	-0.000*	-0.000
Support: other	0.000	-0.000*
Community services	-0.000	-0.000
Other	0.000	0.000*
ELL shortfall	0.000	-0.000
Year	-0.000	0.006
Efficiency Variables		
Delta constant	0.261*	0.365*
Percentage ELL	0.310*	0.150
Percentage FRL	0.237*	0.107*
Percentage minority	0.222*	0.192*
District size	0.000	0.000*
Percentage gifted/talented	-0.412*	-0.257*
Percentage SPED	0.146	0.336*
Percentage homeless	-0.001	-0.029
Percentage migrant	-0.322	-0.180
Percentage immigrant	-0.070	-0.160
Percentage Title 1	0.447	0.246
Disciplinary rate	0.189*	0.118*
Percentage of superintendents with MA or more	-0.123*	0.015
Percentage of principals with MA or more	-0.112*	-0.056*
Percentage of teachers with MA or more	-0.072	-0.027
Mean experience of principals	0.001	0.001
Mean experience of superintendents	0.003*	0.001
Mean experience of teachers	-0.003	-0.006*
Student-to-teacher ratio	-0.005	0.000
Year	-0.014*	-0.027
σ^2	0.031*	0.013*
γ	0.940*	0.917*
Log likelihood	867.0	1001.34

*p<.05

Table 4 includes results for Model 2, which moves the ELL percentage variable into the production part of the model. As in Model 1, ELL shortfall is not significantly related to overall student achievement. However, ELL percentage is, and the relationship is negative, indicating that a greater percentage of ELL students is related to a smaller percentage of students performing at proficient or advanced in reading and math. Of the other input variables, instruction salary/benefits is positively related to student achievement whereas support general administration is negatively related. Added to these in Model 2 are other instructional spending (positive), other spending (positive), and expenditures on food (negative). In the efficiency part of the model, five variables appear to result in greater efficiency: percentage migrant, immigrant, gifted and talented, principals with an MA, and year. Percentage free and reduced lunch, disciplinary rate, mean experience of superintendents, and mean experience of teachers appear to decrease efficiency.

Table 5 presents results for Model 3, which includes an interaction between year and ELL shortfall in the production part of the model and ELL percentage in the efficiency part. In this model, ELL shortfall is not significant in math but is so in reading. However, these results need to be interpreted in light of the interaction between shortfall and year, which is significant in both reading and math. Beginning with reading, we examine the effect of ELL shortfall at different years. At year 1, the effect of ELL shortfall is .0000; at year 4, the effect is .00005; and at year 8, the effect of ELL shortfall is .0001. Note that shortfall is measured in negative values, so interpreting the shortfall coefficient in traditional regression terms (i.e., an increase in the shortfall term) means moving toward zero, or reducing the shortfall between total ELL spending and the state's allocation. As seen in the table, the coefficient on ELL shortfall is negative, but that is only so when year is one. So practically speaking, narrowing the shortfall increases percentage proficient or advanced (PPA) in reading. Moreover, the interaction indicates that at increasing levels of year, the effects of ELL shortfall are greater. Of course, the interaction can be examined a second way—the effect of year at different levels of ELL shortfall. In other words, how does reading PPA change over time for school districts at different levels of ELL shortfall? For districts with the greatest shortfalls in the data, the year effect is -1.78; for those with a "medium" amount of shortfall, the year effect is -.889; and for districts with no shortfall, the effect is .001. Thus, for districts with no shortfall, reading PPA increases over time, and in districts with "medium" and larger shortfalls, reading PPA decreases over time.

