On The Revenue–Expenditure Nexus: Evidence From Local School Districts

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The paper examines the causal effects between local property tax revenues, local school district expenditures, and state grants for education to local school districts in Missouri from 1980 to 1988. Estimating vector autoregressions and employing Granger causality tests, evidence is found of bidirectional causality between revenues and expenditures, while grants cause expenditures but not revenues. An implication of the finding of bidirectional causality is that those who seek to control local property tax growth will be forced to accept less spending for public education, while those who seek to expand local spending for public education will have to find ways of raising local property tax revenue.

INTRODUCTION

This paper examines the linkage between spending and taxing decisions for local education. The paper addresses the following questions:

- Do changes in local school district spending and state grants for education precede changes in local school district property tax revenues?
- Or do changes in local school district property tax revenues and state grants for education precede changes in local school district spending for education?

We answer these questions by combining cross-sectional and time series data for 541 Missouri school districts for the school years 1980/1981 to 1987/1988 and employ the Holtz-Eakin, Newey, and Rosen (1989) model of revenue-expenditure Granger-causality.

Past studies of revenue-expenditure causality have examined federal and state spending and tax decisions across broad categories of public services. By examining a specific public service, education, we can avoid problems that may arise from aggregating broad categories of services and revenue sources. By using data from a single state, problems that may arise from states having different constitutions and financing provisions for public education are minimized. The tradeoff made when using disaggregated data for education is that the empirical results may not hold for other narrow categories of public services, such as police and fire protection or highway services. On the other hand, there were over 14,700 local school districts in the U.S. during our sample period and the financing of these school districts accounted for the largest proportion (approximately 34 percent in 1988) of local government budgets (*Statistical Abstract of the United States*, 1992). In

* We would like to thank Rolf Fare and Shawna Grosskopf for helpful comments and suggestions on an earlier version of this paper. The editor and three anonymous referees have also helped sharpen the ideas and exposition of the paper. Daneshvary would like to acknowledge partial financial support by the First Interstate Bank of Nevada. We maintain responsibility for any remaining errors or shortcomings.

0747-5535/95/1600-0025 $01.00

addition, local spending for primary and secondary education grew 82 percent in the U.S. and 83 percent in Missouri in nominal dollars during our sample period 1980 to 1988, which should allow for extensions of our results to other states.

We also examine the effects of state grants for education on the spending and tax decisions of local school districts. Flypaper effects are said to exist when a dollar increase in lump-sum grants stimulates public spending by more than a dollar increase in local income. In other words, the money sticks where it hits. With cross-section data, researchers have found the existence of flypaper effects. The existence of such effects can be attributed to fiscal illusion by the representative voter or by bureaucrats (school boards) that are able to exercise control over the agenda.

There are several reasons to believe that flypaper effects may diminish over time. Fiscal illusion exists when voters perceive the tax price they face to be less than the true tax price. Using time series data allows us to investigate whether the representative voter acquired greater information on the consequences of intergovernmental grants as time elapsed. If voters are faced with monopolistic bureaucratic control of school boards and if school boards prefer more spending for education than voters, then increases in grants should cause spending for education to increase. In this case, spending is resource or supply determined. School board elections, however, tend to occur frequently. Such elections should enable the representative voter to choose board members that set an agenda more in line with their preferences, so that public spending for education is determined by the demanders (citizens). Employing time series and cross section data, we seek to determine if flypaper effects are a short-run phenomenon or if they hold over time as well. The econometric technique we employ helps to account for regime changes at the state level (such as changes in political leadership and educational statutes) that may influence the role that grants play.[1]

There are four hypotheses concerning causality between government revenues and expenditures. The first hypothesis is that government spending and taxing decisions change simultaneously. This hypothesis often is attributed to policy makers comparing the marginal benefits and the marginal costs of a proposed change and implementing those changes where the marginal benefits outweigh the marginal costs. For local school districts, one also can think of the median voter casting a ballot in a school election after weighing the benefits and costs of the proposed change.

