Oleg A. Smirnov & Neil Reid

The Return on Investment and Economic Value of Toledo Public School System

Urban Affairs Center
The University of Toledo

OLEG A. SMIRNOV AND NEIL REID

THE RETURN ON INVESTMENT AND ECONOMIC VALUE OF TOLEDO PUBLIC SCHOOL SYSTEM

URBAN AFFAIRS CENTER
THE UNIVERSITY OF TOLEDO

PUBLISHED BY URBAN AFFAIRS CENTER
THE UNIVERSITY OF TOLEDO

First printing, July 2014

Contents

List of Figures

List of Tables

Executive Summary

The Toledo Public School District is the largest school district in Lucas County, Ohio, and the fifth-largest school district in the state of Ohio. With an annual budget in excess of $400 mln ($412 mln in FY 2012-13), it is one of the most valuable public enterprises in Lucas County with an economic footprint that spreads beyond the city limits into the wider local economy. The effectiveness of local public investments in education is characterized by the following results:

1. for every $1,000 of locally-originated expenditures per pupil in the district, the percentage of students who pass the Ohio Graduation Tests (OGT) increases by 0.28 percent;
2. a one percentage point increase in academic achievement (measured as percentage of students who pass the OGT) results in an increase of the average annual earnings in the local economy by $13;
3. a one percentage point increase in academic achievement results in the increase of the average personal income in the local economy by $3,011 per year;
4. a one percentage point increase in academic achievement results in an increase of employment in the

local economy by up to 0.052 percentage points of the total population in the locality;

5. altogether, for every dollar of locally-funded public education, the economy receives back between $4.0 and $5.6.

THE PERFORMANCE of the school district is sensitive to the local public's willingness to support public education. Out of an array of factors with potentially strong positive effects on public education, the amount of local taxes in the district's revenue is identified as the only significant factor that falls within the reach of public policy. Local support for public education is a unique public policy variable that shows a consistent positive effect on the academic achievement in the district; as such, it cannot be substituted with support from any other source of funding (either state or federal), which have negative effects on academic achievement.

THE ECONOMIC IMPACT of TPS is determined by the sheer size of the TPS budget, which is indicative of the cost of education but it does not directly translate into the district's performance or the quality of education. In contrast, the economic value of public education is linked to the quality of education; it is measured my district graduates' preparedness for the labor market or college – not the amount of money spent on their education. The investment component of these expenditures is equal to local proper taxes spent on public education. Hence, the return on investment is defined as a response of the district's average academic achievement to a change in per pupil's level of tax revenue, which is estimated to be of 0.28 percent per $1,000. That is, spending extra $1,000 per pupil increases hit or her changes of passing OGT by 0.28 percent.

THE ECONOMIC VALUE of academic achievement has a profound effect on the functioning of the local labor market. The indication of the economic value of a quality education is measured by the effect of the previous year's academic achievement in the district on the local economic variables of average earnings, per capita income, and labor force participation. Meeting higher academic performance benchmarks in TPS is instrumental for boosting economic growth in the local economy and increasing standards of living. The overall effect implies a $4.00 – $5.60 average return to local residents for each dollar committed to improving the quality of public education.

A JOB-CREATING effect of an improvement of public education is very important for TPS and the local economy. Given the significant potential for improving academic achievement in the district, a one percentage point increase in academic achievement implies an improvement in the employment/total population ratio of up to 0.052 percentage points. This translates into 0.35 new jobs per 1,000 district residents. Not only do new jobs increase average earnings, the investment in public education is one of the most cost-effective job-creation policies.

Introduction

Toledo City Public Schools District is the largest school district in Lucas County, Ohio, and the fifth largest school district in the state of Ohio. In academic year 2012–2013, with 21,233 students, it was was triple the size of the next-biggest school district in Lucas County, the Sylvania City school district.[1] As of 2013, the district serves the community through its network of 61 schools and academies, operates two preschool locations, and a number of local learning centers including an adult education center.

[1] Ohio Department of Education. *District Profile Report* http://education.ohio.gov/Topics/ Finance-and-Funding/Finance-Related-Data/District-Profile-Reports/FY2013-District-Profile-Report

Given the sheer size of the district and its relevance in educating students for both the labor force and college contingent, the economic impact of TPS on the city of Toledo, Lucas county, and wider economy is large. However, the quantitative assessment of the impact is important for shedding the light on the relevance of TPS for the local economy.

The objective of the current study is three-fold:

(a) identify relevant factors affecting the performance of TPS and estimate their contributions to the performance of the school district;
(b) define and estimate the return on investment – a mea-

sure of academic achievement relative to the district's taxpayer's contribution; and

(c) quantify the effect of academic achievement on the various relevant aspects of the local community's economic performance.

The statistical data for this report are compiled from numerous data sources that include Ohio School Report Cards for a number of years.[2]

[2] Ohio Department of Education *Ohio School Report Cards* http://reportcard.education.ohio.gov/ Pages/default.aspx

As an important social institution, public schools have been around for many decades so that it seems that public schools have been here almost forever. As an institution, public schools have ups and downs, enjoying success stories and learning to overcome disappointments and failures. If successes and contribution of the public schools to the society are not fully recognized, the imperfections are more apparent. In the United States, many people are dissatisfied with the performance of public schools.[3] But what are the contributions of public schools to the society and how relevant they are for the community's future?

[3] Hanushek, Eric A. (2006) Alternative school policies and the benefits of general cognitive skills, *Economics of Education Review, Vol. 25*, 447–462

Public perceptions about public schools affect the level of attention and financial resources public schools receive. According to a comprehensive study of education across major economies commissined by the Organization for Economic Cooperation and Development,[4]:

(a) the odds that a young person in the U.S. will be in higher education if his or her parents do not have an upper secondary education are just 29% – one of the lowest levels among OECD countries;

(b) the unemployment rate among 25–64 year olds with no high-school diploma is 16.2% (12.6% OECD average), which is 9th highest among 36 OECD countries;

(c) the average earnings penalty for 25–64 year olds

[4] OECD. (2013) *Education at a Glance 2012: OECD Indicators*, OECD, Directorate for Education and Skills. http://www.oecd.org/edu/United States _EAG2013 Country Note.pdf

who have not attained a high school diploma is 64% (OECD average is 76%);

(d) the U.S ranks 25th (out of 36 countries) in the percentage of 4-year-olds in early childhood education, with a 78% enrollment rate (OECD average 84%);

(e) primary teachers in the U.S. spend almost 1100 hours a year teaching (OECD average is 790 hours) — much more than in almost every country; upper secondary school teachers spend about 1050 hours a year (OECD average is 664 hours);

(f) across all OECD countries, 30% of the expenditure on higher education comes from private sources, while in the U.S., 62% does.

The OECD study also identifies that the level of attainment of higher education among younger Americans (25-34 years old) lags the nation's average (that is, this age cohort in the USA lags other age cohorts in educational attainment) and is not as favorable in comparison to other developed nations. All these indications prompt simple questions: how to determine the economic value of public education and how to assess the return on investment in public education?

ROI: Methodology

The concept of return on investment in public education has received substantial attention in the literature attempting to summarize the efficacy of public education as a social institution. There is an immense body of literature studying the relationship between the resources spent on public education and educational outcomes such as performance on education tests, graduation rates, college acceptance rates, and other measures. While many aspects of the public education system can be learned from existing literature,[5] it is impossible to review all of the findings in a single report[6]. Nonetheless, it is worthy to note that the predominant thinking of value of schools' resources to students' achievements has been evolving around a simple formula that more money spent on education delivers a better quality of education[7]. It is not surprising that these studies are being invoked predominantly by the proponents of spending more resources on public education as means for achieving better educational outcomes.

The single-sidedness and apparent methodological deficiency of the over-simplified formula "more resources = better education" not only oversimplifies and distorts the

[5] Weiss, Jonathan D. (2004) *Public Schools and Economics Development: What the Research Shows* KnowledgeWorks Foundation, KnowledgeWorks Foundation, Cincinnati, OH

[6] Hampdel, Martin. (2005) Measuring Educational Productivity in Standards-Based Accountability Systems," *OECD Education Working Papers, No. 4*, OECD Publishing. http://dx.doi.org/10.1787/224417012465

[7] Boser, Ulrich (2011). *Return on Educational Investment. A district-by-district evaluation of U.S. educational productivity.* www.americanprogress.org

real contribution of teachers and public education administrators, but also obscures a meaningful societal debate about the merits and issues of public education. The key reason frequently cited in public policy debate is the fact that despite ever increasing amount of resources per pupil spent in the U.S., the educational attainment of students (measured as the U.S. standing in the ranking among developed countries) has been steadily declining. Consequently, the expenditures and attainment moving in the opposite directions suggests a negative impact on student attainment from further increasing of expenditures per student. For instance, although the U.S. spend about 13.1% of total public expenditures on education (OECD average is 13.0 %), the percentage of young people expected to complete high school is 77% (OECD average is 84%)[8] and the competence in reading, mathematics, and sciences in the U.S continues to decline.[9]

[8] OECD. (2013) *Education at a Glance 2012: OECD Indicators,* OECD, Directorate for Education and Skills. http://www.oecd.org/edu/United States _EAG2013 Country Note.pdf

[9] OECD: Program for International Student Assessment (PISA) PISA 2012 Results in Focus http://www.oecd.org/pisa/keyfindings/pisa-2012-results.htm

Huge discrepancies in reported assessments of return on investment in public education is troubling for two reasons. First, it creates public distrust in empirical analysis of performance of public education, which – if settled – becomes difficult to overcome. Second, the measurement of economic impact of public schools on the local economy is obscured by lack of understanding of what affects performance of public schools and what role does their performance play in the local economy.

ROI: Theoretical Framework

Given evidence suggests that either conclusion – an extremely optimistic or an overly pessimistic – is remote from being useful for estimating the return on investment in public education. The purpose of this study is to utilize an unbiased, theory-based approach for assessing the return on in-

vestment in public education. Here we highlight four steps toward this goal:

(a) outline an economic theory-based framework for characterizing the provision of public education;
(b) identify relevant and potentially relevant factors affecting educational outcomes using the theory-based framework;
(c) identify a procedure for quantifying the factor impacts on educational outcomes and assessing the accuracy of the measurements; and
(d) qualify and quantify the return on investment in public education for TPS.

