

Security Spending in Schools as an Independent Variable
in an Education Production Function

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Abstract

School security expenditures have increased immensely, especially after highly publicized school shootings. Much of the policy decisions are based in fear. Little research has been done into the effects of the new levels of security. This thesis attempts to gain insight into the impact that security spending has on the achievement of students. An education production function is formed with student achievement as the dependent variable and financial information, student characteristics, and teacher qualities as the independent variables. An empirical analysis was possible through the use of data relating to school districts in Texas. After using a two-stage least squares regression, it appears that schools that underspend on security measures will have students who do better academically. Some flaws in this model are noted, but these results still open up the door to much more future research.

In the wake of tragic school shootings and increased violence, school security levels have been amped up to unprecedented levels, but at a cost. The 1999 shooting at Columbine High School left 13 dead and the 2012 shooting at Sandy Hook Elementary School left 28 dead, but these are just a few of the highly publicized school shootings that have caused a wake-up call in America. An estimated 1.9 million crimes (violence, theft, or other crimes) occurred in public schools in the 2009-2010 school year (U.S. Department of Education 2014). Many schools face a constant threat of violence, but even the most unlikely schools need to be on alert for unexpected mass violence. Subsequent outcry from fearful parents has forced policy makers and school leaders to require higher levels of security.

It is predicted that school security spending will reach \$4.9 billion by 2017, which is an 81% increase from \$2.7 billion in 2012 (“IHS Projects Rapid Growth” 2013). A new market of security technologies is cashing on in parental fears. New cameras, metal detectors, and security guards are just a few of the measures being taken by school districts across the nation. A lot of the money funding these changes comes from the government in the form of grants, which makes it hard to believe that so little research is being done into the value of this spending. There are three main problems with the recent increase in security: the cause of the increase, the effectiveness of the new security measures, and the impact on students. Policy makers are bending to the demands of overly fearful parents, most of whom are over-estimating the likelihood of danger. Only recently has research been done into the effectiveness of many of the security measures schools are employing. Much of this research is even showing that the new measures are not making schools safer, which is creating a false sense of security (Addinton 2009). That’s not the only consequence of increased school security, though. Increased security has both positive and negative effects on students. Assuming everything is working properly,

students are protected from an array of possible dangers. However, recent research has begun to attack school security for the unintended negative consequences it introduces. Surveys of students' perceptions of increased security show that schools have started to have a "prison-like" feel (Horner 2013). Another consequence, which can be either positive or negative, is the impact that this increased security has on students' education. Up until now, this topic has not been researched. Given that security measures cost money and schools seek to educate their students within a given budget, a connection needs to be made between the two.

An education production function can be used to make judgments about the efficiency of security spending on student achievement. Since so little, if any, research has been done on this topic, regression analysis will help determine if security spending has a positive or negative impact on education as well as the magnitude of that effect. This information can be beneficial to future policy decisions surrounding security spending. If better informed decisions are made, everyone will benefit. Given the increased attention and money being put into increasing security in schools, an empirical analysis of the effects of security spending as part of the education production function will help evaluate current programs and help shape future policy.

Literature Review

Although school security dominates modern media, the body of literature surrounding school safety tends to be very small. In particular, there is an absence of research on the connection between school security spending and student performance. There are, however, two other themes that can be explored in order to build the larger picture. There is a fairly substantial body of research on education production functions. Those works, in combination with the more recent literature on what measures school districts are employing to increase safety, will build the framework for an education production function with security spending as an input variable.

This new education production function will hopefully begin to bridge the gap between the two topics.

Because production functions measure the efficiency of the factors in the production process, education production functions are a common way to measure the relationship between different resources and educational output. Policy makers especially rely on education production functions to determine the most efficient distribution of resources. In David Monk's work on the use of the education production function in policy analysis, he began by confirming the existence of the function, which is questioned by some. He then discussed three different approaches to the education production function: deductive, inductive and the gateway approach (Monk 1989). The deductive approach is the most common and the one that is most based in economic theory. Education production functions can take on many different forms depending on the originator's goals. Most education production functions use school resources, teacher quality, and family attributes as the input variables with student achievement as the output variable. The specific variables used to measure each of those categories is what makes each education production function unique. Hanushek looked at 377 different production functions from 90 publications appearing before 1995 (2008). In doing so, he found that school resource use is inefficient because school districts continue paying for inputs that are not consistently proven to improve educational achievement. Even when consistency was found, the factors of production tended to be statistically insignificant. Some versions of the education production function focus on a small number of variables related to policy decisions. For example, Lamdin specifically examined the attendance variable (2001). Each education production function is unique and adds something new to the field. So long as policy decisions are being made based on education production functions, the search for a better function will continue. Although no solid

education production function has been reached yet, it is still the most commonly used method to analyze school resource allocation.