Turning to math, we begin with the effect of ELL shortfall at different years. Similar to reading, at year 1, the effect of ELL shortfall is -.0000; at year 4, the

Table 4. SFA Results for Model 2

	Reading Coefficient	**Math Coefficient**
Production Variables		
Beta constant	0.780*	0.555*
Instruction: salary/benefits	0.000*	0.000*
Instruction: services	-0.000	-0.000*
Instruction: supplies and materials	0.000	-0.000
Instruction: other	0.000*	0.000*
Support: pupils	-0.000	-0.000
Support: instructional staff	-0.000	-0.000
Support: general administration	-0.000*	-0.000*
Support: school administration	-0.000	-0.000*
Support: operations/maintenance	0.000	0.000
Support: transportation	0.000	-0.000
Support: food	-0.000*	-0.000*
Support: other	0.000	-0.000
Community services	0.000	0.000
Other	0.000*	0.000*
ELL shortfall	0.000	0.000
Year	-0.002	0.015*
Percentage ELL	-0.724*	-0.619*
Efficiency Variables		
Delta constant	-0.024	0.280*
Percentage FRL	0.992*	0.252*
Percentage minority	-0.118	0.073
District size	0.000*	0.000
Percentage gifted/talented	-1.761*	-0.761*
Percentage SPED	-0.179	0.390*
Percentage homeless	-0.659*	-0.141
Percentage migrant	-3.555*	-1.422*
Percentage immigrant	-13.874*	-3.837*
Percentage Title 1	1.711*	0.359
Disciplinary rate	0.593*	0.221*
Percentage of superintendents with MA or more	-0.361*	0.042
Percentage of principals with MA or more	-0.324*	-0.138*
Percentage of teachers with MA or more	-0.293*	-0.012
Mean experience of principals	0.006*	0.001
Mean experience of superintendents	0.009*	0.003*
Mean experience of teachers	0.010*	-0.008*
Student-to-teacher ratio	-0.007*	-0.004
Year	-0.055*	-0.041*
σ^2	0.110*	0.029*
γ	0.978*	0.852*
Log likelihood	968.7	998.9

*p<.05

Table 5. SFA Results for Model 3

	Reading Coefficient	**Math Coefficient**
Production Variables		
Beta constant	0.834*	0.774*
Instruction: salary/benefits	0.000*	0.000*
Instruction: services	-0.000*	-0.000
Instruction: supplies and materials	-0.000	-0.000*
Instruction: other	0.000*	0.000*
Support: pupils	0.000	0.000
Support: instructional staff	-0.000	-0.000
Support: general administration	-0.000*	-0.000*
Support: school administration	-0.000	-0.000*
Support: operations/maintenance	0.000	-0.000
Support: transportation	-0.000	-0.000*
Support: food	-0.000*	-0.000
Support: other	0.000	-0.000*
Community services	-0.000	-0.000
Other	0.000	0.000*
ELL shortfall	-0.000*	-0.000
Year	0.001	0.014*
ELL shortfall × year	0.000*	0.000*
Efficiency Variables		
Delta constant	0.267*	0.347*
Percentage ELL	0.305*	0.146*
Percentage FRL	0.244*	0.109*
Percentage minority	0.231*	0.200*
District size	0.000	0.000*
Percentage gifted/talented	-0.409*	-0.260*
Percentage SPED	0.168	0.358*
Percentage homeless	0.012	-0.026
Percentage migrant	-0.334	-0.213
Percentage immigrant	-0.169	-0.208
Percentage Title 1	0.374	0.200
Disciplinary rate	0.184*	0.105*
Percentageof superintendents with MA or more	-0.121*	0.015
Percentage of principals with MA or more	-0.119*	-0.057*
Percentage of teachers with MA or more	-0.074	-0.024
Mean experience of principals	0.002	0.001
Mean experience of superintendents	0.003*	0.001*
Mean experience of teachers	-0.003	-0.006*
Student-to-teacher ratio	-0.005	0.000
Year	-0.015*	-0.018*
σ^2	0.031*	0.012*
γ	0.947*	0.998*
Log likelihood	876.8	1004.5

*p < .05

effect is .00001; and at year 8, the effect of ELL shortfall is .00003. Thus, the effects parallel those in reading. When examining the effect of year at different levels of ELL shortfall, for districts with the greatest shortfalls in the data, the year effect is -.5875; for those with a "medium" amount of shortfall, the year effect is -.2867; and for districts with no shortfall, the effect is .014. So, as in reading, for districts with no shortfall, math PPA increases over time, and in districts with "medium" and larger shortfalls, math PPA decreases over time.