The second hypothesis maintains that taxes cause spending. Governments that are restricted from running deficits, either statutorily or as a result of pressure from citizen voters who are averse to budget deficits, must raise tax revenues before spending can be increased. Supply-siders also support this hypothesis when they claim that the way to slow or halt the growth of expenditures is to cut taxes, while raising taxes to fight deficits may be self-defeating if taxes cause spending. The landmark 1971 *Serrano v. Priest* Supreme Court case alludes to the taxes-cause-spending hypothesis for local schools; in this case, the justices ruled that local school district spending could not be a function of local school district wealth. Even though Serrano subsequently was over-

[1] Our model is able to control indirectly for regime changes at the school district level by allowing each school district to have an individual effect that varies across school districts.

turned, most states still feel an obligation to provide aid to local school districts to reduce the differential effects of wealth on local spending for education.

The third hypothesis maintains that spending causes taxes. It is consistent with the displacement effect of Peacock and Wiseman (1979) in which a *social disturbance* occurs that causes public spending to increase initially, after which taxes begin to rise to a permanently higher level as citizen voters inspect social problems that have become more visible because of the disturbance.

A fourth hypothesis maintains that there is no causal relationship between spending and taxing decisions, suggesting that fiscal policy is random. This hypothesis, although partially supported by the work of von Furstenburg, Green, and Jeong (1986), may not be plausible when examining a narrow spending category such as education, where local control is generally high.

THE FLYPAPER EFFECTS OF GRANTS

While past empirical studies have found the existence of flypaper effects, several recent theoretical studies have sought to explain why these effects exist. The production of education generally is thought to depend on the level of home inputs (such as past student achievement and parental involvement) and purchased school inputs (such as teachers, administrators, and libraries). Bruce Hamilton (1983) shows that observed flypaper effects may occur because own income, serving as a proxy for home inputs, is a substitute for purchased school inputs in the production of education. In his model, an increase in grants causes the demand for all purchased inputs to increase. When income increases, however, two effects occur simultaneously. One effect is that the demand for all purchased inputs increases. At the same time, schools may substitute home inputs for purchased school inputs. This leads to a flypaper effect, with an increase in grants having a larger effect on school spending than an equivalent increase in income.

Jonathan Hamilton (1986) built a model to explain flypaper effects by assuming that citizens in a locality ignore the efficiency loss due to price distorting federal taxation, but account for the efficiency loss due to price distorting local taxation. Citizens in local communities have a higher propensity to spend for public services from grants than they do from their own income.

Winer (1983) and Logan (1986) examine how fiscal illusion by citizen voters may lead to an expansion of the local public sector. In Winer's model, when the central government finances local public services, voters may perceive grants as a decrease in the marginal cost of public services with part of the cost shifted to other local governments. Logan, however, argues that the fiscal illusion present in Winer's model leads to actual realized disposable income being less than perceived disposable income. To reconcile this discrepancy, Logan assumes that federal grants to local governments cause voters to perceive that federal tax prices are rising while local tax prices are falling. This dual illusion by citizen taxpayers brings actual and perceived disposable income into line and theoretically should lead to an expansion of the local public sector at the expense of federal non-aid expenditures. Logan's empirical work supports his theory.

Holtz-Eakin, Newey, and Rosen (1989) examine the effects of grants on spending and revenues in a dynamic model using cross-section data for 171 municipalities and time series data for 1972 to 1980. They find that grants do appear to affect both the expenditure

and the revenue structure of the municipalities, suggesting the existence of flypaper effects. In examining the effects of grants on education, Cohn (1987) finds that state and federal education grants to local school districts in South Carolina are stimulative, indicating a flypaper effect. Craig and Inman (1982), however, find that unconstrained federal aid for education usually have no flypaper effect, with the aid being used for tax relief by the state governments. Examining the expenditure response of grants for 41 Virginia cities, Gist (1988) hypothesizes that flypaper effects should be greater for cities experiencing high fiscal stress and lower for cities that are in good shape financially. Yet his findings suggest that for public education, flypaper effects are not present for cities of either type.

The theoretical and empirical literature on the flypaper effects of grants is far from conclusive. The mixed evidence suggests that when testing for revenue-expenditure causality, grants should be included as an explanatory variable. Our model of revenue-expenditure causality accounts for the effects of grants and provides a test for the existence of flypaper effects by examining whether changes in grants precede revenues and whether changes in grants precede expenditures.