Toledo Public School District is the producer and the entire population of the District is the intended consumer of the public education.[10] In a classical economic theory analysis, the behavior of producer is described by supply and the behavior of consumer is described by demand. The distinction between the two is important to avoid the pitfalls and false conclusions that are common in theoretically-unprepared studies. Under normal circumstances, both consumers and producers are price-takers (they assume that the price of the good is determined by the market) and their decision variable is the quantity of the good supplied (for producers) and demanded (for consumers). The synthesis of supply and demand yields the point of (market) equilibrium, thus determining the quantity and price of the good (Figure 1).

[10] Smirnov, Oleg A. (2014) What is investment in public education and how to measure return on it? Working paper. Department of Economics, University of Toledo

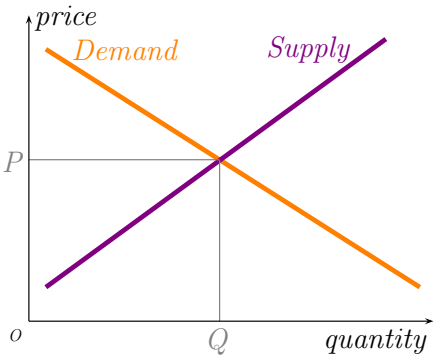

Figure 1: Private good market: the equilibrium price (P) and quantity (Q) are the interplay of Demand and Supply.

Theoretical consequences of districts being exposed to different Supply curves and different Demand curves would be the situation that across-the-district variations in equilibrium levels would be determined by the interplay of district-specific demand and supply conditions. In contrast, if all districts are placed in similar conditions (uniformity of labor

laws, educations standards, school year, etc.), behaviors of districts will be identical.

UNLIKE common private goods, which are excludable and rival in consumption, the district produces education – a public good. The specific distinction of this public good is that the district has no direct control over the quantity of education (the number of students eligible to attend the school). In this respect, the district differs substantially from the private good provider, and the quantity of the good supplied is no longer the relevant decision variable for the district. For these reasons, the supply curve (per student) in Figure 2 is depicted as nearly vertical to indicate the fact that the district accommodates whatever number of students choose to attend public schools.

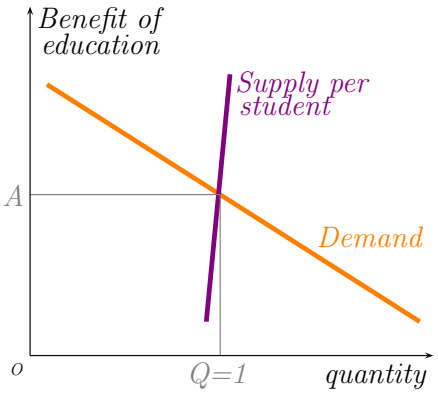

Figure 2: Public education equilibrium: when Supply Per Student tudent is extremely inelastic, Academic achievement (A) is determined by the Demand (Per Student) curve.

TO CLARIFY THE ARGUMENT, the supply-side factors are all pertaining to aspects of the school district that affect its cost (marginal cost in the short-run and average cost in the long-run) of providing the public good. Specifically, these factors include

1. wages of personnel directly involved in instruction (teachers) and their benefits;
2. average class size (students per teacher ratio);
3. wages of school administrators, other staff and their benefits;
4. expenditures on materials and supplies;
5. expenditures for maintaining buildings to the extent as they vary with the number of students; and
6. some subsidies from state and federal government agencies (as these offset the cost of providing education per student).

All of these components are observable, stable and well-documented measures of district performance and, conse-

quently, are available for further economic analysis of the supply side of public education.

In contrast, the demand for education downward-sloped curve, which in part reflects the point that Demand for education reflects households willingness to pay for public education regardless of whether it is provided as a public good or a private good. It should be noted, however, that the financing of public goods differs dramatically from how private goods are paid for. In this respect, Demand for public education is unaffected by the fact that it is provided as public good. As with most public goods, the specific household-level benefit from public education is impossible to directly observe and include in any meaningful economic analysis. In an ideal but non-realistic world, the district's willingness to pay for public education affects the equilibrium state of the provision of the public good and hence, the equilibrium level of academic achievement in the district (Figure 2). In reality, households' the willingness to pay for public education is not directly observed. For these reasons, one has to rely on quantifying and estimating the influence of factors that affect the demand for public education. Therefore, *the constructive way to quantify the parameters of the demand for public education is to relate (a typical) district's households' public education contributions to actual academic achievements by the students of that district*. This contribution is well-observed and documented – it is equal to the amount of property taxes used to finance a local public school district. However, there are other factors that affect the slope and position of the demand curve.

Demand factors include

1. income: households with higher income tend to exhibit higher demand for normal and luxury goods

(an increase in income shifts the demand curve to the right);
2. wealth: wealthy households tend to demand higher volumes of normal and luxury goods (an increase in wealth shifts the demand curve to the right);
3. poverty: districts with higher levels of poverty (other things being equal) tend to demand less of education (an increase in poverty shifts the demand curve to the left);
4. parental educational attainment: children of parents with low level of educational attainment tend to exhibit smaller demand for public education (an increase in parent's educational attainment shifts the demand curve to the right).

NOTE, that the approach of relating district households' expenditures on public education to academic achievements of students in the district differs dramatically from earlier attempts to quantify return on investment in public education. First, the proposed approach evolves from the commonly used Demand and Supply framework. A solid theoretical framework is important for better understanding the fundamental relationships between investments in public education and returns on these investments. The use of the Supply and Demand framework allows us to make consistent with empirical evidence, non-contradictory analysis.[11] Second, components of the district's cost of production and factors affecting Supply do not constitute investments in public education, so none of them is expected to have a measurable positive return.

[11] Smirnov, Oleg A. (2014) What is investment in public education and how to measure return on it? Working paper. Department of Economics, University of Toledo

TO SUMMARIZE, the basic idea of the analysis is to separate the impact of investment in public education from other factors, and quantify the effect of investments on academic

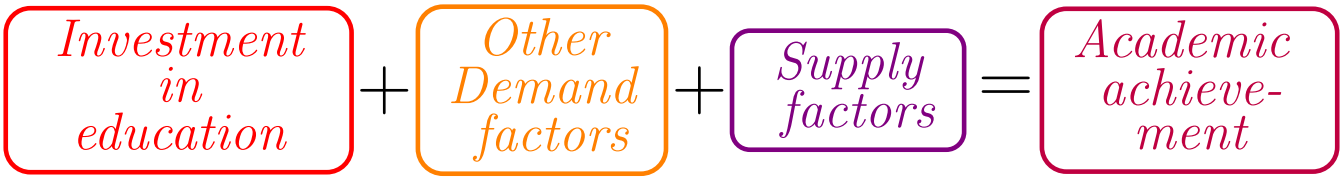

Figure 3: Investment in public education and other factors of academic achievement.

achievement as depicted on Figure 3.

ROI: Measurement

THE KEY to accurate measurement of the return on investment in public education is to insulate the effect of a change in investment from other factors. From an economic perspective, when other factors are held constant, a measurable change in the academic achievement is attributed to a measurable change in the level of investments (see Figure 4).

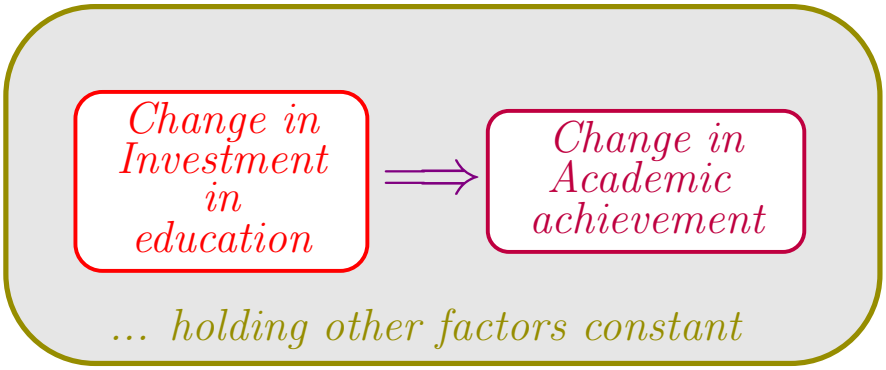

Figure 4: Setting a new level of investment in public education leads to a new level of academic achievement.

POTENTIALLY, the relationship between the investment in public education and academic achievement is possible to identify and quantify using empirical data. The critical complicating aspect of making statistical inference using empirical data is that the data are not the result of a scientific experiment, so the statistical inference typical for experimental data should be avoided in favor of methods and models that are more appropriate for observational studies. The unit of

analysis here is a school district because the economically independent producer is a school district – given that school districts have the authority to allocate resources between the schools, a school is not independent producer of education. Therefore, all relevant data concerning the supply side are to be aggregated to the level of school district even when the data by schools are available. The consumer of the school district's production is the entire population residing within the school district. Therefore, the data concerning academic achievement and other demand factors are also aggregated by school districts.

THE DATA for this study were collected over all 610 school districts in the State of Ohio and covers three time periods of observations: FY2012–13, FY2011–12, and FY2010–11. The source of data is the set of Ohio School Report Cards[12]. The dataset comprises of indicators of academic achievement, socioeconomic characteristics of districts' population and student body, indicators of districts' expenditures, and sources of districts' revenues. The complete list of variables collected for this study is provided in Appendix A1. As an indicator of academic achievement, we use Ohio Graduate Test (OGT) results, which comprise official State of Ohio tests in five subjects: Reading, Mathematics, Writing, Social Studies, and Sciences. This test is an objective (does not depend on district's wishes), nontrivial (no districts have all maximally possible scores), and uniform (State-level standards apply to all districts) across all public school districts. Its use in this study makes it possible to quantify academic achievements of students in the district. To summarize academic achievements over five subjects, we computed a synthetic variable, which is the average of the five OGT test results for all Ohio school districts.

[12] Ohio Department of Education *Ohio School Report Cards* http://reportcard.education.ohio.gov/ Pages/default.aspx

THE EXTENSIVE list of factors affecting the demand for education in the district as well factors affecting the supply of education by the district are provided in Appendix A1. A preliminary inspection of the dataset established that only one school district (Put-in-Bay) contains incomplete records in part because the district is so small that in some years there are no students taking the OGT. Given that this is an outlier, further analysis was performed using perfectly balanced panel data that comprises 609 Ohio school districts. Each of the districts is viewed as a local monopoly in producing public education.

