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The Effects of States' Economic Conditions on the Quality of Public Education System

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Abstract

Many previous researchers have looked at the effects of education on certain economic factors. However, this paper investigates the topic of education from a different perspective: using data of several economic factors for all 50 states in America from the year of 2017 and an education ranking system from U.S. News & World Report, this paper analyzes the effects of a state's economic conditions on its quality of public education system through a cross-sectional model. Results from the analysis show that poverty rate, current expenditure per pupil, public high school graduation rate, and share of revenues for public elementary and secondary education have a significant impact on education quality.

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Introduction

Nowadays, more and more people are getting educated, and education is undoubtedly one of the most important experiences in our lives. As is well known, most students in the United States go through the public education system: according to the National Center for Education Statistics (n.d.), 50.7 out of 56.4 million students will attend public schools for PreK-12 education in fall 2020. That's approximately 90 percent of all PreK-12 students enrolled in the public education system, and thus it's an important task to ensure the quality of public education.

Unfortunately, the declining quality of public education in the United States has become a frequently discussed topic. Black and Sokoloff (2006) also state that "in recent decades, there has been rising anxiety about the quality of the public education in the United States" (p. 70). With increasing public concern over the quality of public education across the country, governments at both the state and national levels have been looking for effective ways to improve the public education system. With this trend, it is necessary to find out and understand some factors that can potentially influence the quality of public education.

There have been a lot of academic articles about education, but most previous studies just focused on the effects of education quality on certain economic factors, and found out that education quality can significantly affect those economic factors, such as average personal income, poverty rate, and inequality. Besides, those relationships have been studied not only in the United States, but also across the world, and results from previous studies could have potentially positive inspirations by motivating governments to improve the quality of education and encouraging people to pursue better education. This paper, however, analyzes the topic of education from a different perspective by investigating the effects of economic factors on the quality of education.

This paper looks at certain economic factors that can potentially influence the quality of the public education system in each of America's 50 states. In this analysis, the quality of public education is measured by using the rankings from U.S. News & World Report, and data for a variety of economic factors from all 50 states are collected from several government statistics websites. Those economic factors include per capita disposable personal income, poverty rate, Gini index, total Internal Revenue collections, government expenditures for public elementary and secondary education, current expenditures per pupil for public elementary and secondary education, and public high school 4-year adjusted cohort graduation rate. Data analysis will determine what factors significantly influence the quality of public education system based on an analysis of the results. If the results can identify relationships between state economic conditions and the quality of public education, then the government in the United States can further improve the public education system by implementing relevant economic policies.

The rest of this paper is organized as follows. A brief literature review is followed by the exploration of previous studies regarding education. Then, data collection and analysis and the methodology of this paper are presented. Next, a discussion of the results is given. Finally, this paper ends with a conclusion and policy recommendations.

Literature Review

Economists have been doing a lot of sophisticated research on education, and one of the most investigated topics is the impact of education on people's future labor market results. Although many sociologists, psychologists, and political scientists usually measure education's impact by students' scores in standardized tests, more and more economists have accepted the approach to determine education's effectiveness by testing education's effect on income. According to Card and Krueger (1996), "To economists, however, the labor market is the natural

yardstick for measuring the effectiveness of schools" (p. 1). Betts (1995) also presents a similar idea that "Indeed, if earnings are the metric by which economists measure success in the labor market, it makes more sense to use wages or earnings to gauge the effectiveness of schooling (p. 231)."

Wilson (2002) examines the relationship between education spending and future incomes. While this relationship may seem apparent – more education spending should be related to higher future earnings, Wilson indicates that "there is certainly not a consensus on the answer to the question in the empirical economics literature" (p. 579). Using a unique set of data created by combining the Panel Study of Income Dynamics with school data from the Common Core of Data, Wilson finds out that there is a statistically significant and strong positive relationship between school expenditure and future earnings. Other independent variables in this study include family characteristics, neighborhood characteristics, and years of labor market experience. Wilson's study is also more reliable because, unlike previous researchers, he collects data from individuals until they reach their early thirties so that the data can provide a longer time period for analysis and reflect more trustworthy results. Two variables from Wilson's study – school spending and incomes – are included in this paper, but they are considered as independent variables to test their impact on education quality. This paper further considers the effects of other independent variables to make the analysis more extensive.