As in earlier models, spending on instructional salaries and benefits is positively related to achievement, and support spending on general administration is negatively related and consistently so in reading and math. Added to this model is the consistent positive influence of other instructional spending on reading and math. Turning to the efficiency variables, ELL percentage appears to decrease efficiency in both reading and math. The other variables that consistently decrease efficiency are the percentage of students qualifying for free and reduced lunch, the percentage of minority students, mean experience of superintendents, and disciplinary rate. Conversely, three variables consistently increase efficiency: the percentage of gifted and talented students, year, and the percentage of principals with an MA.

Model 4 results are presented in Table 6. In this model, the interaction term is retained and ELL percentage is moved into the production part of the model. As in Models 1 and 2, ELL shortfall is not significant, and only in math is ELL percentage a significant predictor of student achievement. This result shows a negative relationship between greater percentages of ELL students and those performing at proficient or advanced in math. Unlike Model 3, the interaction between ELL shortfall and year is not significant. Of the efficiency variables, only variables for math proved significant. Those results indicate that greater percentages of students qualifying for free and reduced lunch and special education services, greater disciplinary rates, district size, and greater mean experience for superintendents result in decreased efficiency. Conversely, greater percentages of gifted and talented, immigrant, and migrant students; a greater percentage of principals with an MA; greater experience among teachers; year; and a greater student-to-teacher ratio result in greater efficiency.

In looking across models, ELL shortfall appears to not be significantly related to the overall percentage of students performing at proficient and advanced, except for reading in one model (when an interaction between ELL shortfall and year is included in the model). In that case, over the course of the years included in this analysis, narrowing the ELL shortfall results in greater percentages of students performing at proficiency in reading and math. Moreover, districts with greater shortfalls see reading and math PPA decrease over time, but those with no shortfall realize an increase in reading and math PPA over time. Finally, when

Table 6. SFA Results for Model 4

	Reading Coefficient	Math Coefficient
Production Variables		
Beta constant	0.799	0.523*
Instruction: salary/benefits	0.000	0.000*
Instruction: services	-0.000	-0.000*
Instruction: supplies and materials	-0.000	-0.000
Instruction: other	0.000	0.000*
Support: pupils	-0.000	0.000
Support: instructional staff	-0.000	-0.000
Support: general administration	-0.000	-0.000*
Support: school administration	-0.000	-0.000*
Support: operations/maintenance	0.000	0.000
Support: transportation	0.000	-0.000
Support: food	-0.000	-0.000*
Support: other	-0.000	-0.000
Community services	-0.000	0.000
Other	0.000	0.000*
ELL shortfall	-0.000	-0.000
Year	0.002	0.019*
ELL shortfall × year	0.000	0.000
Percentage ELL	-0.537	-0.657*
Efficiency Variables		
Delta constant	0.033	0.214*
Percentage FRL	0.054	0.282*
Percentage minority	0.046	0.030
District size	0.000	0.000*
Percentage gifted/talented	-0.009	-0.921*
Percentage SPED	0.004	0.336
Percentage homeless	-0.001	-0.078
Percentage migrant	-0.002	-1.888*
Percentage immigrant	-0.002	-7.044*
Percentage Title 1	0.002	0.292
Disciplinary rate	0.027	0.239*
Percentage of superintendents with MA or more	-0.025	0.047
Percentage of principals with MA or more	-0.008	-0.164*
Percentage of teachers with MA or more	0.000	0.014
Mean experience of principals	0.001	0.002
Mean experience of superintendents	0.007	0.003*
Mean experience of teachers	-0.009	-0.010*
Student-to-teacher ratio	-0.005	-0.002*
Year	-0.007	-0.038*
σ^2	0.044	0.035*
γ	0.923	0.853*
Log likelihood	861.6	1002.8

*p<.05

ELL percentage is included in the efficiency part of the model, larger percentages consistently result in decreased efficiency; when it is treated as an input, it is often related to lower percentages of students performing at proficiency.