LITERATURE REVIEW

A common method of testing for causality involves estimating vector autoregressive (VAR) models and employing the concept of Granger causality. Let E_t and R_t be defined as expenditures and revenues in period t and let $E_t^* = (E_{t-1}, \ldots, E_{t-L})$ and $R_t^* = (R_{t-1}, \ldots, R_{t-L})$ represent the L lagged values of expenditures and revenues. Let the expression $\sigma^2(E_t|E_t^*)$ represent the conditional variance of the forecast error of expenditures from lagged values of expenditures and let the expression $\sigma^2(E_t|E_t^*, R_t^*)$ represent the conditional variance of the forecast error of expenditures on the lagged values of expenditures and the lagged values of revenues. If the current values of expenditures can be better explained by the past values of both expenditure and revenue than the past values of expenditure alone, then revenues are said to Granger cause expenditures. In other words, expenditures can be predicted more efficiently (in a statistical sense) when the information in past values of revenues is taken into account. This condition is reflected by

$$(1)\ \sigma^2 (E_t|E_t^*, R_t^*) < \sigma^2 (E_t|E_t^*).$$

Expenditures are said to Granger cause revenues if

$$(2)\ \sigma^2 (R_t|R_t^*, E_t^*) < \sigma^2 (R_t|R_t^*).$$

Bidirectional causality exists if equations (1) and (2) both hold. With bidirectional causality, revenues and expenditures are determined simultaneously.

Depending on the data set employed, past empirical research on revenue-expenditure causality has yielded differing results.[2] Using annual federal data, Manage and Marlow

[2] The divergence in results can be attributed to several factors. These factors include the choice of time period, the use of quarterly or annual data, and the lag structure. Also important is the choice of government unit to analyze: local, state, or federal. Whether the researcher defines revenues and expenditures in nominal, real, or per capita terms also can lead to varying results. Of additional concern is whether revenues and expenditures are adjusted for the effects of automatic tax and spending changes due to the business cycle and for nondiscretionary changes in interest payments on expenditures. Another possible

(1986), Blackley (1986), and Ram (1988) find bidirectional causality between federal revenues and expenditures. Anderson, Wallace, and Warner (1986) find that expenditures cause revenues. Using quarterly federal data, von Furstenberg, Green, and Jeong (1986) find that expenditures cause revenues, while the results of Ram (1988) suggest that revenues cause expenditures for a different time series of federal data.

Marlow and Manage (1987) employ Granger causality tests using spending and tax data for the 50 states and find evidence that revenues cause expenditures and weak evidence of bidirectional causality for a model with only two lags. They also aggregate local government spending to the state level and find that revenues cause expenditures for a model with two lags. Ram (1988), however, concludes that expenditures cause state and local revenues. Joulfaian and Mookerjee (1990) employ data from Massachusetts to avoid the potential bias from multistate aggregation of expenditures and revenues and find that revenues cause expenditures. Holtz-Eakin, Newey, and Rosen (1989) employ cross-section and time series data and conclude that revenues cause expenditures in their sample of 171 municipalities.

Blackley (1990) investigates the existence of asymmetric causality between federal revenues and expenditures. Blackley assumes that voters perceive tax decreases and expenditure increases as benefits, while tax increases and expenditure decreases are perceived as costs. Because rational voters seek to avoid any fiscal loss when tax revenues and expenditures are changed, they will require expenditure increases before revenues can be raised and will require tax cuts before expenditures can be reduced. Expenditure cuts, however, likely will not precede tax cuts and tax increases likely will not precede expenditure increases. Again, this is because voters seek to avoid any fiscal loss when faced with uncertainty. If asymmetric causality exists, budget deficits will be required to finance any change in expenditures and revenues. Blackley's hypothesis is supported empirically with data from 1946/1947 to 1986/1987.

Despite the large number of studies examining revenue-expenditure causality, consensus on the direction of causality is still elusive. Of the studies examining federal revenue and expenditures, three find bidirectional causality, two find evidence that expenditures cause revenues, and one study finds that revenues cause expenditures. For the studies examining state and/or local revenues and expenditures, two find that revenues cause expenditures, one finds that expenditures cause revenues, and one finds the existence of bidirectional causality.

This study seeks to resolve some of the issues that may have led to a divergence in the results of previous studies. Rather than choose an arbitrary lag length, we test for an optimal lag length. We also test the implicit assumption of parameter stationarity and account for possible simultaneous equation bias in our model. In addition to examining the issue of revenue-expenditure causality for local school districts, we also seek to clarify the influence that grants have on local school district spending and local school district revenues.

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reason for divergence in results is due to the measurement of revenue and expenditure changes. These changes can be measured in absolute terms, in percentage terms, or as the proportion of aggregate economic activity, such as GNP.