Hanushek and Kimko (2000) measure the effect of education quality on the economic growth of nations. Instead of relying on conventional measures, the authors build a new way to measure education quality by using students' results on many international exams of academic achievement in science and mathematics. Results of the analysis demonstrate a strong positive relationship between education quality and economic growth. Jamison et al. (2007) build on the

study from Hanushek and Kimko to further assess the importance of education quality and they also examine the robustness of previous findings to a larger number of countries by including exam score data for more countries. After analyzing data for 62 countries from 1960 to 2000, the authors conclude that the results support the relationship between education quality and economic outcomes such as income per capita and that better education quality speeds up the rate of decline in infant mortality. These two studies leave some important inspirations to this paper: the first study demonstrates the existence of a relationship between education quality and economic conditions, and the second gives a more specific conclusion that education quality can affect income per capita. This paper, assessing the effects of economic conditions on education quality, will include income per capita as an independent variable.

Other subjects that researchers often look at with education include poverty and inequality. Tilak (2002) indicates that the approach of education "may be long term in nature and effect, making the gains in poverty reduction more effective and sustainable" (p. 191). However, Barham et al. (1995) point out the dilemma of the poverty trap: because some parents' earnings are too little to enable them to afford tuition, and as a result, their children will stay uneducated and consequently poor. Thus, it seems that there is an awkward bilateral relationship between education and poverty: even if education can help reduce poverty effectively, poverty can restrict poor people's access to education. As a result, it is also an important task to promote equal access to education opportunities. Santos (2011) builds a model of the poverty trap that results from "an unequal initial income and human capital distribution and differences in the quality of education between children from more and less advantaged social sectors" (p. 25). The results of this model indicate that when poor families only have access to poor-quality education, poverty traps will form, and policies designed to equalize the quality of education in the long run will be

necessary to reduce initial inequalities. Blankenau and Youderian (2015) also come to the finding that it is important to reduce education inequality, but with a more specific policy suggestion. After analyzing a life-cycle model in which both families and the government can accumulate human capital of children by investing in education in early, middle, and late childhood, Blankenau and Youderian indicate that government spending in education can reduce education inequality caused by parental incomes, but higher government spending in education has a larger effect when distributed to poor families in early childhood, while it poses almost no impact in later childhood. This paper, similar to the previously mentioned literature, taking into account the phenomenon of the poverty trap and income inequalities, and the analysis will include poverty rate and Gini index as independent variables to investigate the effects of poverty and inequalities on education quality.

Baydu et al. (2013) examine the effect of poverty on public high school graduation rates for the 2007-2008 school year in the United States. The authors indicate that poverty is a long-term issue in the United States and that a significant consequence for students failing to graduate from high schools is the continuation of poverty. To analyze this matter, the authors collect poverty data from Current Population Survey which is conducted by the U.S. Census Bureau, and the data they use, represent the percentage of households in poverty from October 2007 to October 2008. Data for high school graduation rates were obtained from the Common Core of Data which is produced by the National Center for Educational Statistics, and the authors decide to use Averaged Freshman Graduation Rates of high school students for the 2007-2008 school year in the United States. In this study, data for all fifty states and the District of Columbia are utilized and the relationship between the poverty rate and public high school graduation rate is assessed through bivariate analysis. The result shows that there is a statistically significant

negative relationship between poverty rate and graduation rate. Since public high school graduation rate is also a factor to measure the effectiveness of the education system, this paper will include this factor as an independent variable.