More recently, a growing body of research has been devoted to the various security measures being implemented by schools across the nation. Highly publicized school shootings, such as those at Columbine and Sandy Hook, have led to an increased fear among parents of school children. This increased fear has driven policy changes to increase security measures in schools. However, only recently have people been analyzing the actual effects of these new measures. A 2013 study by John Horner set out to document how students felt with the increased security in their school. It found that students felt that they were treated unfairly, felt marginalized, and felt disenfranchised. Horner, however, was more focused on students' legal rights than on their education. Lynn Addington also found that new measures of school security tend to encroach on students' civil liberties and privacy concerns (2009). In addition, Addington looked at the motives behind the policies that increased school security, which was prompted by parental fear most of the time. A lack of a priori research has caused schools to implement measures which might be doing more harm than good. Addington did not touch on the educational achievement effects of increased security, but she did talk about the unintended negative consequences of creating a negative school environment and infringing on student's rights. Although research is starting to delve into the effects of increased school security, most research is still ignoring the educational ramifications.

Although there has been an immense increase in school security measures after highly publicized school shootings, a number of school districts have increased security to combat more constant violence and crime in the hallways. A bulletin from the Department of Justice's Office of Juvenile Justice and Delinquency Prevention examines the types of street violence threatening

schools and ways to reestablish safety (Arnette and Walseben 2000). While focusing mostly on public concern and prevention methods, this bulletin helps illustrate why so many school districts are increasing their security. What it lacks, though, is any mention on how the increased spending necessary to implement these new programs will impact students. The best it does is talk about how safer schools will increase attendance, which other studies have found to increase student achievement. Pedro Noguera looks at preventing violence in inner-city schools through fostering a strong sense of community and collective responsibility, but he does not talk about the costs of such programs (1995). No matter how much violence and crime a school faces on a daily basis, it is important not to forget that school districts' first goal should be to educate children. The money being spent to decrease crime needs to be looked at in the larger context of education.

The most influential paper about the costs of security spending in school districts thus far is a 2011 paper by DeAngelis, Brent, and Ianni. Although they didn't look at the relationship between security spending and student achievement, their paper is the most substantial overview of how much districts spend on security, how they put resources to use, and how spending differs. These authors also felt hindered by a lack of previous research and available data. After seeing the growing attention given to increasing security measures in school districts, the authors set out to draw the attention of policymakers to the actual costs of these new measures. They found that security spending was greatest in urban areas with high poverty rates. Although this paper does not make any claims about the impact of high levels of security spending, it does express that, "a dollar spent in one area cannot be spent in another, perhaps more productive, way" (DeAngelis, Brent, and Ianni 2011). This opens up the door for further research based

around the efficiency of security spending as part of the overall budget. A production function will help determine whether increased security spending helps or hurts student achievement.

Economic Model

In economics, there are three main questions: what to produce, how to produce, and for whom to produce? As firms, school districts must answer these questions. What they produce is education, and who they produce it for is the children. How exactly to produce this education for children is not quite as easy to answer. There are many different ways to achieve educational output. The school district superintendent must decide which factors of production to utilize given the limited budget of the school district. Different combinations of production factors will produce different results. A production function is used to relate input production factors with the resulting output. In this case, school districts are seeking to determine which combination of factors of production will create the best educational achievement. In a production function, the input factors are the independent variables and the output is the dependent variable. Commonly used independent variables include financial information, student characteristics, and teacher qualities (Gyimah-Brempong and Gyapong 1991). However, few if any education production functions consider security spending as a separate independent variable. Given the increased attention to crime in schools, though, the relationship between security spending and educational achievement needs to be looked at explicitly.