MODEL AND EMPIRICAL RESULTS

THE MODEL

We create a model to test for revenue-expenditure causality using local school districts in Missouri as observations for the eight year period 1980/1981 to 1987/1988. The release of *A Nation at Risk: The Imperative for Educational Reform* in 1983 (Gardner *et al.*, 1983), which focused public attention on education and triggered a wave of state educational reforms, makes 1980 to 1988 a compelling period for study. During the sample period Missouri implemented a major reform in the delivery of state aid to local school districts with the passage of Proposition C in 1982. Proposition C increased the Missouri state sales tax by one cent, with half of the additional revenue earmarked for education.

Missouri delivers state aid to local school districts through a hybrid foundation aid and district power equalization (DPE) formula. The foundation part of the formula provides a minimum level of aid to each school district and is essentially a lump-sum grant. The DPE part of the formula adjusts state aid for interdistrict differences in property assessed valuation and therefore, affects the tax price of education faced by the school district. Twenty-six states delivered aid to local school districts through a foundation program in 1985/1986, and another twelve states delivered aid through hybrid formulae which include either a foundation program or a DPE program (Cohn and Geske, 1990). Because our model accounts not only for lump-sum grants, but also grants that change the tax price faced by local school districts, it should be applied to individual state data sets to compare revenue-expenditure causality effects across states.

The total number of school districts in Missouri ranged from 554 in 1980 to 545 in 1988. Complete data on 541 school districts are available for each year and are used to estimate the model. We follow the model developed by Holtz-Eakin, Newey, and Rosen (1988, 1989) to combine the cross-section and time series data. School districts are indexed by the subscripts i = 1, ... N, and time periods are indexed by the subscripts t = 1, ... T. The number of lags on the right side variables are indexed by the subscripts m = 1, ... L. We describe our model using expenditures for school district i at time t, E_{it}, as the dependent variable with local property tax revenues for district i at time t, R_{it}, as the independent variable. We also interchange E_{it} and R_{it} and consider a model with revenues as the dependent variable.

State grants to the ith school district at time t are G_{it}, and the equalized assessed valuation of property per student, AV_{it}, serves as our proxy for demographic and taste variables. A variable, f_i, corresponds to an individual effect for the ith school district and accounts for demographic and taste differences not captured by assessed valuation. An error term is defined as u_{it}, and the parameters of the model are α_o, Γ_t, the α_{mt}s, β_{mt}s, δ_{mt}s, and τ_{mt}s.

The model takes the form:

$$(3)\quad E_{it} = \alpha_o + \Gamma_t f_i + \sum_{m=1}^{L} \alpha_{mt} E_{it-m} + \sum_{m=1}^{L} \beta_{mt} R_{it-m} + \sum_{m=1}^{L} \delta_{mt} G_{it-m} + \sum_{m=1}^{L} \tau_{mt} AV_{it-m} + u_{it}$$

$$i = 1, \ldots N,\ t = m+1, \ldots T.$$

The slope coefficients for the lagged dependent variables, α_{mt}s, and the slope coefficients for the lagged independent variables, β_{mt}s, δ_{mt}s, and τ_{mt}s, vary for each time period but are constant across school districts. The time-varying slope coefficients allow for regime changes at the state level to occur. These regime changes may include changes in political leadership and changes in the general economic climate of the state.

A test of the hypothesis that revenues cause expenditures involves jointly testing whether the β_{mt}s are significantly different from zero. A test of the hypothesis that grants cause expenditures involves jointly testing whether the δ_{mt}s are significantly different from zero.

The variables f_i and AV_{it} in equation (3) are included to capture individual differences in local school districts because of differences in socioeconomic variables. In examining the issue of causality between spending and taxing decisions, we seek to explore the effects of spending and taxes that are not explained by differences in socioeconomic variables. Missouri's hybrid formula for allocating aid to local school districts has aspects of both a lump-sum grant and a matching grant. The total value of grants received is included in the term Γ_{it}. Matching grants, in addition to having an income effect, also have price effects that vary between school districts and depend on assessed values. The term f_i serves to capture the price effects of matching grants and also serves to capture any additional differences in school district preferences not accounted for by AV, such as regime changes at the school district level that may result from school elections where voters choose new board members.