THE USE OF PANEL DATA for this study is important because unlike cross-section data-based studies, panel data are needed for estimating panel data models. Specifically, the panel data are needed for estimating panel data models with random effects, that generally are written as follows:

$$y_{it} = X'_{it}\beta + u_i + \varepsilon_{it}, \qquad (1)$$

where y_{it} is academic achievement by students of district i at time period t, X_{it} is a $1 \times k$ vector of regressors (explanatory variables), β is a $k \times 1$ vector of coefficients, each of the coefficients is the marginal effect of the corresponding regressor on academic achievement, u_i is the district-specific (unobserved) combination of socio-economic, demographic, and other factors (from either Supply or Demand sides), and ε_{it} is the stochastic error term at district i and time period t, which is the effect of unobserved influences. Under fairly mild conditions, that require that district-specific factors do not change over the entire time span, and the error terms do not correlate with observed regressors, the model can be estimated by established statistical techniques, such as maximum likelihood or method of moments, so that the estimates of β are consistent and unbiased.

THE STRONGEST ADVANTAGE of model (1) against a cross-section model

$$y_{it} = X'_{it}\beta + \varepsilon_{it},$$

is in the robustness of estimates of parameters β when some of relevant regressors (factors) are missing but these unobserved factors are constant over time. For example, suppose the population density in the district is an important factor but is not included in the set of regressors. As long as population density does not change dramatically over time, the estimates of β from random effects panel data model are unbiased and consistent, whereas estimates of β from a cross-section model are subject to omitted variable bias. Unless the omitted variables are explicitly brought in the analysis, the omitted variable issue persists even in large datasets. In sum, the random effects panel data model is commonly used in the literature for dealing with omitted variable issues as well as endogeneity, which is frequently a factor of many econometric models.

ELIMINATING omitted variables and endogeneity concerns in random effects panel data model (1) enables one to effectively relate the change in investment to a corresponding change in academic achievement (Figure 4). Consequently, the panel data estimation results can be summarized in the form of ROI formula:

This formula defines the procedure for computing a typical improvement (or a deterioration) in the district's academic achievement from a $1 increase (or decrease) in investment in public education. It is important to underscore that the implied approach is independent of any assumptions about the values of return on investments in public education. Specifically, if the return on public education is positive (as is stressed by the first group of studies identified

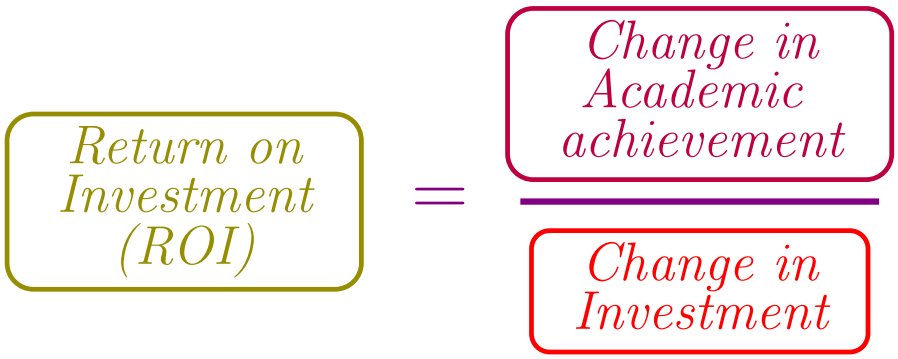

Figure 5: Return on Investment (ROI) is defined as a change in academic achievement associated with a change of investment by $1.

in the first section of this report), the coefficient from the formula in Figure 5 will have a positive value. In contrast, if it is negative (as implied by alternative theories' proponents), the coefficient will have a negative value.

The combination of the strong theoretical model and reliance on statistical analysis is critical for providing an unbiased estimate of return on investment (as a numerical value) and providing a confidence interval for that estimate, which is relevant for determining the level of uncertainty associated with computed coefficients.

ROI: Empirical Results

The framework described above was applied to estimate ROI in Ohio public education. We have used a random-effects panel data model to measure the effect of various Supply- and Demand-side factors of public education on academic achievement. Descriptive statistics of key variables for Ohio public school districts are provided in Appendix A2. We also highlighted average (across three-year period of 2010–11, 2011–12, and 2012–13) for the Toledo City public schools. In all tested models, the dependent variable is the average of the five-subject Ohio Graduation Tests (OGT). The models differ in the emphasis on supply-only, demand-only, or supply and demand factors.

To skip the details of the model selection process, we focus on the model specification that we found to be relevant for (1) demonstrating the correctness of the made assumptions, and (2) quantifying the return on investment. The model is

specified as follows:

$$\begin{aligned} OGT\_AVE_{it} = {} & \beta_0 + \beta_1 TEA\_SAL_{it} + \beta_2 ADMIN\_SAL_{it} + \beta_3 TEACH\_RATIO_{it} \\ & + \beta_4 FED\_REV_{it} + \beta_5 STATE\_REV_{it} + \beta_6 LOC\_REV_{it} \\ & + \beta_7 MED\_INC_{it} + \beta_8 POVERTY_{it} + \beta_9 RACE\_BL_{it} \\ & + u_i + \varepsilon_{it}, \end{aligned}$$

where OGT_AVE_{it} is the weighted average of the five OGT percentages for the school district i in time period t,

1. *Supply factors*

   TEA_SAL_{it} is the teacher's salary in time period t in school district i (excludes fringe benefits),
   $ADMIN\_SAL_{it}$ is the salary of administrators in time period t in school district i (excludes fringe benefits),
   $TEACH\_RATIO_{it}$ is the student-teacher ratio in time period t in school district i,

2. *Other supply factors*

   FED_REV_{it} is the amount received by district i from the federal government, per pupil,
   $STATE\_REV_{it}$ is the amount received by district i from the state government, per pupil,

3. *Investments in education*

   LOC_REV_{it} is the amount received by district i from local revenue (local property taxes), per pupil,

4. *Demand factors*

   MED_INC_{it} is the median income in district i, time period t,
   $POVERTY_{it}$ percentage of students living in poverty in district i,
   $RACE\_BL_{it}$ percentage of black students in district i, time period t,

$u_i \sim N(0, \sigma_u^2)$ and ε_{it} are independently identically distributed with mean zero and variance $\sigma_\varepsilon < \infty$.

REMARKS ON THE MODEL. All model coefficients β indicate marginal effects of the corresponding variables on academic achievement. For example, β_1 is a measure of the mean of improvement in OGT_AVE from an increase in TEA_SAL by \$1. In this respect, all districts are assumed to be equally responsive to exogenous changes in the values of regressors. However, random effects u_i signify districts' specific combination of conditions that do not need to be observed or measured but which might be responsible for observed differences in the attained levels of academic achievements even if the marginal effects across districts are identical. Variable $RACE\_BL$ is used as a proxy for parental level of educational attainment because these are known to be positively correlated but data on educational attainment of parents is unavailable by school districts. District's median income (MED_INC) correlates with poverty ($POVERTY$). The combination of the two variables is indicative of income inequality among households in the district.

The summary of the regression statistics is provided in Appendix A3. The notable statistic is that the overall coefficient of determination is 0.69; that is the model explains just over two-thirds of the total variation in academic achievement across districts. The model performs well in explaining inter-district variation, but has little significance in explaining (predicting) within the district trends. The latter effect might be associated with insufficient data – we have collected data only over three consecutive time periods; that is there are only three observations over each school district. Table 1 summarizes the measurements of the marginal effects using the panel data model.

Factor	Effect	Value	Std. Error
TEA_SAL	none	—	—
ADMIN_SAL	none	—	—
TEACH_RATIO	none	—	—
FED_REV	strong	-0.00199	0.00038
STATE_REV	strong	-0.00057	0.00014
LOC_REV_{it}	strong	0.00028	0.00009
MED_INC	strong	0.00012	0.00003
POVERTY	strong	-11.676	1.231
$RACE\_BL_{it}$	strong	-16.536	1.116

Table 1: The summary of marginal effects in the panel data model

The results of the empirical analysis indicate the following public education trends in Ohio public school districts:

(a) supply factors pertaining to labor markets (salaries of teachers and salaries of administrators) have no statistically significant effect on average performance of students in Ohio graduation tests;

(b) average across the district student-teacher ratio has neither a positive nor negative effect on academic achievement;

(c) both federal and state sources of funding of school districts have a statistically negative effect on academic achievement;

(d) local expenditures on public education have strong positive effects on academic achievement;

(e) factors of income, poverty, and socioeconomic predisposition to education play important roles in defining other (non tax related) aspects of demand for public education; and

(f) there are only two variables that have strong positive effects on academic achievement: median income of households in the district and per pupil expenditures from local taxes.

Result (a) suggests that although there is quite substantial

variation in the salaries of educators across school districts, this variation pertains rather to the conditions on the local labor market (the prevailing wage on the labor market in a particular location) rather than academic achievement of students. This result, however, does not contradict to the possibility of within-the-district variation in teacher's salary to be in part explained by the teacher's performance.

Result (b) might have more to do with the fact that classroom size is an across-the-state regulated parameter, so that many school districts have little or no control over the classroom size. Consequently, classroom size is affected by the demographic trends in the school district and varies over time.

Result (c) is statistically significant and indicates that the more federal and state monies that are spent in a school district, the lower the level of academic achievement in that school district. Evidently, the federal and state funding affects some other aspects of school district operations, but the district averages of academic achievements are affected detrimentally. For instance, federal and state funding might increase accessibility of public education.

Result (d) is one of the key findings of this study – it enables one to quantify the return on investment in public education. The combination of results (c) and (d) suggests that the source of funding (and the purpose of funding) of public schools is an important factor in determining the quality of public education. This implies that it would be erroneous to conclude (as some empirical studies alluded to) that an increase in educational expenditures automatically implies an improvement in academic achievements. Empirical evidence suggests that academic achievement is much more sensitive (and is positively correlated to) local sources of funding. This suggests that academic achievement is determined by a local community's commitment to public education and its

willingness to contribute (through taxes) to improvement in local public education.

Result (f) suggests that the economic well-being of district households has positive effect on academic achievement. It also shows that economic well-being (median income) alone is unable to explain academic achievement – the amount of local taxes contributed to public education is an equally significant factor.

Local tax is the only public policy variable that has strong positive effect on academic achievement of pupils in public education systemm.