For the production function utilized by school districts, the dependent variable, or output, is education. There are, however, many different ways to measure education. It used to be enough to just measure years in school, but research has shown that not all educations produce the same results (Hanushek 2008). Better education will produce laborers with greater productivity and human capital. This means that school district superintendents are trying to maximize the quality

of education rather than the quantity of education. Several commonly accepted measures of education are standardized test scores, high school graduation rates, and college attendance. All of these will measure the qualitative success of schools.

When looking at the input variables in a production function, it is important to see how each individual variable affects the output variable. The input variables should be considered separately with all other variables held constant. School funding is considered as one of the financial variables because there is much debate about whether or not funding even influences educational achievement. Some reports show that school funding in the aggregate, specific school resource funding, and school finance reform has been shown to positively impact education (Fortune 1993). However, other reports consider it to be “risky” to conclude a relationship between school funding and educational achievement. Moving forward, though, it will be hypothesized that school funding has a positive relationship with educational achievement.

Another aspect of school finances is the money devoted to increasing and improving security in schools. Since little research has been done on the effects of security spending in schools, it is hard to predict how it will impact educational achievement. On one hand, higher security spending means safer schools, and safer schools mean that children will be less likely to skip. It has been shown that increased attendance has a positive relationship with educational achievement (Lamdin 2001). It follows that safer schools will have higher attendance and higher student achievement. The feeling of being safer in school is hard to measure objectively. Many interviews and surveys have been conducted to determine if increased security makes both students and teachers feel safer (Horner 2013). Assuming that security methods are operating correctly, students should be safer in school. Therefore, the amount of money put into increasing and updating security measures can serve as a measure of safety in schools. Given the large amounts

of funding for school security programs, it would appear that policymakers believe that security spending has a positive effect on education, but they have little actual evidence to back up that claim.

Although increased security spending could positively relate to educational achievement, it could potentially have a negative relationship. When school district superintendents put money into security measures, they are not putting it into some other resource that could have a potentially greater impact on education. Limited budgets make the efficient allocation of money a crucial decision in education. An increase in security spending could decrease educational achievement as a result of diverting funds from programs and resources that have been proven to be successful. Until further research has been done, there is no reason to completely disregard the possibility that security spending is negatively related to student achievement. Regression analysis of an education production function can help back up various claims about the relationship between security spending and education.

The student characteristics are qualities that relate directly to individual students, which will impact the quality of education they receive. Students taking advance courses should have a positive effect on educational achievement. Advance course work is indicative of a commitment to learning and an above average intelligence. Likewise, high attendance rates show a commitment to learning and therefore should produce a positive effect on education. The graduation rate represents a successful completion of a student's education. Graduation rates are expected to show a positive effect on student achievement because students who meet all of the requirements of a quality education are the students who graduate. The dropout rate, on the other hand, is expected to have a negative impact on educational achievement because it is symptomatic of a failing education system. The same is true for students considered at-risk for dropping out of school. The

number of students in a school district is hypothesized to have a negative effect because it means limited resources are being spread among a larger population. Economically disadvantaged students may be facing outside factors that would prohibit achieving their fullest educational potential, which would result in a negative hypothesized influence on achievement. All of these student characteristics are anticipated to impact educational achievement in different way. A mix of controllable and uncontrollable variables were included to provide insight for policymakers. When school superintendents are making decisions concerning the maximization of educational achievement, they must consider which positive variables they can increase the effects of, which negative variables they can decrease the effects of, and which variables are completely out of their hands.

The quality of educators at a school directly impacts the quality of education that students receive. Teacher experience levels have shown a positive relationship with student achievement levels, but the strength of that relationship is questioned (Hanushek and Welch 2006). The same is true for teacher salaries. Higher paid teachers don't always produce better students. The percent of teachers that are full-time and the student-teacher ratio measure the relationship between students and teachers. High percentages of full-time teachers and low student-teacher ratios should be indicative of closer ties in the school. This should increase educational achievement as well as lessen the need for security spending. Students are more likely to report a crime if they feel comfortable going to their teachers. Similarly related, teacher turnover rates should negatively affect educational achievement. If teachers remain constant, students will be more likely to trust them.