Letting one of the 541 school districts in our sample serve as a reference, estimation of equation (3) would include estimating 541 – 1 = 540 individual effect parameters, a burdensome number. Because the goal of this study is to examine issues related to revenue-expenditure causality and not to estimate individual effects, we follow a standard procedure to eliminate the individual effect parameters. To eliminate the term, f_i, present in equation (3), multiply equation (3) for period t by $r_t = \Gamma_{t+1}/\Gamma_t$ and subtract it from the equation for period t+1. Rearranging and collecting terms yields

$$(4)\quad E_{it} = a_t + \sum_{m=1}^{L+1} b_{mt}E_{it-m} + \sum_{m=1}^{L+1} c_{mt}R_{it-m} + \sum_{m=1}^{L+1} d_{mt}G_{it-m} + \sum_{m=1}^{L+1} h_{mt}AV_{it-m} + v_{it},$$

$$i = 1, \ldots N,\ t = m+2, \ldots T,$$

where the parameters of the model have been redefined as

$$\begin{aligned}
&a_t = \alpha_0 - r_t\alpha_0,\\
&b_{1t} = r_t + \alpha_{1t},\ b_{mt} = \alpha_{m1} - r_t\alpha_{m-1,t-1},\ m = 2, \ldots L,\\
&b_{L+1,t} = -r_t\alpha_{L,t-1},\\
&c_{1t} = \beta_{1t},\ c_{mt} = \beta_{mt} - r_t\beta_{m-1,t-1},\ m = 2, \ldots L,\\
&c_{L+1,t} = -r_t\beta_{L,t-1},\\
&d_{1t} = \delta_{1t},\ d_{mt} = \delta_{mt} - r_t\delta_{m-1,t-1},\ m = 2, \ldots L,\\
&d_{L+1,t} = -r_t\delta_{L,t-1},
\end{aligned} \qquad (5)$$

$h_{1t} = \tau_{1t}$, $h_{mt} = \tau_{mt} - r_t\tau_{m-1,t-1}$, $m = 2, \ldots L$,
$h_{L+1,t} = -r_t\tau_{L,t-1}$, and
$v_{it} = u_{it} - r_t u_{it-1}$.

From equation (1), revenues are said to cause expenditures when the conditional variance of the forecast error of expenditures is less when the past values of expenditures and revenues are accounted for than when the model is restricted to include only the past values of expenditures. To test the hypothesis that revenues cause expenditures, we test the joint hypothesis that $c_{1t} = c_{2t} = \ldots = c_{L+1,t} = 0$. To implement equation (1), we test whether the restricted sum of squared residuals is significantly different from the unrestricted sum of squared residuals, using a chi-square test, where the restrictions are embodied in the joint hypothesis given above. To test the hypothesis that grants cause expenditures, we test the joint hypothesis that $d_{1t} = d_{2t} = \ldots = d_{L+1,t} = 0$. Because the dependent variable in equation 3, E_{it}, depends on u_{it}, the transformed error term in equation (4), $v_{it} = u_{it+1} - r_t u_{it}$, will be correlated with the transformed regressor $(E_{it+1} - r_t E_{it})$. Thus, estimation of equation (4) by OLS or GLS will not produce accurate results because of simultaneity bias. To account for this simultaneity problem when estimating equation (4), we implement an instrumental variables technique. Holtz-Eakin, Newey, and Rosen (1988) provide formulae for estimation and discuss identification and hypothesis testing of the system of equations given by equation (4).[3]

For the system of equations given by equation (4), there are N observations (school districts) for each period and L lags. The equation for each period has 4*L right-side variables and an intercept. There also must be at least ((4*L)+1) instruments for identification of each equation. The instruments that are available for each time period are $[1, E_{it-2}, \ldots, E_{i1}, R_{it-2}, \ldots, R_{i1}, G_{it-2}, \ldots, G_{i1}, AV_{it-2}, \ldots, AV_{i1}]$. Therefore, only the equations for the periods $t \geq L + 3$ can be estimated. For example, when there are two lags, L = 2, and eight periods, only equations for periods 5, 6, 7, and 8 can be estimated.

