Do Spillover Benefits Create a Market Inefficiency in K–12 Public Education?

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In economics there is a well-established framework for determining whether government intervention into a market is justified. If we look from the perspective of economic efficiency, government intervention has the *potential* to improve the market outcome when a so-called market failure exists. As Bator (1958) suggests, certain categories of market failures such as public goods, externalities, and monopoly all contain certain properties that lead to an allocation of resources that is not Pareto-efficient—that is, does not equate marginal social benefits and costs.

The use of the word potential is important to note when referring to government intervention and improved market outcomes because modern public choice theory also suggests the presence of government failures. It is conceivable that even in a case where the private market fails to reach an efficient outcome, government intervention might actually worsen, rather than improve, the situation (Sobel 2004).[1] A possible explanation for this occurrence is given by Buchanan (1962), who discusses the concept of political externalities, which refer to situations where political action is carried out without unanimous consent thereby reducing the range of choices open to individuals.

One of the more interesting markets within which to apply these theories is K–12 education. While the production of K–12 education has been and continues to be dominated by the public sector, there still remains an open-ended question regarding the proper role of government in K–12 education. If a market failure exists in K–12

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[1]For example, Husted and Kenny (2000) find that government policies that equalize spending within a state make schools less efficient.

education due to the public goods problem, the government may be able to improve efficiency. But if the K–12 education market is not subject to this type of market failure, there is clearly a justification for less government involvement.

In this article, I present and estimate a model that examines the market failure argument in K–12 education by producing a measure of the degree to which public K–12 education creates Pareto-relevant external benefits to the median voter. Applying an empirical median voter demand curve model, I am able to obtain an estimate (on a scale of 0 to 100 percent) of the degree to which K–12 public education is really a pure private good producing no spillover effects. My results suggest that K–12 education is largely a private good, creating few external benefits to the median voter (above and beyond his or her own private benefit from K–12 education).

Benefits of Education

When an individual becomes more educated, other people besides that individual are made better off. For instance, if we suppose a certain individual goes to medical school and then one day uses her academic research to cure cancer, then this education will have made many people better off. However, these spillover benefits create problems for markets only when a person is not fully compensated for the generation of these spillover benefits. In competitive markets, labor earns the value of its marginal product, and the individual mentioned above will be well compensated for inventing the cure for cancer. Thus, these types of spillover benefits that result from greater individual knowledge contributing to economic progress are fully internalized into one's own individual demand curve for education. The issue discussed in this article is whether K–12 education produces any spillover benefits for which the individual is left uncompensated.

The most compelling argument is that as individuals become educated, others benefit from their ability to interact with one another and share a common language and numbering system, which facilitates trade and human interaction on a broader social scale. It can be argued that these types of benefits cannot be *fully* internalized by the individual receiving the education. For the remainder of this article I will use the term spillover benefits only when referring to these types of external benefits, excluding the positive benefits that accrue to others for which the individual is fully compensated through market earnings.

It is important for a moment to digress into a discussion of whether these spillover benefits are, at the margin, a case of a relevant positive

externality problem or an irrelevant positive externality problem. Even if K–12 education creates a positive externality, this outcome does not necessarily imply the presence of a market failure. Following Buchanan and Stubblebine (1962), some externalities can be *inframarginal*, and thus not Pareto-relevant.[2] This may be the case if the external benefits produced in the first few years of education are followed by additional years of education that fail to produce additional external benefits. As Holcombe (1996) argues, the external benefits accruing from the knowledge of a common language and numbering system are produced almost entirely in the first few years of school.

In addition to the first few years of elementary education, students may also gain certain skills from the first few years of secondary education, which gives them the ability to create external benefits that are not entirely compensated through market earnings. For instance, everyone as a consumer is benefited by the presence of other informed consumers in the marketplace. In addition, benefits are also gained from active and informed citizens participating in the political process.