In an attempt to unearth the relationship between security spending in schools and the educational achievement of students, a production function can assist in calculating the effect of

spending on the output. Many input variables, even beyond what has been specified, can be combined to get at the source of educational output. When considering the impact of a variable, it is crucial to consider only that variable with all others held constant. In addition to determining how big of an impact a specific variable has on the output, a production function can be used to define efficiency. The school district superintendent should put more funding into the programs and resources that show a large and positive influence on educational achievement. If security expenditures show this large, positive impact then increased the spending is justified.

Data and Methods

The data for this model comes from the Texas Education Agency. Very few states require a separate budget code for security-related purchases, so the data prospects are limited. Fortunately, the TEA keeps a very extensive collection of data. All of the school districts in Texas were ranked by the size of the student body. Then a random sample of 100 districts was taken from the largest 25% of districts. Texas requires school districts to classify “activities to keep student and staff surroundings safe, whether students and staff are in transit to or from school, are on a campus, or are participating in school-sponsored events at another location” under budget code 52 (TEA 2013). Expenditures from this budget can be measured as a percent of the general fund or per pupil. The per pupil measurement is better for policy analysis since it provides a more manageable context for other school districts to base their spending off of. The expenditure by program measured per pupil is also considered to provide a framework for overall school district budgets.

All of the data for the independent variables is taken from the 2011-2012 Academic Excellence Indicator System (AEIS), which encompasses the financial information, student characteristics, and teacher qualities for each school district. Variables that measure exceptional

academic performance include the rate of students taking Advanced Placement and International Baccalaureate classes as well as the rate of students taking other advanced courses. Similarly, the graduation rate will also be indicative of student achievement. However, the dropout rate and percent of students that are at risk of dropping out is also included. Data has shown that violent crime rates are higher in low-income neighborhoods (Kelly 2006). The percent of economically disadvantaged students as measured by the percent of students eligible for free lunch might shed light on a connection to school district security spending. The average teacher experience and teacher base salary average would add a measure of the skill and knowledge of the teachers in each school district. The percent of teachers that are fulltime and the teacher student ratio indicates how much time teachers can spend observing students. Crime and violence is a lot more prevalent when there are no teachers to keep an eye on students. High teacher turnover rates can reveal a lack of trust between students and teachers if teachers do not remain long enough to form bonds. All of these measurements will be used in the education production function.

The dependent variable, student achievement, comes from 2013 Accountability Summary Report. The student achievement rating for each district “provides an overview of student performance based on satisfactory student achievement across all subjects for all students” (Housson 2013). Student scores from reading, mathematics, writing, science, and social science are gathered from the State of Texas Assessments of Academic Readiness (STAAR) standardized test. The data used for this model is the two year average of the STAAR-based student achievement rating. This rating is out of 100, with a target score of 50 for each district. Standardized test scores are a common measure of student achievement and will be a useful measure for the output of the education production function.

A two-stage least squares regression appears to be the best model for this data. Initially, all of the independent variables were included in a least squares regression. After some reconsideration, a two-step least squares regression was implemented. There are many things that could influence school district security spending, but were not included. Their impact on student achievement ends up as part of the error term in the one-step least squares regression. To account for this, district security spending per pupil was measured as an endogenous variable. A separate regression (see table 1 for results) uses the size of the district and the percent of students who are at risk of dropping out to estimate the per pupil amount of security spending for each district. Although only two independent variables were used, 26.2% of the variation in security spending is accounted for. From this equation, the residuals measure how much over or underspending a school district was actually doing compared to what the model suggested. Because these residuals are normally distributed, there is increased confidence that the regression was appropriately modeled. These residuals were collected and used in the second equation as an independent variable to estimate student achievement.