To estimate the model given by equation (4), a suitable lag length for the right-side variables must be chosen. Holtz-Eakin, Newey, and Rosen (1989) find that a lag length of L = 2 sufficiently characterizes their data. Manage and Marlow(1986) also find weak evidence that revenues cause expenditures for a model with two lags. We also begin by estimating a model with L = 2 lags and test whether this lag structure is sufficient to characterize the data and then test whether shorter lags can characterize the data.[4] With two lags, the equations for periods 5 through 8 (1984/1985 to 1987/1988) can be estimated. These equations are estimated using three stage least squares and the minimized value of the chi-square statistic, denoted by Q, is calculated. The minimized value of Q is equal to the unrestricted system sum of squared error terms, accounting for the instrumental vari-

[3] To implement the model, we first stacked the cross-section data for each time period, took appropriate lags, and defined instrumental variables for each period. To estimate the model we used the SAS algorithm, PROC SYSNLIN 3SLS.

[4] The choice of L = 2 lags is used to estimate the variance-covariance matrix of residuals which then is used to test various restrictions. While the choice of lag length is somewhat ad hoc, the lag length chosen should be long enough to avoid truncating the data. The test statistic of the restriction that L = 2 is consistent with the data.

ables employed and the simultaneity of the system.[5] To test whether the system with two lags is sufficient to characterize the data, we compare Q with the critical chi-square value.[6] The number of degrees of freedom is equal to the sum of the number of instrumental variables for each time period minus the number of parameters estimated.[7] There are 76 instrumental variables and 13 parameters to be estimated for each of the four years for a model with two lags. The number of degrees of freedom is thus 76 – 52 = 24.

Table 1 provides descriptive statistics of the variables for expenditures, property tax revenues, state grants, and property assessed valuation. All variables used in the empirical section are in logarithmic real terms per eligible pupil in the school district.

Table 1—Means and Standard Deviations of Expenditure, Revenue, Grants, and Assessed Valuation[1]

Year	Expenditure	Revenue	State Grants	Assessed Valuation
1980 to 1981	$2131.77	$905.62	$1122.75	$34542.58
	(392.51)	(523.89)	(255.94)	(19299.66)
1982 to 1982	2115.42	935.19	1110.54	34877.54
	(435.00)	(556.51)	(250.74)	(21520.72)
1982 to 1983	2148.40	1051.86	1123.06	34835.56
	(449.99)	(580.95)	(443.10)	(25480.24)
1983 to 1984	2310.06	782.36	1127.96	33087.54
	(471.62)	(572.33)	(243.64)	(25939.40)
1984 to 1985	2372.34	738.24	1123.03	33757.60
	(488.88)	(669.84)	(247.98)	(30331.98)
1985 to 1986	2516.05	714.37	1285.00	34500.02
	(485.12)	(562.08)	(514.64)	(23883.24)
1986 to 1987	2625.82	750.08	1404.86	34937.44
	(520.36)	(584.80)	(307.10)	(22936.20)
1987 to 1988	2720.12	785.00	1486.14	32781.44
	(515.02)	(624.79)	(322.94)	(23448.96)

Source: Data are taken from the annual issues of the *Report of the Public Schools of Missouri*

[1]All variables are in constant 1983 dollars per eligible pupil in the school district. Standard deviations are in parentheses

[5] Define v to be the stacked vector of residuals, z to be the matrix of instruments used in each equation, and S to be the variance-covariance matrix of residuals.

Then $Q = v'zS^{-1}z'v$. This statistic is reported by SAS as OBJECTIVE*N. The SAS option OUTS = SMATRIX is used in estimating the unrestricted equations given by equation (4) so that the unrestricted variance-covariance matrix, S, can be used for testing restrictions. When imposing the restrictions implied by causality, parameter stationarity, or checking for appropriate lag length, the SAS option SDATA = SMATRIX is included in the PROC SYSNLIN 3SLS statement to read in the unrestricted variance-covariance matrix of residuals. To test each restriction, the statistics OBJECTIVE*N are found for the restricted and the unrestricted models. Gallant and Jorgenson (1979) demonstrate that the difference in the two statistics has a chi-square distribution with degrees of freedom equal to the difference in the number of parameters estimated for the two models.

[6] Following Holtz-Eakin, Newey, and Rosen we use 10 percent significance levels to test for lag length to avoid possible type II errors resulting from an incorrectly truncated lag length. For causality tests and the tests for parameter stationarity we employ a 5 percent significance level.

[7] For time period 5 there are three years of data for each of the four lagged right-side variables plus a constant term for a total of 13 instrumental variables. In time period 6 there are four years of data and a constant term; in time period 7 there are five years of data and a constant term; and in time period 8 there are six years of data and a constant term. The sum of the number of instrumental variables is 13 + 17 + 21 + 25 = 76.