The Empirical Model

In order to test for the presence of these Pareto-relevant external benefits, I employ a median voter demand curve model. Originally developed by Bowen (1943), and conceptually enriched by Downs (1957) and Black (1958), this model is frequently used to measure the degree of publicness (versus pure privateness) for a good produced by the public sector. For example, Holcombe and Sobel (1995) test the degree to which legislative activity is a public good; Deno and Mehay (1987) use the median voter model to analyze the expenditure levels adopted by two forms of government; and Bergstrom and Goodman (1973) and Borcherding and Deacon (1972) analyze the demand for various public goods and services. In addition, Langbein (2004) uses the median voter model to analyze whether a publicness element is present for public school music.

Inman (1978) provides empirical evidence that the median voter model is a good predictor of reality showing that a sample of Long Island schools created their budgets "as if the median income family were decisive." In addition, researchers such as Congleton and

[2]A marginal external benefit with a zero value at the market output is known as an inframarginal externality. In this case, the market outcome is optimal from consumers' viewpoint. A government subsidy would lead to overproduction and overconsumption.

Shughart (1990) and Congleton and Bennett (1995) have shown that the median voter model does a better job explaining large-scale public programs than comparable interest group models. It is important to note however, that the median voter model is not always a perfect predictor of public policy outcomes when political institutions are taken into account. Holcombe (1980) and Frey (1994) have shown significant policy differences between representative and direct forms of democracy resulting from possible agency problems contained within representative government. For the purposes of this article, I follow Congleton (2003) in assuming that the median voter can "credibly be thought to understand and care about public policy," in particular about education. Under these circumstances Congleton (2003) states, "The median voter model appears to be quite robust as a model of public policy formation."

The model employed here attempts to analyze whether a change in population results in a change in the quantity of the education provided. The logic is that for a good that is joint-in-consumption, if another individual were to relocate into the community, they could share in the amount already being produced. Thus, the optimal quantity does not change with the size of the population. The benefits from the production of the education, if it is a pure public good, can be extended to additional people at zero marginal cost. Rather than estimating whether the coefficient on population is zero, however, this test takes into account that the tax cost per person is also reduced as more people consume the education already being produced, which should result in a higher quantity demanded and optimal level of provision.

In order to utilize the median voter model we will assume that spending on public education is determined in a political framework in which voters have demands for the output derived from education. Following the original analysis of public goods by Bowen (1943), it is assumed that public elementary and secondary education can be provided at a constant marginal cost. The marginal cost (MC) is divided between the N individuals/voters who reside in the community for which the school is located. Each individual's tax share is therefore MC/N, which we assume each voter wants to equate with the marginal benefits from an additional unit of output from public education. Following these assumptions, the majority voting rule implies that the median voter's preferences prevail. In addition, it is the case that successful candidates for government office, or more specifically in this case, candidates for the school board, will be those who propose platforms that bring the median voter's marginal tax price in line with the marginal benefit received by that voter.

Voters will decide how much education they desire by comparing the marginal benefits of education with their marginal tax prices. If voters are well informed regarding the costs and benefits of local government services, individual preferences are single peaked and no strategic vote trading occurs. The elected school board candidates will ensure that the marginal tax price charged to the median voter equals the marginal benefit received from public education. The quantity of education supplied will therefore be equal to the quantity demanded by the median voter.[3] Let the utility function of the median voter be given by

$$(1) \quad U_i = U_i (X_i, e_i)$$

where e_i is the quantity of public education consumed by the median voter, and X_i is the quantity of other goods consumed. Of the total amount of education supplied (E) the amount that is consumed by the median voter (e_i) can be defined by the function

$$(2) \quad e_i = N^{-\alpha}E$$

where N is the number of people sharing the benefits of public education.[4] Thus, the value $\alpha = 1$ implies that education is a purely private good, and $\alpha = 0$ implies that education is a pure public good. Intermediate values of α imply quasi-publicness or quasi-privateness in consumption.