Dependent Variable: EXSECPUGF
Method: Least Squares
Sample: 1 100
Included observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.80475	8.972612	1.315642	0.1914
ALLSTUDCOUNT	0.000333	9.17E-05	3.634004	0.0004
ATRISKPER	0.804903	0.197394	4.077653	0.0001
R-squared	0.261951	Mean dependent var		52.96000
Adjusted R-squared	0.246733	S.D. dependent var		32.24587
S.E. of regression	27.98650	Akaike info criterion		9.530862
Sum squared resid	75974.66	Schwarz criterion		9.609017
Log likelihood	-473.5431	F-statistic		17.21378
Durbin-Watson stat	2.140408	Prob(F-statistic)		0.000000

Table 1 – Regression Results: Security spending per pupil as dependent variable

After removing statistically insignificant variables, the remaining independent variables are the percent taking advanced courses, the attendance rate, the dropout rate, the percent of economically disadvantaged students, the per pupil expenditure by program, security spending as a percent of the general fund, and the residuals from the first equation. This final equation (see table 2) produced strong results with 82% of the variation in student achievement being accounted for. All of the coefficients have their predicted signs, but it is the -0.072791 coefficient on the residuals variable that is of most interest. The residuals from security spending have a negative relationship with student achievement. A scatter plot (see figure 1) of student achievement and security spending per pupil suggests a weak, but negative relationship. Because the regression results are about residuals it is not exactly comparable to the prediction about security spending and achievement. However, the results are still shocking. This negative coefficient on the residuals means that school districts that underspend on security measures can do better academically than schools that overspend. Each one dollar decrease below the expected security spending for that school district, given what the first equation predicts, will increase the student achievement test score by 0.073 points on average. There is, however, one curious result from the regression analysis. The coefficient for security spending as a percentage of the general fund is 4.22. This suggests that each 1 percentage point increase in security spending's share of the general fund would increase the student achievement score by 4.22 points. Although each variable should be taken *ceteris paribus*, this seems to contradict the coefficient on the residual. This suggests that this model should not be taken as infallible. Future research is necessary to support or dispute these claims.

Dependent Variable: ACHIEVE

Method: Least Squares

Sample: 1 100

Included observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-76.93101	47.14174	-1.631909	0.1061
ADVCOURSES	0.138913	0.048380	2.871291	0.0051
ATTEND	1.678646	0.483883	3.469113	0.0008
DROPOUT	-1.336017	0.447714	-2.984086	0.0036
ECONDISPER	-0.288420	0.025169	-11.45922	0.0000
EXPRPUGF	0.000523	0.000300	1.744556	0.0844
RESIDUAL	-0.072791	0.030032	-2.423799	0.0173
EXSECPGF	4.218965	2.091759	2.016946	0.0466

R-squared	0.819953	Mean dependent var	76.26000
Adjusted R-squared	0.806253	S.D. dependent var	8.637036
S.E. of regression	3.801736	Akaike info criterion	5.585411
Sum squared resid	1329.694	Schwarz criterion	5.793825
Log likelihood	-271.2705	F-statistic	59.85375
Durbin-Watson stat	1.818898	Prob(F-statistic)	0.000000

Table 2 - Regression Results: Student achievement as dependent variable

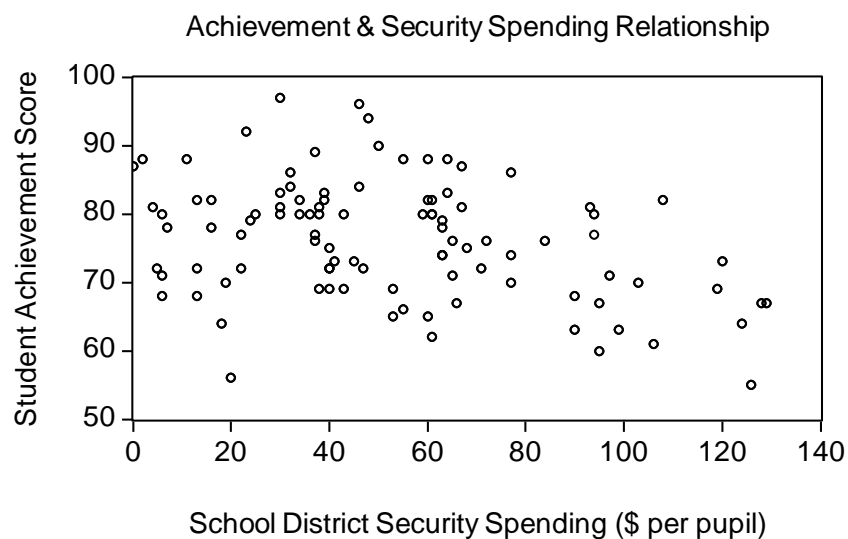


Figure 1 – Scatter plot of the relationship between school district security spending and student achievement

Discussion

Given that this is likely the first education production function which focuses on security spending as an independent variable, more research can and should be done. There are some flaws in this model which could be fixed in subsequent models. However, the biggest obstacle to further research is a lack of data on security spending trends by school districts. The problem is not that schools aren't recording security expenditures, but that they are recording it under more general categories. This makes it difficult to extrapolate the impact of security spending. Once more states require a specific budget code for security expenditures, then more empirical studies can be done.