All these studies demonstrate that education can be related to certain economic measures, but most of them don't prove whether education quality can be determined by economic conditions. This paper sums up previous literature and includes those important economic measures as independent variables to examine their effects on education quality. In addition, Blankenau (2005) indicates that "government plays an important role in funding both K-12 and college education" (p. 502) and "government uses tax revenue to provide quality in K-12 schooling and to subsidize college tuition" (p. 487). Thus, the analysis will further include tax collections and government expenditures as independent variables. Overall, this paper collects data for all 50 states in the United States and follows the hypothesis that economic conditions will have significant effects on the quality of public education system.

Data and Methodology

In this paper, the dependent variable, which measures the quality of public education system, is represented by the ranking of a state's PreK-12 education from U.S. News & World Report. This ranking system is quite sophisticated because it takes five major metrics into consideration. The first metric is college readiness, which measures the approximate percentage of high school graduates who have passed the SAT, the ACT or both. The second metric is the high school graduation rate, which gives a full picture of a state's success in graduating students from public high school. The third and fourth metrics are the NAEP (National Assessment of

Educational Progress) math and reading scores, and the last metric is preschool enrollment, which measures the percentage of children under age 5 enrolled in a preschool program or nursery school in any state.

The independent variables include a variety of economic factors to reflect the overall economic conditions in a state, and all data are collected from several government statistics websites. In addition, these data are from the year of 2017 because most metrics in the ranking system from U.S. News and World Report use data from 2017, and this choice can potentially reflect the effects of those economic factors more accurately. The following are descriptions and sources of these economic factors included for analysis.

Per capita disposable personal income is defined as the average amount of discretionary income an individual has for spending and saving after income taxes have been accounted for. Disposable personal income is often considered as one of the many important economic indicators used to gauge the standard of living and reflect the overall state of the economy. In this paper, disposable personal income is worth analyzing because more of it can also imply more individual spending for education. Data for per capita disposable personal income is collected from the Bureau of Economic Analysis.

Poverty rate is the percentage of people whose income is below the poverty line (the estimated minimum level of income needed to secure the necessities of life), and I hypothesize that higher poverty rate will result in worse quality of public education system. Data for poverty rate is collected from United States Census Bureau.

The Gini index is a measure of statistical dispersion intended to represent the income inequality in an area or within a group of people. I am hypothesizing that a higher Gini index

(more income inequality) will lead to worse quality of public education system. Data for the Gini index are collected from United States Census Bureau's ACS 5-Year Estimates Detailed Tables.

Total Internal Revenue collections indicate the total federal tax revenues collected by the U.S. Internal Revenue Service (IRS) from each state, and they are measured in thousands of dollars. I assume that more Internal Revenue collections will lead to better quality of public education system because there will be more funding available for local government to improve schools. Data for total Internal Revenue collections are sourced from Internal Revenue Service.

Expenditures for public elementary and secondary education is a state's total expenditures in that area, and they are measured in thousands of dollars. Total expenditures include three types of spending: current expenditures (instruction, instruction-related, support services, and other elementary/secondary current expenditures), capital outlay (expenditures on property and construction of facilities), and other program expenditures (expenditures for community services, adult education, community colleges, private schools, interest on debt, and other programs that are not part of public education). In theory, higher expenditures for public elementary and secondary education will improve the quality of public education system. Data for this measure are collected from National Center for Education Statistics.

Share of revenues for public elementary and secondary education is an independent variable that I created on my own for further analysis, and it is the ratio of expenditures for public elementary and secondary education to Total Internal Revenue collections in a state. This variable can tell how much a state is using its government revenues for a major part of public education. A higher share of revenues for public elementary and secondary education will bring about better quality of public education system, ceteris paribus. However, this variable is not used in the first stage of analysis.

Current expenditures per pupil for public elementary and secondary education is the average current expenditures for each pupil in a state. I assumed that higher current expenditures per pupil will result in better quality of public education system. Data for this measure are collected from National Center for Education Statistics.