The return on investment in public education for school districts in Ohio is equal to 0.00028 per $1 of local expenditures per pupil. In other words, an additional $1,000 per student leads to 0.28 points increase in academic achievement measured by OGT results. The standard error of this effect is 0.00009 points per $1, or 0.09 points per $1,000 spent per pupil from local taxes. The result is statistically significant; that is, empirical evidence suggests that with probability of more than 99 percent that indeed a local tax has a positive influence on academic achievements of students in the local public schools.

An increase in local support of the school district improves district's performance on OGT at the rate of 0.28 points per $1,000 per pupil.

Do Subjects Matter?

In addition to the model described in the previous section, we have also quantified five subject-specific models:

$$\begin{aligned} OGT\_SUBJECT_{it} = {} & \beta_0 + \beta_1 TEA\_SAL_{it} + \beta_2 ADMIN\_SAL_{it} + \beta_3 TEACH\_RATIO_{it} \\ & + \beta_4 FED\_REV_{it} + \beta_5 STATE\_REV_{it} + \beta_6 LOC\_REV_{it} \\ & + \beta_7 MED\_INC_{it} + \beta_8 POVERTY_{it} + \beta_9 RACE\_BL_{it} \\ & + u_i + \varepsilon_{it}, \end{aligned}$$

where $OGT\_SUBJECT$ stands for one of each of the subjects: OGT_READ, OGT_MATH, OGT_WRITE, OGT_SS, and OGT_SCI. Estimation results for these models are provided in Appendix A3. Table 2 summarizes the relevant effect of investment in public education on subject-specific academic achievement.

Table 2: The summary of estimates of ROI in subject-specific panel data models

Subject	ROI	Std.Err.	Pr >z	Effect
Reading	.00019	.00008	0.023	positive
Mathematics	.00022	.00011	0.044	positive
Writing	-.00014	.00010	0.155	none
Social Studies	.00030	.00012	0.016	positive
Science	.00051	.00013	0.000	strongly positive

Table 2 suggests ROI varies by subjects; that is investments in public education produce returns that are different across subjects. The strongest effect of local taxes on public education is observed in *Science*. The next best-affected subject is *Social Studies*. Student's performance in *Writing* appears to be unaffected by local taxes. Academic achievement in *Reading* and *Mathematics* shows an intermediate level of responsiveness to local taxes.

Although the mechanics of districts' students on OGTs might vary dramatically across public school districts in Ohio, a certain tendency is apparent from these five test results. It is a common phenomenon that teachers of languages and arts are typically paid less than teachers in natural sciences, mathematics, and technologies. Therefore, one of the possible explanations of what is observed in Table 2 is that districts with strong local taxes (stronger Demand for desirable skills) tend to offer better curriculum in *Sciences* rather than languages. In contrast, districts with low local tax support and strenuous budgets are compelled to offer a less costly curriculum, which would be heavy in languages, so these students tend to perform relatively better in *Writing*. A preliminary support to this claim can be found in Appendix A3 – OGT: Writing is the only model where student achievement is negatively correlated with average teachers' salaries in the district. It should be noted that the effect is

This argument also helps to explain a previously mentioned conclusion that *average* teachers salaries have no apparent effect on average OGT results.

small: a $1,000 increase in average teachers' salary leads to a drop in Writing by 0.07 points. Also, the results for writing show that the within-district variation in academic achievement in Writing is related to changes in districts' conditions (this is the only model with double-digit within variation explained by the model). Another component of the explanation of this phenomenon is a hypothesis that teachers who are designated to teach languages or other writing-intensive classes earn smaller salaries than those who teach other classes. A district, heavily skewed toward hiring these teachers would have lower average teacher salaries and better writing students (at the expense of other subjects as indicated by average OGT).

ROI: Summary

IN SUM, the return on investment in public education for school districts in Ohio is equal to 0.00028 per $1 of local expenditures per pupil. In other words, an additional $1,000 of local expenditures per student leads to 0.28 points increase in academic achievement measured by the average OGT results.

AMONG ALL REVENUE-RELATED and local school district variables, local tax is found to be the only variable that has a statistically significant positive effect on academic achievement of students in public school districts – all other variables either have negative (detrimental) no measurable effects on academic achievement. It should be noted that the measurements here are made at the school district level, so that within the district policies on academic achievements have not been studied.

THE PRIMARY BENEFICIARY of an increase in local taxes are

academic achievements in *Science* followed by *Social Studies* and *Mathematics*. Investment in public education has no statistically significant effect on academic achievement in *Writing*. It should be noted that in the Toledo City public school district the worst-performing subject is *Science* (see Appendix A2) – only 61.7% of the district's students have passed *Science* during 2010–2013 period.

Accessing Economic Value of Public Education

The economic value of public education comprises two somewhat interrelated aspects: individual level and community level. At the individual level, a higher level of attained education benefits the individual by enhancing quality of life, opening new career opportunities, reducing the chances of being unemployed or employed in a low-wage position, etc. Better-educated individuals are less likely to be a public burden (e.g., receiving unemployment or Medicaid payments), demand assistance from public finances, or commit violent crimes. Since the population mobility in the U.S. is relatively high, the individual (human capital) benefits of education acquired in one community travels with that individual and can thus be enjoyed by other communities – depending on the individuals' choice of his or her residence, employment, or other social activities. In this respect, since public education enhances individually owned human capital, the question is if and how do public expenditures on education benefit the locality that has supported these expenditures via property taxes.

THE IMPACT of public education on state and local economic growth has been intensely studied in the past using various techniques. A useful survey of these studies and the summary of their conclusions indicate that good public education is pivotal for faster and more robust economic growth in the local economy.[13] However, it is underscored that economic development requires more than good public schools. Public schools are identified as an important tool of economic development policy as regions with great educational systems and little else manage to surpass others in economic development. This conclusion echoes conclusions drawn from many international studies [14] as well as specific policies' analysis.[15]

[13] Weiss, Jonathan D. (2004) *Public Schools and Economics Development: What the Research Shows* KnowledgeWorks Foundation, KnowledgeWorks Foundation, Cincinnati, OH

[14] OECD. (2013) *Education at a Glance 2012: OECD Indicators,* OECD, Directorate for Education and Skills. http://www.oecd.org/edu/United States _EAG2013 Country Note.pdf

[15] Hanushek, Eric A. (2006) Alternative school policies and the benefits of general cognitive skills, *Economics of Education Review, Vol. 25,* 447–462

IN PRACTICE, the empirical measurement of the effect of public education on economic growth encounters methodological and econometric issues.[16] Conceptually, the difficulty arises from the fact that human capital – the set of individual's skills and knowledge – is an intangible asset and as such has characteristics of an asset but cannot be directly observed and quantified. Many studies focus on quantifying its benefit for individuals which is quite different from its effect on the local or overall economy. It is hypothesized that the mechanism through which public education influences local economic growth involves social networks or social capital, but concrete measurements of these ephemeric constructs is methodologically problematic because these are difficult to observe directly. Alternative measurements (via quantifying public perceptions) run into typical non-market valuation problems and concern with public opinions on economic issues rather than with the factitious state of the economy. Consequently, researchers suggest the use of instrumental variables – such as use of property valuations as a proxy of economic development – to measure the difficult-

[16] Richter, Francisca G.-C., and Lisa Nelson. The Prospects of Non-College-Bound Workers in the Fourth District Cleveland Federal Reserve Bank Working paper Series

to-observe effects.[17]

[17] Barrow, Lisa, and Cecila Elena Rouse. (2002) Using Market Valuation to Assess Public School Spending NBER Working paper No. 9054

THE TRIED AND TESTED ECONOMIC IMPACT analysis has been used widely for quantifying the effect of education spending on state and local economies. Weiss[18] argues that most studies found either positive or "a significant positive" relationship between public education spending and economic development. An exemplary study of Virginia Beach schools[19] unwarrantably assumes that any expenditures on public education – regardless of their agenda or purpose – are equally productive, hence, must have a positive effect on the local economy, real estate values, etc. In practice, an unscrupulous mix of productive and unproductive expenditures obscures the analysis and complicates an objective quantification of real effects.

[18] Weiss, Jonathan D. (2004) *Public Schools and Economics Development: What the Research Shows* KnowledgeWorks Foundation, KnowledgeWorks Foundation, Cincinnati, OH

[19] Walden, Michael L. (2012) Quantifying the Successes of Public Schools, *School Administrator, Vol. 69 (6),* 20–25

The serious methodological simplification (a "shortcut") requires one to assume that the value of effect exerted by public education on the rest of the economy is equivalent to the value of resources the society commits to public education. Indeed, in economic analysis, where equilibrium is an important starting point of the analysis, it is safe to assume that under quite reasonable assumptions, the value of what is produced is equal to the sum of values of resources. In a competitive economy, resources are allocated and reallocated in a way to foster this relationship and on average there is no way to arbitrary improve competitive (market) economy outcomes. However, education is a public good and market economy tends to incorrectly allocate resources to such goods. In other words, "you get what you paid for" is an oversimplified paradigm of assessing the value of public education and frequently is misleading. Consequently, the key aspect of the proper analysis involves differentiating value of resources committed to public education from the value of the product of public education.

In the previous chapter, we have highlighted the point that the product of public education (an improvement of human capital) is typically measured by academic achievements. We have also concluded that the profoundly significant resource that positively affects academic achievement is local expenditures on public education. In fact, our results indicated that it is the only source of revenues of public school districts that positively influences average academic achievement in the district. Consequently, it would be erroneous to assume that the value of the output of the public school district is simply identical to its revenue. Hence, in studying the effect of public education on the local economy, one has to focus on the measures of human capital – regardless of how difficult it is to quantify them – rather than assume that district's total revenue is automatically equivalent to its output.

District's total revenue is its total cost of production, while district's academic achievement of its pupils is its total output.

Measuring Economic Value of Public Education

A systematic approach to quantifying the local communal (rather than individual) effect of public education on the local economy is to pursue the approach favored in economics where only the cause and the result are allowed to vary, while all other factors are held constant. This paradigm is very important for the scientific approach in economics but its implementation is problematic because – unlike in natural sciences – social sciences are unable to stage and properly measure the results of social experiments. Hence, most of the empirical studies are observational studies, where the data are *ex post* outcomes of 'naturally' occurring activities rather the result of a thorough scientific experiment.