The median voter's demand function for education is found by maximizing (1) subject to

$$(3) \quad Y_i = P_x X_i + T_i P_E E$$

where Y_i is the median voter's income after federal and state taxes, P_x is the price of the other goods X, T_i is the voter's tax share, and P_E is the unit cost of providing education.

Substituting from equation (2), the budget constraint can be re-written as

$$(4) \quad Y_i = P_x X_i + T_i P_E e_i N^{\alpha}$$

which through optimization generates the demand equation

$$(5) \quad e_i = e_i(P_x, T_i, P_E, N, Y_i).$$

For empirical purposes, I assume that the price of other goods is the same across states, but I will allow for differences in the unit cost of

[3]Deno and Mehay (1987) use this model to analyze expenditure levels across municipalities to determine the characteristics of local public goods.

[4]In the empirical estimation, total population less than 65 is used to better gauge those people in the community who are actually sharing in the benefits of education.

providing education. In addition, let vector A represent differences in tastes across states while using a constant elasticity demand function to produce

$$(6) \quad e_i = A(T_i N^{\alpha})^{\sigma} Y_i^{\lambda}.$$

The total demand for E, is given by

$$(7) \quad E = AT_i^{\sigma} N^{\alpha(1+\sigma)} Y_i^{\lambda}$$

or

$$(8) \quad E = AT_i^{\sigma} N^{\theta} Y_i^{\lambda}$$

where $\theta = \alpha(1 + \sigma)$. Taking logarithms, the median voter's demand equation for E is

$$(9) \quad \ln E = \ln A + \sigma \ln T_i + \theta \ln N + \lambda \ln Y_i.$$

The median voter's disposable income Y_i, is calculated as

$$(10) \quad Y_i = Y_i^{*} + T_i G - F$$

where Y_i^{*} is gross state median income, G is federal grants to the state in which the median voter lives, and F is the voter's federal tax liability, which is calculated by multiplying the average federal tax rate by median income.[5] The voter's share of federal grants is represented by $T_i G$ and is calculated under the assumption that the voter's benefit share is the same as the voter's tax share. T_i is calculated by multiplying the average tax rate on income and sales taxes by the median income to get the median state income and sales tax liability, and then dividing this number by total individual income and state general sales tax revenues.[6] The calculations involved in determining $T_i G$ allow for the final measure of median income (Y_i) to take into account the financing of K–12 education at the state level. Finally, because median income is a before-tax measure, the median voter's state and federal tax liabilities must be deducted from gross median income Y_i^{*} in order to obtain the correct measure of disposable income.[7]

[5]See Bradford and Oates (1971) for an analysis showing how lump-sum grants have the same impact on local public good demand as a grant given in proportion to an individual's local tax share.

[6]An alternative calculation of T_i was also analyzed which included the effective property tax rate, based on the median value home for the year 2000 with no significant changes occurring in the resulting estimates of tax share liability.

[7]Many papers have followed this approach to calculating disposable income. I continue to follow Deno and Mehay (1987) on this issue.

The shift parameter A in equation (9) captures any fundamental differences in preferences across states. Although a precise theory of preference formation is nonexistent, certain control variables seem appropriate when considering the demand for education. Following Holcombe and Sobel (1995), I use population density, median age of the residents in the state, the percent of population non-white, and the percent of the population under 18 to reflect voter preferences. Population density is included to capture the ease with which different states are able to take advantage of scale economies in schooling, while median age is used to control for the possibility that older populations may have less demand for public education. Although the following variables are not perfect proxies, the percent of population non-white and the percent of the population less than 18 are used as controls to account for the fact that the cost of raising the quality of education received by each student is greater if there are more students who need additional resources. If any *perceived* differences in the cost of raising the quality of education exist, this factor may influence the demand for education by the median voter.