Public high school 4-year adjusted cohort graduation rate (ACGR) is the ratio of the number of students who graduate from high school in four years with a regular high school diploma to the number of students who form the adjusted cohort for the graduating class. I hypothesized that higher graduation rate will result in better quality of public education system. Data for this measure are obtained from National Center for Education Statistics.

Below is a summary table that include the mean, standard deviation, minimum value, and maximum value for each independent variable.

Summary Statistics of Independent Variables

	mean	sd	min	max
per capita disposable personal income	44152.22	6298.731	33566	61023
poverty rate (percent)	12.098	2.873062	7.2	20.5
Gini index	.46355	.0188461	.418	.5129
total Internal Revenue collections	6.74e+07	8.32e+07	4393700	4.40e+08

expenditures for public education	1.41e+07	1.74e+07	1571670	8.80e+07
current expenditures per pupil for public education	12434.22	3601.089	7206	22861
share of revenues for public education	.2474406	.0885077	.1315492	.4996419
Public high school 4-year ACGR	84.82	4.345723	71	91
N	50			

Because data for all independent variables are collected from the year of 2017, my model is cross-sectional, and the following equation represents my initial model (without share of revenues for public elementary and secondary education):

$$\text{PreK-12 rank}_i=\alpha+\beta_1\text{pcdpi}_i+\beta_2\text{pr}_i+\beta_3\text{gi}_i+\beta_4\text{tirc}_i+\beta_5\text{efpease}_i+\beta_6\text{ceppfpease}_i+\beta_7\text{phs4yacgr}+e_i$$

PreK-12 rank means the predicted rank of PreK-12 education in a certain state, and the independent variables are abbreviated as the combination of first letters from all words that describe them. For instance, pcdpi stands for per capita disposable personal income and pr stands for poverty rate, etc. It is necessary to point out that the dependent variables in this model can

seem a little bit counter-intuitive because it is measured by rank: the state with the best quality of public education system is ranked as number one, and thus higher number in ranking means worse education quality.

This paper also performs diagnostic tests for the analysis. Because some of these independent variables can closely relate to each other, the VIF test is used to detect multicollinearity. In addition, the Ramsey Regression Equation Specification Error Test (RESET) test is used to check for omitted variable bias and the Breusch-Pagan test is used to check for heteroskedasticity.

Results and Discussion

The following chart shows the regression results in the first stage.

	(1) PreK-12 rank	(2) PreK-12 rank
pcdpi	-0.000331	-0.000549
	(-0.69)	(-1.21)
pr	2.535***	2.666***
	(3.34)	(3.51)
gi	-74.10	-104.5
	(-0.66)	(-0.94)
tirc	-0.000000132	

	(-1.30)	
efpease	0.000000660	6.76e-08
	(1.41)	(0.62)
ceppfpease	-0.000542	-0.000135
	(-0.72)	(-0.20)
phs4yacgr	-0.776**	-0.788**
	(-2.13)	(-2.15)
_cons	115.9*	133.5**
	(1.98)	(2.32)
N	50	50
R^2	0.608	0.592
adj. R^2	0.542	0.535

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The first regression indicates that each of these independent variables has a p-value higher than 0.05 except poverty rate and public high school 4-year adjusted cohort graduation rate. Thus, only the coefficients of poverty rate and public high school 4-year adjusted cohort graduation rate are shown as statistically significant. Results from the first regression indicate that ceteris paribus, for every percent increase in poverty rate in a state, the state's PreK-12

education rank increases by approximately 2.535, and for every percent increase in public high school 4-year adjusted cohort graduation rate in a state, the state's PreK-12 education rank decreases by approximately 0.776.

However, one concern in this analysis is the existence of multicollinearity because some independent variables can be closely related to each other. For example, poverty rate may potentially influence Gini index because with more people living under poverty line, income inequality may increase in an area. Also, total Internal Revenue collections may potentially influence expenditures for public elementary and secondary schools because if the government has more revenues, it can provide more funding to improve public schools. After running a VIF test, I find out that tirc and efpease have very high VIF values: tirc has a VIF value of 35.75 and efpease has a VIF value of 33.38. The VIF values of other variables are all below 5. However, results from this VIF test prove the existence of multicollinearity. Thus, I decide to remove the variable with the highest VIF value and run another regression.