An econometric approach to circumvent the problem

of the lack of experimental data in economic studies is to observe "naturally" occurring behavior of socioeconomic systems and establish (or undertake a statistical testing) empirical regularities between their various aspects. For this, we turn to a panel data model, and here we highlight the rationale for this approach. Suppose we observe an important variable, such as wealth, and we are interested in how it is affected by the Human Capital of our public school graduates. In this exercise, we are not interested in other factors that might affect wealth formation, so the model is

$$Wealth_{it} = \beta_0 + \beta_1 HC_{i,t-1} + u_i + \varepsilon_{it}, \quad (2)$$

where $Wealth_{it}$ is wealth of households in district i at time period t, $HC_{i,t-1}$ is Human Capital created by school district i in time period $t-1$, u_i denotes "all other factors" that affect wealth formation in district i, and ε_{it} is the stochastic component in district i, time period t. The point of interest is to estimate the effect of Human Capital on Wealth, which is denoted here as unknown model parameter β_1.

Here, u_i indicates the districts' "individuality", the value of which is absolutely irrelevant from the perspective of estimating β_1. The critical assumption is that u_i does not change over time and u_i does not correlate with Human Capital. In other words, we are concerned with a uniform improvement induced by Human Capital rather then by individualities or students. Note, that Human Capital is taken in model (3) with one-period lag, so that we were better prepared to answer a simple question: how improving human capital today affects the future economy?

To ILLUSTRATE the purpose of the panel data model, consider its implication. In particular, model (3) implies

$$Wealth_{it} - Wealth_{i,t-1} = \beta_1(HC_{i,t-1} - HC_{i,t-2}) + \eta_{it}, \quad (3)$$

where η_{it} is an independently identically distributed error term. In other words, attributing changes in wealth over time to changes in produced human capital in previous time periods gives a framework for measuring the effect of human capital on local economy. In the model, we simplify the effect to be measured: we assume that this year's effect of the district's academic achievement is fully determined by the previous year's district's performance. In reality, this year's effect is the weighted sum of previous years' academic achievements (distributed lag model). On the other hand, instead of assuming that last year's academic achievement lasts for several years, we assume that it lasts only one year. This simplification reduces the number of parameters to be estimated.

To SUMMARIZE a rather complex set of technical details[20] of estimating the effects of academic achievement on the local economy using panel data models, we provide the outline of the econometric issues resolved during this exercise:

(a) as a panel data model (rather than a cross-section model more commonly used in the literature), each school district is modeled as a combination of typical effects (these effects are explicitly being estimated) and district-specific effects (these effects are implicit in the model), which is important when districts are heterogeneous in their socio-economic conditions and education outcomes;

(b) to account for time-varying economic conditions (that also vary by locations) we include the logarithm of the average size of establishments (measured as the number of employees on private non-farm single- and multi-unit firms), which serves as a proxy for

[20] Smirnov, Oleg A. (2014) Estimating the Effects of Public Schools on Local Economies Working paper. Department of Economics, University of Toledo

fluctuations in economic conditions;

(c) to avoid spurious regressions, we have tested and removed if necessary trends from the variables of interest, so that all key variables in the model are de-trended;

(d) to resolve the issues with endogeneity that typically arise in a rather complex economic system, we used the Arellano–Bond estimator (an implementation of the GMM);

A *spurious regression* is an outcome of statistical analysis when a statistical correlation is detected between variables that have no meaningful causal relationship.

To ESTIMATE model parameters, we collected data by school districts in Ohio and by counties. Then we matched districts to the counties in which they are located to related academic performance by districts to economic performance by counties in which the districts belong. The data by districts cover seven annual assessments of 609 public school districts in Ohio. The scope of the data: Ohio graduation test results (source: Ohio Schools Report Cards[21]) for corresponding years. All report cards have five subject tests: *Reading*, *Mathematics*, *Writing*, *Social Studies*, and *Science*. As an explanatory variable in our study, we used the weighted average of these results – variable *OGT_AVE*. Time period: 2006–2013.

There are 610 public school districts in Ohio, but only one school district – Put-in-Bay – has zero graduating students in some years, so data for that district were omitted.

[21] Ohio Department of Education *Ohio School Report Cards* http://reportcard.education.ohio.gov/ Pages/default.aspx

Data for 88 Ohio counties include U.S. Census-generated County Business Patterns annual data on the size distribution of private non-farm establishments.[22] These data contain relevant information on the number and size of private non-farm establishments. We obtained data for 8 years (from 2004 to 2011).

[22] United States Census Bureau. *County Business Patterns, 2011*. U.S. Census Bureau, May 2013. *online resource:* https://www.census.gov/econ/cbp/

Finally, we used data from the Bureau of Economic Analysis of the United State Department of Commerce on local employment, personal income, and average earnings – series CA30 and CA34 – of annual reports by counties. The time period of available data runs from 1969 to 2011.[23] We used data only for 8 years to match other components of this com-

[23] Bureau of Economic Analysis; U.S. Department of Commerce. *Regional Economic Information System*, 2013 *online resource:* http://www.bea.gov/regional/

plex dataset.

Empirical Results

THREE panel data models were estimated. The summary of the regressions are provided in Appendix B2. A summary of the results is provided in Table 3.

Table 3: The summary of estimates of the effect of academic achievement on the local economy

Economic variable	Change or level	Effect	Std. Error	z	Pr >z
Personal Income	change	$3,011	$380	7.92	0.000
Average Earnings	change	$13.33	$2.04	6.54	0.000
Percent Employed	level	0.052	0.0068	7.67	0.000

THE EFFECT of academic achievement on *average earnings* is positive and statistically significant; it is estimated to be around $13 per worker. It should be noted that this increase is applied to all workers in the local economy (not just high-school graduates). The estimation result is relatively modest in value, but is not particularly surprising. Indeed, a labor market puts a fairly low priority on new high school graduates so that their wages are typically below the prevailing wage in a well-established economy. Given that high school graduates are likely to be paid less than workers with stronger professional backgrounds (more experience in their profession, higher level of education, or both), high school graduates tend to have lower wages and higher unemployment rates. In addition, the average income undervalues the full-scale effect of academic achievement because it effectively excludes those who migrate to other locations. From an economics perspective, when new high school graduates

enter the labor market, and increased supply of labor puts a downward pressure on wages (the quantity of students effect). On the other hand, a higher quality of labor force puts an upward pressure on the average earnings (the quality of academic achievement of labor market participants). Therefore, a $13 increase in average earnings is the net of the effects (increase in supply of labor and an increase in demand of labor). It is very difficult to separate the one from the other, so only the net of these two effects is captured by using this variable.

In contrast, the effect of academic achievement on *personal income* is much higher – a one percentage point increase in Ohio graduation tests on average results in a following year increases district personal per capita income by $3,011. The difference in part is associated with the fact that for most school districts, well-performing high-school graduates migrate to another location (move to college), thus reducing the district's (low or non-income earning) population and, other things being equal, increasing per capita income of the remaining district households. It should be noted that college freshmen – when they relocate and move to another school district's territory – effectively contribute to the college-bound school districts rather than their home district. However, 85% of students choose a college in Ohio rather than move out of state. Although the estimated effect of academic achievement on personal income is $3,011 in Ohio, it is safe to say that the full effect would have been higher if Ohio managed to attract more high-skills jobs.

In 1996–2006, of all high school graduates in Ohio who go directly to college, about 85% stay in-state. *Source: Ohio Regent's Migration Report, p.6.*

Despite differences in migration patterns of high-school graduates with different career choices, the effect of academic achievement on recent high school graduates has a broad positive effect on labor market outcomes. In terms of

personal income, high-school graduates who manage to get a job have higher incomes than those who don't even if the job they have pays less than the prevailing wage in the economy. This implies that better achieving high-schoolers tend to be more successful in getting a job. This phenomenon boosts local personal per capita income but might not have a strong positive effect on the average earnings.

A JOB-CREATING EFFECT of investments in public education is statistically significant and economically meaningful: a one percentage point increase of academic achievement increases employment / total population ratio by 0.052 percentage points. This translates to approximately 0.35 new jobs per 1,000 residents in the local economy. Thus, an improvement in public education is an important and cost-effective mechanism for job-creation.

One should understand that this pertains to districts that still have potential form improving academic achievement. In contrast, districts that perform at or close to their maximum potential academic achievement might have already exhausted this opportunity for growth.

THE ARGUMENT that academic achievement improves broader labor market outcomes is supported by the third line in Table 3. Specifically, the ratio of the total employment to total population (as a proxy for the labor market participation rate) is positively affected by the level of academic achievement – a one point increase in academic achievement tends to push up employment-to-population ratio by up to 0.052 percent. This effect is statistically significant at the one percent level. In practice, higher academic achievement of public school students leads to better matching in the labor market. This is an important factor in raging public policy debates where it is argued that high unemployment levels are attributed to the lack of skills needed in the economy. Our result contains a meaningful contribution to this debate by suggesting that the investment in public education (as it improves academic achievement) is an important factor of filling the gaps in existing labor demand and also increase

In economics, a concurrent increase in price of the good (average earnings is the price for labor) and its quantity (employment is indicative of the quantity of labor being used) suggests a shift in the Demand for labor upward.

wages. Consequently, public policy seeking to boost employment and raise wages might focus on achieving these goals via public education channel.

Economic Value: Summary

THE ECONOMIC effect of academic achievement in public education shows prominently in all three aspects of economic growth of the local economy: personal income, average earnings of full-time and part-time employees, and employment. All effects are positive, statistically and substantively significant. Although measured from three independent models, the results are generally consistent and are intrinsically noncontradicting. The overall picture of these measurements is an impressive display of the multifaceted and relevant influence exerted on the local economy by better performing public schools.

AS A PART OF A COMPREHENSIVE assessment of the return on investment in public education, we have taken into account many problems that emerge from measuring the intangible increase in local human capital that we attribute to the academic achievement of public school students. Our modeling methodology relies on the use of empirical economic, demographic, and academic achievement data from three distinctive data sources and arranged as panel data. The entire approach and its implementation is a pioneering work in the field and is the first attempt to quantify the difficult-to-measure direct effects of academic achievement on local economic growth.