The median voter's demand equation for public education becomes:

$$\begin{aligned}(11)\quad \ln \text{Expenditures} &= \beta_1 + \beta_2 \ln \text{Tax}_i + \beta_3 \ln \text{Population} \\ &+ \beta_4 \ln \text{Income}_i + \beta_5 \ln \text{Population Density} \\ &+ \beta_6 \ln \text{Median Age} + \beta_7 \ln \text{Non-White} \\ &+ \beta_6 \ln \text{Population Less Than 18} + \varepsilon, \text{ where } \varepsilon \text{ is the error term.}\end{aligned}$$

The Empirical Results

Equation (11) is estimated using state and local expenditure data for 48 states and the District of Columbia for the 1979–1980, 1989–1990, and 1999–2000 school years, and the results are reported in Table 1.[8] The measure of publicness, α, was calculated as $\alpha = \theta/(1+\sigma) = \beta_3/(1+\beta_2)$ where β_3 and β_2 are the estimated elasticities of expenditures with respect to population and tax share, respectively.

Table 1 reveals that for the 1999–2000 school year, K–12 education was 93.7 percent private and thus only 6.3 percent public.[9] An F-test was performed to determine whether α; was significantly different

[8]Alaska and New Hampshire are excluded due to missing data in various years. Data were collected from the U.S. Census Bureau and Feenberg and Rosen (1985).

[9]To benefit the reader, the measure of publicness is shown in the tables in two ways. Because α was found to be close to 1 implying a more private good, I refer to α as the "degree of privateness." The degree of publicness is thus expressed in Table 2 as $1-\alpha$.

TABLE 1

K–12 PUBLIC EXPENDITURE ESTIMATES: UNRESTRICTED MODEL

Independent Variable	Coefficient Estimates: 1999–2000 School Year	1989–1990 School Year	1979–1980 School Year
Constant	–8.501**	–6.802*	–7.320**
	(3.434)	(3.664)	(3.115)
Tax Share (TAX)	0.018	–0.056	0.029
	(0.039)	(0.062)	(0.036)
Population (POP)	0.953***	0.951***	0.979***
	(0.018)	(0.022)	(0.019)
Disposable Income (INCOME)	0.087	0.198	0.601***
	(0.177)	(0.262)	(0.250)
Population Density (DEN)	0.038*	0.042	–0.024
	(0.022)	(0.025)	(0.018)
Median Age (AGE)	1.281***	1.653	0.802
	(0.503)	(0.954)	(0.812)
Percent Non-White (NW)	–0.054**	–0.068***	–0.026
	(0.025)	(0.026)	(0.019)
Percent under 18 (LESSTHAN18)	1.102**	1.066	0.168
	(0.477)	(0.643)	(0.562)
Salary (SALARY)	0.661***	0.673**	0.484**
	(0.168)	(0.270)	(0.218)
Calculated Degree of Publicness ($1-\alpha$)	0.063	0.000	0.048
Calculated Degree of Privateness (α)	0.937	1.000	0.952
Adjusted R^2	0.991	0.987	0.989
Observations	49	49	49

NOTES: For the coefficient estimates, standard errors are in parentheses and the asterisks indicate significance as follows: *** = 1 percent, ** = 5 percent, * = 10 percent. The asterisks on calculated numbers represent the results from an F-test performed to determine whether α was significantly different than one and indicate significance as follows: *** = 1 percent, ** = 5 percent, * = 10 percent.

from 1 by testing the linear restriction H_o: $\beta_2 - \beta_3 = -1$. The results indicate that the degree of privateness, α, is in fact *not* significantly different than 1 and therefore implies that K–12 education is almost entirely a private good with little or no spillover benefits. The same analysis applies to the 1989–1990 and 1979–1980 school years with the results showing education to be approximately 100 and 95.2 percent private in each respective school year. The degree of publicness,

1–α, from Table 1 implies that K–12 education has been largely a private good for the past three decades with the measure changing very little over time.