The second regression doesn't include tirc, and a new VIF test shows the VIF values of all variables are below 5. Thus, multicollinearity is not a problem in this regression. Similar to the first regression, this regression only has poverty rate and public high school 4-year adjusted cohort graduation rate as statistically significant variables because all other variables have p-values above 0.05. According to this regression, ceteris paribus, for every percent increase in poverty rate in a state, the state's PreK-12 education rank increases by approximately 2.666, and for every percent increase in public high school 4-year adjusted cohort graduation rate in a state, the state's PreK-12 education rank decreases by approximately 0.788.

Another concern is that there may exist omitted variable bias. For example, a state's total number of students in the public education system may potentially affect the analysis: the

number of total students in a state can influence average student-teacher ratio and average expenditures allocated to each student in public schools, which are factors that are often looked at when measuring the quality of education system. Although my model has current expenditures per pupil for public elementary and secondary schools, this factor may not be comprehensive enough because it doesn't include other types of expenditures allocated to each student, such as capital outlays and other programs. Thus, a Ramsey RESET test is run to determine whether there is omitted variable bias. However, this test gives a p-value of 0.4294, which is higher than 0.05, and thus I cannot reject the null hypothesis that this model has no omitted variables. This information indicates that this model doesn't have omitted variable bias and disproves previous assumption.

The Breusch-Pagan test is also used to determine whether there is heteroskedasticity. The result of this test gives a p-value of 0.6642, which is higher than 0.05. Thus, there is not heteroskedasticity in this analysis.

These results, so far are what I have achieved in my first stage of analysis, and after careful deliberation, I decided to make some changes to my analysis model. I, initially, chose to remove the independent variable of per capita disposable personal income. Because "per capita" means "average per person," per capita disposable personal income can be seriously impacted by some outliers such as high-income earners and low-income earners. With the data collected, some states with higher per capita disposable personal incomes have higher poverty rates, and these states clearly have a lot more high-income earners that have dragged the per capita disposable personal income to a higher value. Furthermore, living expenses vary dramatically in each state, people's real expenses for education can vastly differ in each state, too. Thus, I think that per capita disposable personal income is not a reliable economic factor that can potentially

influence the quality of public education system. Secondly, I have come up with a new variable called share of revenues for public elementary and secondary education. It is calculated by dividing expenditures for public elementary and secondary education by Total Internal Revenue collections in a state. This variable shows how much a state is devoting its government revenues to an important component of public education, and I think it is a much better variable because this ratio can tell much more than mere numbers. In the following analysis, I will use the share of revenues for public elementary and secondary education and remove Total Internal Revenue collections and expenditures for public elementary and secondary education. I, then, decided to remove Gini index because most states' Gini indexes are too similar to have contrast significance. For example, only New York state has a Gini index higher than 0.5, and the Gini indexes for all other states range from 0.418 to 0.495. Thus, measures of income inequality in each state are very similar, and having the independent variable of Gini index is not very meaningful. The following chart shows the regression results of my new analysis model with aforementioned changes.

	(1) prek12rank
Pr	2.269***
	(3.93)
Ceppfpease	-0.00111**
	(-2.63)

Sorfpease	34.23*
	(1.99)
phs4yacgr	-0.703**
	(-2.06)
_cons	63.01*
	(1.98)
N	50
R^2	0.603
adj. R^2	0.568

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The new regression shows that each of these independent variables except share of revenues for public elementary and secondary education has a p-value lower than 0.05, and these coefficients are considered as significant. Thus, ceteris paribus, for every percentage increase in poverty rate in a state, the state's PreK-12 education rank increases by approximately 2.269; for every thousand dollars increase in current expenditure per pupil for public elementary and secondary education in a state, the state's PreK-12 education rank decreases by about 1.11; and for every percentage increase in public high school 4-year adjusted cohort graduation rate in a state, the state's PreK-12 education rank decreases by roughly 0.703. When detecting for

multicollinearity, the VIF values of all variables are lower than 5. The model does not appear to suffer from multicollinearity. In addition, the Ramsey RESET test indicates that there is no omitted variable bias and the Breusch-Pagan test tells that there is no heteroskedasticity.