Although the Texas Education Agency's security expenditure data was extremely helpful, there are some inherent drawbacks in the numbers. Budget code 52 doesn't include preventative measures, such as anti-bullying campaigns. These programs have been shown to decrease crime in schools, which lessens the need for traditional security measures (Wilson 2001). This exclusion of preventative measures could potentially skew the results. Given the definition from the TEA, however, budget code 52 still encompasses enough security spending to be used in an empirical education production function. The expenditure reported in budget code 52 also doesn't account for items, such as metal detectors and cameras, that were bought in previous years, but that are still in use. This is due to the accounting standards used, and would be a problem with almost any state collecting similar data. Given that so little data is available on security expenditures, a few problems are to be expected.

The data available limited the ability of this model to fully account for difference in security spending. Although the equation that models security spending per pupil accounts for a quarter of the variation, the other three-quarters could be accounted for with more independent

variables. This model included a sample of the largest districts in Texas. Future models should consider separating districts by type, such as urban, suburban, town, and rural as DeAngelis, Brant, and Ianni did in their study (2011). Another possible indicator of security expenditure is the crime rate in each school district. Schools that face frequent security threats have different needs than schools that face rare or infrequent threats. Different districts face different safety concerns, so security expenditure should fit each specific school district. By lumping all districts together, these subtle differences are ignored. As the residuals from the first equation show, overspending on security measures hurts academic achievement. Imagine a rural school with few security threats investing more and more money into increased security out of fear not facts. Instead of protecting the students it serves, it will end up hurting them by limiting the resources that could actually increase their academic potential. Security spending decisions need to be conditioned on the environment of the district. Future research should account for different district types and different crime levels in order to best relate security spending and student achievement.

Up until now, most school security-related policy decisions are based in fear, not facts. With more research into the effects of security spending on student achievement, future policy can have a more reliable support. This model, however, is just the beginning. One education production function is not enough to decree new policy requirements for security expenditures. As mentioned previously, this simple model has some obvious flaws, but it is a good first step. Education production functions are notoriously inconsistent. If multiple new education production functions that include security spending measurements show consistent results, then new policies can begin to be enacted based off of those findings. This model can provide some insight, though. From this model, it appears that underspending on security measures helps

student achievement. Before increasing security measures, school districts should do their research. If they are already overspending on security, then an increase will probably do more harm than good. Future policy decisions should be based around the appropriate level of spending given the financial information, student characteristics, and teacher qualities of each school district.

Conclusion

School shootings in the past two decades have received a lot of media attention and have ignited immense parental fear. During this same time, increased effort has been put into ending youth crime and violence. In an effort to sooth parental fear and combat crime rates, school districts have been funneling millions of dollars into increase security measures in schools. Little research has been done into the effects of these changes, though. When security spending per pupil is examined in the context of an education production function, it appears that a school district's overspending hurts the academic achievement of the students it is supposed to be serving.

This leads to the question: what is the purpose of schools? Are they built to educate the youth of a nation or protect them? If school districts seek to educate children, this inefficient allocation of budget hinders student achievement maximization. However, if school districts serve to protect children for the seven hours a day they are there, then overspending on security measures is not a problem so long as the security measures are effective. Most people would probably argue that the two goals are not mutually exclusive. When schools seek to educate and protect children, it becomes a question of how much of one thing are we willing to give up to increase the other. In assuming that education is more valuable than security, it appears that school districts are currently giving up too much education for an unnecessary increase in safety,

or perceived safety. Moving forward, school district superintendents will need to decide whether they value education or safety more before deciding if they are spending the right amount on security measures.

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