Although each model contributes a different perspective on the questions at hand, Coelli (1996) provides some direction on which models appear to represent the data best. The log-likelihood ratios presented in each table indicate which model represents the best fitting model, with values closer to zero showing the best fit. For math, the best fitting model appears to be Model 2, with no interaction and ELL percentage included in the production part of the model. For reading, the best fitting model appears to be Model 4, which included the interaction and ELL percentage included in the efficiency part of the model.

DISCUSSION

The study set out to investigate the effects of large numbers of ELL students on student achievement and district efficiency. The assumption, based on an earlier adequacy study (Ramirez et al. 2013), was that underfunded ELL programs in Colorado would have an adverse impact on school districts and that this negative influence would increase in proportion to the percentage of ELL students in the school district. The supposition was that as the percentage of ELL students increased, a school district would be more challenged to finance mandated programs and be forced to take money away from other programs, such as those in the general fund. It was anticipated that this shifting of funding would manifest in overall student achievement and efficiencies for affected school districts.

The results show very small effects along both the production and efficiency dimensions. Moreover, the measure of ELL shortfall is the best estimate possible but still is not as precise as desirable. Therefore, these results should be seen as an early appraisal. However, the findings do throw open a new round of conjecture about what is happening in school districts in Colorado with large populations of ELL students. Reflecting on the results of the analysis an array of possibilities is contemplated:

- ELL funding is sufficient as it is in Colorado at less than $200 per student per year for two years of support for an individual ELL student as prescribed by the ELPA state categorical aid program.
- The analysis hints at limited funding eventually having a small impact over time (i.e., more years added to the model shows decreased production in districts with greater shortfalls). This supports results from earlier Colorado adequacy studies in that affected school districts face a steady inflow of new ELL students each year, thus facing a continuous challenge to find resources to serve these students.

- Because the results appear not as dramatic as the findings from prior Colorado studies, perhaps the SFA as applied here was not sensitive enough to detect effects on achievement or efficiency, thus leading to a Type II error.
- The research design for this type of study was too narrow in scope and did not account for other variables that might affect the results, which resulted in unobserved variable bias.
- Other sources of funding, such as ESEA Title I and the At Risk component in the Colorado state funding formula, support ELL students. ELL is highly correlated with poverty, and the percentage of poverty in the student population drives funding programs like ESEA Title I and the At Risk component in the Colorado state funding formula.
- If funding within a school district, regardless of source, is fungible, then what matters is total available funding per student and not individual categorical programs.
- Are school districts robbing Pedro to pay Pablo? Perhaps these production functions have identified an insight into "the achievement gap"; that is, by spreading inadequate resources among ELL and other disadvantage groups, school districts are shortchanging various targeted populations. If so, the study may have uncovered a pattern of supplanting whereby school districts use federal dollars to supplant state obligations and state dollars to supplant local school district obligations. Specifically, districts may be using other categorical aid to "backfill" ELL funding shortfalls, thereby mitigating the diversion of general funds from non-ELL student programs that would hurt achievement levels of the general student population. If school districts are in fact robbing Pedro to pay Pablo, however, the effect is that students traditionally targeted for Title I and At Risk funds fail to receive their full allocation, which may hurt efforts to support those students and retard efforts to narrow achievement gaps.

What is clear is that more investigations are needed. Studies of intradistrict funding should take place to explore the internal funding allocations of school districts with varying populations of ELL students. Such a study should particularly examine the allocation of ESEA Title I and other like supplemental funding programs, comparing high-ELL-percentage districts with low-ELL-percentage districts. The SFA used in the study has opened a window on an assortment of possible insights into the realm of education funding adequacy and the dynamics of school district funding allocation patterns. More in-depth investigations are needed to follow the thread found here.

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