However, it is necessary to point out that the p-value of share of revenues for public elementary and secondary education is 0.052, which is just slightly higher than 0.05. Thus, this coefficient is still significant at the 10% level of significance. The result indicates that, ceteris paribus, for every percentage increase in the share of revenues for public elementary and secondary education in a state, the state's PreK-12 education rank increases by about 0.3423. This result is quite counter-intuitive because that would indicate that if a state spends more government revenues on public elementary and secondary education, its quality of public education system will worsen, while people normally believe that more spending on education will improve the quality of education.

The result of poverty rate corresponds to previous hypothesis that higher poverty rates will result with a poorer quality of public education, and this finding is within my expectation. Because people living below the poverty line don't have enough incomes, they can only afford to live in inexpensive places. However, a major source of funding for public schools is from local real estate tax, and thus the quality of public schools can depend on prices of local houses. As a result, the quality of public schools in poor areas can be negatively influenced by the lack of education funding. Thus, governments should increase efforts to reduce poverty rate and implement relevant policies, such as creating more jobs, increasing benefits to the poor, and promoting universal basic income.

Also, the results for current expenditures per pupil for public elementary and secondary education and public high school 4-year adjusted cohort graduation rate conform to previous

hypotheses and they do make good sense. Higher current expenditures per pupil means each student can receive better educational resources in school, and this will directly improve the quality of education; higher graduation rate means the schools are educating students well, and this proves the quality of the education system. Thus, the government should provide sufficient educational funding and make sure that every student can take advantage of it. The government should encourage high schools to take measures to help students successfully graduate, such as providing enough tutors and counselors.

One shortcoming in this study is that although all data for independent variables are collected from the year of 2017, the ranking system from U.S. News & World Report is not completely based on data from 2017. The metric of college readiness is based on SAT and ACT data from the class of 2018, and the metric of high school graduation rate is based on data for the class of 2016. Thus, there exists some discrepancies in time consistency for data included in this analysis.

Conclusion

While much has been written about education's effects on economic factors, few studies have undertaken the task of determining the effects of a state's economic conditions on the quality of public education system. This paper attempts to do so and finds some very interesting results. First, the higher poverty rate in a state will worsen the quality of public education system in that state. Second, higher current expenditures per pupil for public elementary and secondary education in a state will improve the state's quality of public education system. Third, a higher public high school graduation rate in a state is related to better quality of public education system in that state. Lastly and to my surprise, higher share of revenues for public elementary and secondary education will lead to worse quality, which is counter-intuitive.

These results can give governments important inspirations about methods to improve public schools. Because a higher poverty rate negatively affects education quality in a state, the government should implement policies designed to reduce poverty rate. Some potential methods worth considering include creating new jobs, reducing unemployment rate, increasing benefits for the poor, raising the minimum wage, and providing affordable childcare. When more people jump out of the poverty line, there will be more funding allocated to public education, leading to better education quality. Furthermore, the government should devote enough funding to public education system, make sure that each student can make the most of the educational funding, and motivate high schools to help students graduate successfully. Moreover, the last counter-intuitive result indicates that there might be waste and mismanagement in public school spending, and governments can form independent committees that check whether educational funding is spent effectively on important and necessary areas.

There are also a few suggestions for future research. Because the ranking system used in this paper is not completely based on data from the year of 2017, there are discrepancies in time consistency for data analysis. Future research can look for more rigorous education ranking systems that use data from just one year. Also, future research can include more economic factors that can potentially affect public education quality for a state, such as the total dollar amount of property taxes and municipal bonds, to give a more comprehensive analysis.

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