Consistent with previous studies, the estimates for population are positive and significant for all three school years. Income elasticity is positive in all three specifications but only statistically significant for the 1979–1980 school year. Population density is also significant only in one specification, which is not an uncommon finding in most empirical studies of this nature.[10] Median age is found to be positive and significant in the 1999–2000 school year, which is the opposite of what is to be expected. This may reflect the life-cycle hypothesis or may be capturing the fact that more recently individuals have been putting off the starting of families until a later stage in life. The percent of the population non-white is negative in all three regressions and significant for the 1999–2000 and 1989–1990 school years, which coincides with previous studies. The percent of the population less than 18 is positive and significant in one specification, which does not conform to previous expectations, but may reflect the fact that the median voter is represented by a higher number of parents and thus higher demands for education. Finally, the salary variable used to control for cost differences among states is positive and significant in all three school years.

Further inspection of Table 1 indicates that the tax share elasticity is insignificant in all three periods. However, consistent with the results of the F-test already performed, if education is restricted to be a purely private good, the results indicate that the tax share is negative in all three time periods and significant for the 1999–2000 and 1989–1990 school years. This outcome implies that the tax cost per person may be an important determinant of the amount of education demanded by the median voter as is suggested by theory. The results of the restricted model can be found in Table 2.

Conclusion

Traditionally government has played a large role in providing elementary and secondary public education. The results of this article suggest that K–12 education is entirely, or almost entirely, a private good with little or no significant external benefits. This finding substantially weakens the case for government involvement in K–12 education on efficiency grounds.

[10]See Bergstrom and Goodman (1973), Deno and Mehay (1987).

TABLE 2

K–12 PUBLIC EXPENDITURE ESTIMATES: RESTRICTED MODEL

Independent Variable	Coefficient Estimates 1999–2000 School Year	1989–1990 School Year	1979–1980 School Year
Constant	–7.614**	–6.872*	–6.201**
	(3.434)	(3.560)	(3.001)
Tax Share (TAX)	–0.035**	–0.050***	–0.011
	(0.016)	(0.019)	(0.017)
Population (POP)	0.965***	0.950***	0.989***
	(0.016)	(0.019)	(0.017)
Disposable Income (INCOME)	0.115	0.195	0.559**
	(0.179)	(0.258)	(0.250)
Population Density (DEN)	0.038*	0.042	–0.020
	(0.022)	(0.025)	(0.018)
Median Age (AGE)	1.132***	1.674	0.434
	(0.501)	(0.922)	(0.760)
Percent Non-White (NW)	–0.061**	–0.067***	–0.031
	(0.025)	(0.026)	(0.019)
Percent under 18 (LESSTHAN18)	0.940**	1.078*	0.008
	(0.472)	(0.626)	(0.550)
Salary (SALARY)	0.663***	0.679***	0.495**
	(0.169)	(0.261)	(0.219)
Adjusted R^2	0.991	0.987	0.989
F-statistic for restrictions	2.248	0.011	1.530
Observations	49	49	49

NOTES: For the coefficient estimates, standard errors are in parentheses and the asterisks indicate significance as follows: *** = 1 percent, ** = 5 percent, * = 10 percent. The asterisks on calculated numbers represent the results from an F-test performed to determine whether α was significantly different than one and indicate significance as follows: *** = 1 percent, ** = 5 percent, * = 10 percent.

The purpose of this article was to weigh in on the debate regarding the proper role of government in K–12 education by looking at the extent to which education suffers from a market failure based on the positive externality or spillover argument. Given the assumptions of the median voter model, at the margin, education does not appear to produce significant Pareto-relevant spillover benefits. Consequently, the magnitude of governmental involvement in the K–12 education sector needs to be examined more closely. One could also speculate that the current problems embedded within K–12 education are

manifested by the presence of government failures that perhaps could be corrected if there was more competition in the K–12 education market.

When the public sector produces K–12 education, a good that has been shown to more closely fit the definition of a private good, there is no reason to expect the public sector to outperform the private sector in this market. By measuring the spillover effects created by K–12 education, this article provides some evidence in favor of less government intervention based on the market failure argument and also contributes to the ongoing debate over the proper role of government in K–12 education.

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