THE PRIMARY EFFECT of academic achievement manifests itself in the labor market outcomes. Statistically, higher academic achievement of students (this year) tends to boost em-

ployment in the local economy (the following year). The empirical evidence suggests that both the labor market quantity (employment) and price (average earnings) are positively affected by academic achievement. The concurrent increase in price and quantity implies an increase in demand for labor, which generally occurs (other things being equal) when the potential productivity of supplied labor goes up. Note that we have not observed directly the productivity of labor of school graduates.

THE IMPLIED EFFECT of academic achievement is higher productivity in the local economy, which essentially results in a higher per capita personal income – for the lack of a better measure, personal per capita income is indicative of the productivity of the local economy. Higher productivity in the local economy is important for raising standards of living in the local community via wealth-creating effect (hence, higher levels of consumption, provision of public goods, improved real estate values, lower burdens on public finances from criminal activities, etc.). Without discussing how this wealth-creative effect is distributed between workers and entrepreneurs, private and public sector, etc, we estimate that a one point increase in academic achievement of graduates of local public schools increases personal income on average by $3,011.

Connecting the Dots

Is it possible to think of investments in public education as a vehicle for revitalizing the local economy and igniting economic growth? The logic of the analysis is as follows: *Investment* in public education leads to higher *Academic Achievement* by pupils attending local public schools; higher *Academic Achievement* by students in local public schools has a positive effect (over time) on local labor market and local *Economic Growth*; *Economic Growth* creates more *Wealth*, which leads to *Higher Standards of Living* – see Figure 6.

Given that

(1) from Table 1 it follows that increasing investments in public education by $1,000 per student tends to increase his or her academic achievement by 0.28 points; this means to increase academic achievement of a typical student by one point, it costs about $3,572 per year;
(2) from Table 3 it follows that an increase in academic achievement by one point leads to a per capita increase of personal income by $3,011 per year;
(3) in 2012–13 in Ohio the ratio of public school enrollment (1.6 mln pupils) to total population (11.54 mln

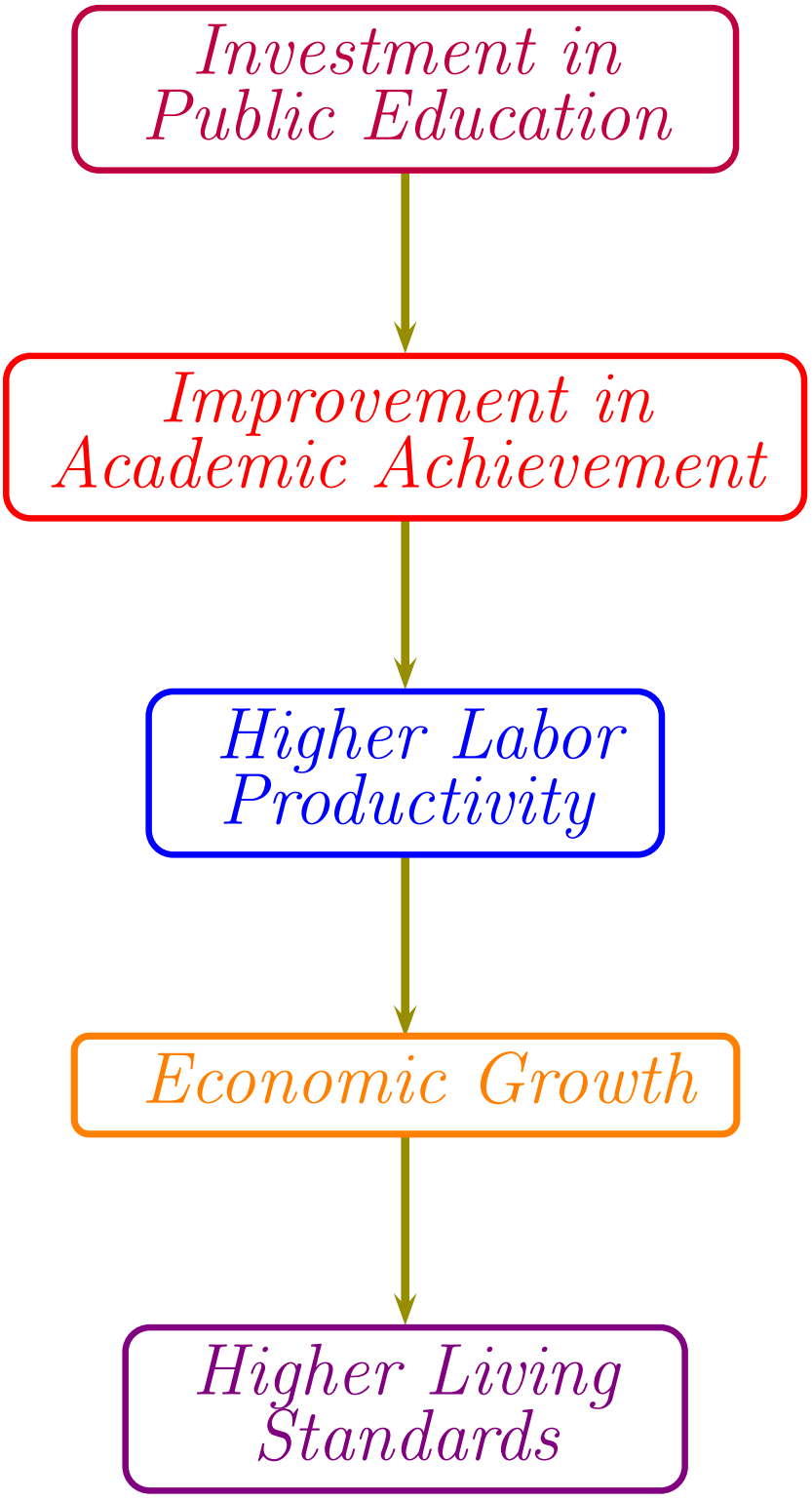

Figure 6: The figure shows how Investments in Public Education work through to higher Living Standards in the local economy.

people) is 7.17 people per one public school student,

the total *Economic Value* of $1 investment in public education in Ohio is $6.03 in gross increase in economic wealth:

$$\begin{aligned} \textit{Economic Value} &= 7.17 \times \frac{\$3,011}{\$3,572} \\ &= \$6.03. \end{aligned} \tag{4}$$

After accounting for federal income tax, federal payroll tax, state income tax, Toledo income tax, other voluntary and mandatory paycheck deductions (retirement contributions, union dues, etc.), the net personal income is less than $6. The exact amount varies across households because effective payroll deductions differ across households (it is an oversimplification to think that it is merely a function of income). Consequently, after assuming typical withholdings and deductions from income, the net individual gain from public investments in public education is $\$4.0 - \$5.6$ for every dollar of investment in public education.

Does this potential apply to the Toledo Public Schools district? Appendix A2 indicates that in terms of academic achievement, there is a big room for improvement in the Toledo Public Schools district. Unlike some (very few in Ohio) schools districts that operate at or close to the maximal academic achievement level measured by OGTs, the average OGT tests in Toledo Public Schools are below the state average. Given that TPS is lagging behind state-averages, one might suggest that improvement is possible but it requires investment in public education. Given that the district has fairly high poverty rates and low income levels, it seems to be a strenuous proposition for most district residents. However, the analysis above suggests that this proposition is not without merit. Specifically, over 2010–2013, TPS locally-funded revenue per pupil was $3,959 per

The maximum possible OGT performance is 100%. If a school district delivers 100% performance on all OGTs, its performance is efficient because it cannot be improved any further.

year, while the average state of Ohio value is $4,521 per year. This suggests that in TPS local community invests less in public education that the average public school district in Ohio does. In contrast, TPS obtains $2,245 per pupil of federal funding (versus $847 of Ohio districts' average) and TPS obtains $6,620 per pupil of state funding (versus $4,674 of Ohio districts' average). Although federal and state funding play important roles in districts' activities, the imbalance in districts' funding schedule and districts' dependence on out-of-district revenue negatively affects academic achievement.

As amounts of money received by the district are important for securing needed education resources, it has a more important role that is difficult to observe directly but which we have attempted to quantify using econometric analysis: population's attitudes toward public education (as well as willingness to materially commit to it) affects the district's accountability to the districts' population. As economists put it, investment in public education is a two-sided sword, that imposes a responsibility on the district and applies pressure on the district to perform in venues that are important to the investor (local population). If the district becomes more dependent on local sources of funding, it creates a firm incentive for the district to deliver improvements in academic achievement. In other words, accountability leads to competence, which leads to more effective performance, and hence, academic achievement.

Our analysis shows that public education is not a zero-sum game: the positive synergies from communal support for public education and all the potential for better schools create for the local economy creates a powerful engine for local economic growth. However, this engine will never function without full-hearted involvement and support of

the local community. Since the level of investment in public education is eventually determined by the local community, the question is if households in the local community prefer to gain from investments in public education?

Appendix A

A1. Statistical data for ROI

Number of observations	1,827 (3 time periods × 609 school districts)
Number of variables	79
Date and time stamp	22 May 2014 12:32

Table 4: Variable list for ROI Analysis

variable name	storage type	display format	variable label
district	str52	52s	District
irn	long	12.0g	IRN
county_name	str10	10s	COUNTY_NAME
Area	int	8.0g	District Square Mileage
Density	float	9.0g	District Pupil Density
ADM	float	9.0g	District Total Average Daily Membership
Enrollment	float	9.0g	District Total Year-End Enrollment
RACE_AS	float	9.0g	District Asian Students As % Of Total
RACE_PI	float	9.0g	District Pacific Islander Students As % Of Total
RACE_BL	float	9.0g	District Black Students As % Of Total
RACE_AI	float	9.0g	District Am. Indian/Alaskan Native As % Of Total
RACE_HI	float	9.0g	District Hispanic Students As % Of Total
RACE_WH	float	9.0g	District White Students As % Of Total
RACE_MR	float	9.0g	District Multiracial Students As % Of Total
Poverty	float	9.0g	District % Of Students In Poverty
Limit_ENG	float	9.0g	District % Of Students With Limited English Prof.
Disability	float	9.0g	District Percent Of Students With Disability

Teach_FTE	float	9.0g	District FTE Number Of Classroom Teachers
Teach_SAL	float	9.0g	District Classroom Teacher Average Salary
Teach_BEG	float	9.0g	District % Of Teachers With 0-4 Years Experience
Teach_MID	float	9.0g	District % Of Teachers With 4-10 Years Experience
Teach_EXP	float	9.0g	District % Of Teachers With 10+ Years Experience
Teach_RATIO	float	9.0g	District K-12 Regular Education Pupil Teacher Ratio
ADMIN_FTE	float	9.0g	District FTE Number Of Administrators
ADMIN_SAL	double	10.0g	District Administrator Average Salary
ADMIN_RATIO	float	9.0g	District Pupil Administrator Ratio
Property_PP	float	9.0g	District Assessed Valuation Per Pupil
Percent_RES	float	9.0g	District Res/Agr Real Valuation As % Of Total
Percent_Other	float	9.0g	District All Other Real Valuation As % Of Total
Percent_PUB	float	9.0g	District Public Utility Tangible Valuation As % Of Total
Percent_BUS	float	9.0g	District Business Valuation As % Of Total
Rev_PP	float	9.0g	District Per Pupil Rev. From 1 Mill Of Property Tax
Tax_PP	float	9.0g	District Total Property Tax Per Pupil
CRED_PP	float	9.0g	District Rollback Homestead Per Pupil
Wealth_PP	float	9.0g	District OSFC 3-Year Valuation Per Pupil FY13
OSFC	int	8.0g	District Ranking Of OSFC Valuation Per Pupil
Med_INC	long	12.0	District Median Income
Ave_INC	long	12.0	District Average Income
CO_Millage	float	9.0	District Current Operating Millage Incl JVS
EC1_Millage	float	9.0	District Class 1 Effective Millage Incl JVS
EC2_Millage	float	9.0	District Class 2 Effective Millage Incl JVS
SI_Millage	float	9.0	District Inside Millage
INC_TAX	float	9.0	District Income Tax Per Pupil
TAX_INDEX	float	9.0	District Local Tax Effort Index
ADM_PP	float	9.0	District Administrative Expenditure Per Pupil
BOP_PP	float	9.0	District Building Operation Expenditure Per Pupil
INS_PP	float	9.0	District Instructional Expenditure Per Pupil
PSUP_PP	float	9.0	District Pupil Support Expenditure Per Pupil
SSUP_PP	float	9.0	District Staff Support Expenditure Per Pupil
TOT_PP	float	9.0	District Total Expenditure Per Pupil
STATE_REV	float	9.0	District State Revenue Per Pupil
SR_Per	float	9.0	District State Revenue As % Of Total
LOC_REV	float	9.0	District Local Revenue Per Pupil
LR_PER	float	9.0	District Local Revenue As % Of Total
FED_REV	float	9.0	District Federal Revenue Per Pupil
FR_PER	float	9.0	District Federal Revenue As % Of Total
TOT_REV	float	9.0	District Total Revenue Per Pupil
FORMULA	float	9.0g	District Formula Funding Per Pupil
FORMULA_PER	float	9.0g	District Formula Funding As % Of Income Tax Liability
SAL_PER	float	9.0g	District Salaries As % Of Operating Expenditures
FRINGE_PER	float	9.0g	District Fringe Benefits As Of Operating Expenditures

SERV_PER	float	9.0g	District Purchased Services As % Of Operating Expenditures
SUPP_PER	float	9.0g	District Supplies & Materials As % Of Operating Expenditures
OTHER_PER	float	9.0g	District Other Expenses As % Of Operating Expenditures
OGT_READ	float	9.0g	Read OGT % at or above proficient
OGT_WRITE	float	9.0g	Write OGT % at or above proficient
OGT_SS	float	9.0g	Social Studies OGT % at or above proficient
OGT_SCI	float	9.0g	Science OGT % at or above proficient
OGT_MATH	float	9.0g	Math OGT % at or above proficient
tp	byte	8.0g	Time period
id	int	8.0g	Panel id
G11_READ	float	9.0g	Read 11th grade % at or above proficient
G11_MATH	float	9.0g	Math 11th grade % at or above proficient
G11_WRITE	float	9.0g	Write 11th grade % at or above proficient
G11_SS	float	9.0g	Social Studies 11th grade % at or above proficient
G11_SCI	float	9.0g	Science 11th grade or above proficient
OGT_AVE	float	9.0g	Average OGT
lMed_INC	float	9.0g	Logarithm of Median Income
TEA_SAL	long	12.0g	Average Teacher salary

A2. Descriptive Statistics of Key Variables in FY 2010–11, FY 2011–12, and FY 2012–13

Variable	Obs	Mean	Std. Dev.	Min	Max	Toledo
	All school districts in Ohio					
ogt_read	1826	90.20066	6.157079	53.9	100	77.13
ogt_math	1826	87.78636	7.746737	44.8	100	69.73
ogt_write	1826	90.39606	6.365969	52.8	100	81.07
ogt_ss	1826	85.41276	8.274558	39.3	100	66.03
ogt_sci	1826	81.8414	9.982677	24.3	100	61.67
ogt_ave	1826	87.12745	7.116636	49.1	99.62	71.13

Note: The complete data set contains 1,827 observations. For some school districts, data are missing, so the number of observations deviates from 1,827.

Variable	Obs	Mean	Std. Dev.	Min	Max	Toledo
	All school districts in Ohio					
tea_sal	1827	$54,039	$7,429	$32,894	$81,851	$56,541
admin_sal	1827	$72,326	$14,266	$25,576	$221,778	$74,396
teach_ratio	1827	18.013	2.072	10.77	25.34	18.04
fed_rev	1826	$847	$466	$273	$3,718	$2,245
state_rev	1826	$4,674	$1,304	$1,384	$12,017	$6,620
loc_rev	1826	$4,521	$2,140	$940	$18,384	$3,959
med_inc	1827	$32,793	$7,586	$16,954	$73,125	$24,647
poverty	1827	.3924	.184	0	1	.7341
race_bl	1827	.05916	.1458	0	.9904	.4390

A3. Panel Data Models for Academic Achievement

OGT: Summary

```
Random-effects GLS regression        Number of obs = 1824
Group variable:  id                 Number of groups = 609

R-sq:  within = 0.0000             Obs per group:  min = 2
between = 0.7749                                   avg = 3.0
overall = 0.6860                                   max = 3

Random effects u_i ~ Gaussian      Wald chi2(9) = 1978.27
corr(u_i, X) = 0 (assumed)           Prob > chi2 = 0.0000
```

ogt_ave	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
tea_sal	5.74e-06	.0000107	0.54	0.590	-.0000152	.0000267
admin_sal	.0000163	9.03e-06	1.80	0.071	-1.42e-06	.000034
teach_ratio	-.0580796	.0693496	-0.84	0.402	-.1940023	.0778431
state_rev	-.0005712	.0001396	-4.09	0.000	-.0008448	-.0002975
fed_rev	-.0019898	.0003813	-5.22	0.000	-.0027372	-.0012424
loc_rev	.0002766	.0000864	3.20	0.001	.0001073	.000446
poverty	-11.67632	1.230608	-9.49	0.000	-14.08826	-9.264371
race_bl	-16.5356	1.115801	-14.82	0.000	-18.72253	-14.34867
med_inc	.0001153	.0000295	3.90	0.000	.0000574	.0001732
_cons	91.57138	2.039556	44.90	0.000	87.57393	95.56884
sigma_u	2.6955778					
sigma_e	2.8576861					
rho	.47083331	(fraction of variance due to u_i)				

OGT:Reading

Random-effects GLS regression — Number of obs = 1824
Group variable: id — Number of groups = 609

R-sq: within = 0.0021 — Obs per group: min = 2
between = 0.7445 — avg = 3.0
overall = 0.6033 — max = 3
Random effects u_i ∼ Gaussian — Wald chi2(9) = 1701.23
corr(u_i, X) = 0 (assumed) — Prob > chi2 = 0.0000

ogt_read	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
tea_sal	7.76e-06	.0000114	0.68	0.497	-.0000146	.0000302
admin_sal	3.30e-06	8.76e-06	0.38	0.706	-.0000139	.0000205
teach_ratio	-.0074175	.0637177	-0.12	0.907	-.1323019	.117467
state_rev	-.00049	.0001383	-3.54	0.000	-.0007611	-.000219
fed_rev	-.0025885	.0003778	-6.85	0.000	-.003329	-.001848
loc_rev	.0001907	.0000841	2.27	0.023	.0000259	.0003555
med_inc	.0000937	.000027	3.47	0.001	.0000408	.0001466
race_bl	-11.38314	1.028372	-11.07	0.000	-13.39872	-9.36757
poverty	-8.720615	1.211614	-7.20	0.000	-11.09534	-6.345895
_cons	94.32678	1.952338	48.31	0.000	90.50027	98.15329
sigma_u	2.1137977					
sigma_e	3.196882					
rho	.30419945	(fraction of variance due to u_i)				

OGT: Math

Random-effects GLS regression Number of obs = 1824
Group variable: id Number of groups = 609

R-sq: within = 0.0005 Obs per group: min = 2
between = 0.7134 avg = 3.0
overall = 0.5962 max = 3
Random effects u_i ∼ Gaussian Wald chi2(9) = 1454.81
corr(u_i, X) = 0 (assumed) Prob > chi2 = 0.0000

ogt_math	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
tea_sal	.0000274	.0000136	2.01	0.044	6.81e-07	.0000541
admin_sal	.0000197	.0000111	1.77	0.077	-2.14e-06	.0000415
teach_ratio	-.1845881	.0846933	-2.18	0.029	-.3505838	-.0185923
state_rev	-.0006081	.0001804	-3.37	0.001	-.0009616	-.0002546
fed_rev	-.0031481	.0004769	-6.60	0.000	-.0040827	-.0022135
loc_rev	.0002222	.0001104	2.01	0.044	5.81e-06	.0004387
med_inc	.0001318	.0000356	3.70	0.000	.0000619	.0002017
race_bl	-19.23387	1.371697	-14.02	0.000	-21.92234	-16.54539
poverty	-7.637127	1.536178	-4.97	0.000	-10.64798	-4.626274
_cons	92.53264	2.546901	36.33	0.000	87.54081	97.52448
sigma_u	3.0934935					
sigma_e	3.6950585					
rho	.41207579	(fraction of variance due to u_i)				

OGT: Write

Random-effects GLS regression — Number of obs = 1824
Group variable: id — Number of groups = 609

R-sq: within = 0.1120 — Obs per group: min = 2
between = 0.6137 — avg = 3.0
overall = 0.4803 — max = 3
Random effects u_i ∼ Gaussian — Wald chi2(9) = 1098.80
corr(u_i, X) = 0 (assumed) — Prob > chi2 = 0.0000

ogt_write	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
tea_sal	-.0000668	.0000133	-5.00	0.000	-.000093	-.0000406
admin_sal	4.70e-06	.0000104	0.45	0.651	-.0000157	.0000251
teach_ratio	-.086562	.0763459	-1.13	0.257	-.2361973	.0630733
state_rev	-.0008402	.000165	-5.09	0.000	-.0011636	-.0005168
fed_rev	.0007979	.0004474	1.78	0.075	-.000079	.0016748
loc_rev	-.0001429	.0001005	-1.42	0.155	-.0003398	.0000541
med_inc	.0000364	.0000323	1.13	0.259	-.0000269	.0000997
race_bl	-5.076136	1.233099	-4.12	0.000	-7.492966	-2.659306
poverty	-19.13127	1.436377	-13.32	0.000	-21.94651	-16.31602
_cons	105.7387	2.32879	45.40	0.000	101.1743	110.303
sigma_u	2.5866032					
sigma_e	3.6849445					
rho	.33008074	(fraction of variance due to u_i)				

OGT: Social Studies

Random-effects GLS regression — Number of obs = 1824
Group variable: id — Number of groups = 609

R-sq: within = 0.0025 — Obs per group: min = 2
between = 0.6854 — avg = 3.0
overall = 0.5693 — max = 3
Random effects u_i ∼ Gaussian — Wald chi2(9) = 1215.93
corr(u_i, X) = 0 (assumed) — Prob > chi2 = 0.0000

ogt_ss	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
tea_sal	.0000175	.0000148	1.18	0.238	-.0000115	.0000465
admin_sal	.0000315	.0000123	2.55	0.011	7.28e-06	.0000556
teach_ratio	-.1453008	.0951811	-1.53	0.127	-.3318524	.0412508
state_rev	-.000939	.0002013	-4.66	0.000	-.0013335	-.0005444
fed_rev	-.002578	.0005266	-4.90	0.000	-.0036102	-.0015458
loc_rev	.0002972	.0001236	2.41	0.016	.000055	.0005394
med_inc	.0001218	.00004	3.05	0.002	.0000435	.0002001
race_bl	-14.76129	1.543582	-9.56	0.000	-17.78666	-11.73593
poverty	-10.45774	1.698868	-6.16	0.000	-13.78746	-7.128022
_cons	91.03168	2.845779	31.99	0.000	85.45406	96.6093
sigma_u	3.558133					
sigma_e	3.9743634					
rho	.44491025	(fraction of variance due to u_i)				

OGT: Science

Random-effects GLS regression — Number of obs = 1824
Group variable: id — Number of groups = 609

R-sq: within = 0.0000 — Obs per group: min = 2
between = 0.7859 — avg = 3.0
overall = 0.6775 — max = 3
Random effects u_i ∼ Gaussian — Wald chi2(9) = 2115.37
corr(u_i, X) = 0 (assumed) — Prob > chi2 = 0.0000

ogt_sci	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
tea_sal	.000034	.000016	2.12	0.034	2.62e-06	.0000653
admin_sal	.0000203	.0000129	1.58	0.115	-4.93e-06	.0000455
teach_ratio	-.0090123	.0965106	-0.09	0.926	-.1981696	.180145
state_rev	-.0005238	.0002066	-2.53	0.011	-.0009288	-.0001188
fed_rev	-.0037738	.0005512	-6.85	0.000	-.0048541	-.0026934
loc_rev	.000511	.0001263	4.05	0.000	.0002636	.0007585
med_inc	.0001425	.0000407	3.50	0.000	.0000628	.0002223
race_bl	-27.47747	1.561492	-17.60	0.000	-30.53793	-24.417
poverty	-12.91603	1.773612	-7.28	0.000	-16.39224	-9.439809
_cons	84.06664	2.916553	28.82	0.000	78.3503	89.78298
sigma_u	3.4122171					
sigma_e	4.3225963					
rho	.3839093	(fraction of variance due to u_i)				

Appendix B

B1. Statistical data for assessing economic value of public education

obs: 4,872	vars: 21	size: 394,632

Table 5: Variable List for Economic Value Analysis

variable name	storage type	display format	variable label
irn	long	12.0g	IRN
fips_cnty	long	12.0g	County FIPS code
avsize	float	9.0g	(The log of) the average size of establishements
ogt_r	float	9.0g	OGT: Reading
ogt_m	float	9.0g	OGT: Mathematics
ogt_w	float	9.0g	OGT: Writing
ogt_ss	float	9.0g	OGT: Social Studies
ogt_sci	float	9.0g	OGT: Science
t11_r	float	9.0g	G11: Reading
t11_m	float	9.0g	G11: Mathematics
t11_w	float	9.0g	G11: Writing
t11_ss	float	9.0g	G11: Social Studies
t11_sci	float	9.0g	G11: Science
pop	long	12.0g	Population
persinc	long	12.0g	Personal Income,$$
avearn	int	8.0g	Average earning of full-time and part-time empl.
emprate	long	12.0g	Employment
year	byte	8.0g	
district	int	8.0g	DISTRICT

ogt_ave	float	%9.0g	Weighted average of OGTs
t11_ave	float	%9.0g	Weighted average of 11th grade tests
erate	float	%12.0g	Employment/population ratio

B2. Estimation results

Annual Change in Personal Income, per capita, in $$

```
Arellano-Bond dynamic panel-data estimation      Number of obs = 3045
Group variable:  district                       Number of groups = 609
Time variable:  year
                                                Obs per group:  min = 5
                                                                avg = 5
                                                                max = 5

Number of instruments = 18                      Wald chi2(3) = 1028.36
                                                  Prob > chi2 = 0.0000
One-step results
```

D.persinc	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
persinc						
LD.	.5089263	.0166437	30.58	0.000	.4763052	.5415474
avsize	-47929.1	36022.03	-1.33	0.183	-118531	22672.77
ogt_ave	3010.665	380.315	7.92	0.000	2265.261	3756.069
_cons	-46647.88	103106.5	-0.45	0.651	-248732.8	155437.1

```
Instruments for differenced equation
  GMM-type:  L(2.).D.persinc
  Standard:  D.avsize D.ogt_ave
  Instruments for level equation
  Standard:  _cons
```

Annual Change in Average Earnings by full-time and part-time employees, in $$

Arellano-Bond dynamic panel-data estimation — Number of obs = 3045

Group variable: district — Number of groups = 609

Time variable: year

Obs per group: min = 5

avg = 5

max = 5

Number of instruments = 18 — Wald chi2(3) = 603.28

Prob > chi2 = 0.0000

One-step results

D.avearn	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
avearn						
LD.	.3328429	.0248264	13.41	0.000	.284184	.3815017
avsize	-3398.679	177.2128	-19.18	0.000	-3746.01	-3051.348
ogt_ave	13.32934	2.038987	6.54	0.000	9.332997	17.32568
_cons	8722.894	524.4431	16.63	0.000	7695.004	9750.783

Instruments for differenced equation

GMM-type: L(2.).D.avearn

Standard: D.avsize D.ogt_ave

Instruments for level equation

Standard: _cons

Percentage of Population in Full-time and Part-time Employment

```
Arellano-Bond dynamic panel-data estimation       Number of obs = 3654
Group variable:  district                       Number of groups = 609
Time variable:  year
                                                Obs per group:  min = 6
                                                                avg = 6
                                                                max = 6

Number of instruments = 24                        Wald chi2(3) = 337.75
                                                   Prob > chi2 = 0.0000
One-step results
```

erate	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
erate						
L1.	.3605405	.022205	16.24	0.000	.3170196	.4040614
avsize	.0320257	.0061066	5.24	0.000	.0200569	.0439944
ogt_ave	.0005229	.0000682	7.67	0.000	.0003893	.0006565
_cons	.1343259	.020909	6.42	0.000	.093345	.1753068

```
Instruments for differenced equation
  GMM-type:  L(2.).erate
  Standard:  D.avsize D.ogt_ave
  Instruments for level equation
  Standard:  _cons
```

Bibliography

Boser, Ulrich (2011). *Return on Educational Investment. A district-by-district evaluation of U.S. educational productivity.* www.americanprogress.org

Barrow, Lisa, and Cecila Elena Rouse. (2002) Using Market Valuation to Assess Public School Spending NBER Working paper No. 9054

Bureau of Economic Analysis; U.S. Department of Commerce. *Regional Economic Information System*, 2013 *online resource:* http://www.bea.gov/regional/

Hampdel, Martin. (2005) Measuring Educational Productivity in Standards-Based Accountability Systems," *OECD Education Working Papers, No. 4*, OECD Publishing. http://dx.doi.org/10.1787/224417012465

Hanushek, Eric A. (2006) Alternative school policies and the benefits of general cognitive skills, *Economics of Education Review, Vol. 25*, 447–462.

OECD: Program for International Student Assessment (PISA) PISA 2012 Results in Focus http://www.oecd.org/pisa/keyfindings/pisa-2012-results.htm

OECD. (2013) *Education at a Glance 2012: OECD Indicators,* OECD, Directorate for Education and Skills. http://www.oecd.org/edu/United States _EAG2013 Country Note.pdf

Ohio Department of Education *Ohio School Report Cards* http://reportcard. education.ohio.gov/ Pages/default.aspx

Ohio Department of Education. *District Profile Report* http://education.ohio.gov/ Topics/ Finance-and-Funding/Finance-Related-Data/District-Profile-Reports/FY2013-District-Profile-Report

Richter, Francisca G.-C., and Lisa Nelson. The Prospects of Non-College-Bound Workers in the Fourth District Cleveland Federal Reserve Bank Working paper Series

Smirnov, Oleg A. (2014) What is investment in public education and how to measure return on it? Working paper. Department of Economics, University of Toledo

Smirnov, Oleg A. (2014) Estimating the Effects of Public Schools on Local Economies Working paper. Department of Economics, University of Toledo

United States Census Bureau. *County Business Patterns, 2011*. U.S. Census Bureau, May 2013. *online resource:* https://www.census.gov/econ/cbp/

Walden, Michael L. (2012) Quantifying the Successes of Public Schools, *School Administrator, Vol. 69 (6),* 20–25.

Weiss, Jonathan D. (2004) *Public Schools and Economics Development: What the Research Shows* KnowledgeWorks Foundation, KnowledgeWorks Foundation, Cincinnati, OH.