EMPIRICAL RESULTS

The system of equations given by equation (4) first is estimated with expenditures as the dependent variable, with the parameter estimates reported in Table 2 and the causality results presented in Table 3. The minimized value of the chi-square statistic, derived from the unrestricted model, takes a value of Q = 16.06 and is reported in line Table 3. The critical chi-square value with 24 degrees of freedom and a 10 percent significance level is 33.196, indicating that a model with two lags sufficiently characterizes the data. The hypothesis tests of various restrictions are performed by recalculating the minimized chi-square statistic with the restriction imposed using the unrestricted across equations variance-covariance matrix. The test statistic is denoted by K and is equal to the restricted chi-square statistic, Q_R, minus the unrestricted chi-square statistic: $K = Q_R - Q$. The number of degrees of freedom is equal to the number of parameters estimated in the unrestricted model minus the number of parameters estimated in the restricted model.

Table 2—Parameter Estimates for the Expenditure Equations[1,2]

Variable	Parameter	1984-1985 Estimates	1985-1986 Estimates	1986-1987 Estimates	1987-1988 Estimates
Intercept	a_i	3.480	4.276	4.179	1.836
		(0.326)	(0.288)	(0.279)	(0.590)
R_{t-1}	b_{1i}	0.186	0.191	0.190	0.557
		(0.032)	(0.031)	(0.031)	(0.179)
R_{t-2}	b_{2i}	0.010	0.020	0.052	-0.019
		(0.036)	(0.032)	(0.032)	(0.045)
R_{t-3}	b_{3i}	0.196	0.086	0.069	0.042
		(0.057)	(0.034)	(0.031)	(0.036)
E_{t-1}	c_{1i}	0.048	0.050	0.050	0.007
		(0.010)	(0.009)	(0.009)	(0.058)
E_{t-2}	c_{2i}	-0.001	-0.000	0.002	-0.001
		(0.011)	(0.010)	(0.010)	(0.021)
E_{t-3}	c_{3i}	0.011	0.016	0.009	0.015
		(0.013)	(0.010)	(0.009)	(0.011)
G_{t-1}	d_{1i}	-0.001	0.008	0.017	0.214
		(0.026)	(0.025)	(0.024)	(0.089)
G_{t-2}	d_{2i}	0.009	0.008	0.019	-0.056
		(0.028)	(0.025)	(0.025)	(0.032)
G_{t-3}	d_{3i}	0.114	0.109	0.069	0.025
		(0.038)	(0.027)	(0.024)	(0.031)
AV_{t-1}	h_{1i}	-0.024	-0.022	-0.018	-0.017
		(0.018)	(0.017)	(0.017)	(0.038)
AV_{t-2}	h_{2i}	-0.000	0.002	0.002	0.003
		(0.021)	(0.018)	(0.017)	(0.025)
AV_{t-3}	h_{3i}	0.027	0.025	0.014	0.015
		(0.024)	(0.019)	(0.017)	(0.022)

[1]Standard errors in parentheses. Data taken from annual issues of *Report of the Public Schools of Missouri*. E = expenditures, R = property tax revenues, G = state grants, AV = assessed valuation

[2]With two lags and eight years of data the system of equations takes the form:

$$E_{it} = a_i + \sum_{m=1}^{L+1} b_{mi}E_{it-m} + \sum_{m=1}^{L+1} c_{mi}R_{it-m} + \sum_{m=1}^{L+1} d_{mi}G_{it-m} + + \sum_{m=1}^{L+1} h_{mi}AV_{it-m} + v_{it}, \; i = 1, \ldots N, \; t = 5, \ldots 8$$

Table 3—Do Revenues and/or Grants Cause Expenditures? Expenditure Equation Test Results $E_t = f(E_{t-1}, \ldots, E_{t-L}, R_{t-1}, \ldots, R_{t-L}, G_{t-1}, \ldots, G_{t-L})$[1,2]

Restriction	Q	$K = Q_R - Q$	X^2	d.f.
(i) Two lags, L = 2	16.06	--	33.196(a = .10)	24
(ii) Stationarity[3], $r_t = 1$	602.96	586.90	9.488(a = .05)	4
(iii) One lag, L = 1	233.96	217.90	23.542(a = .10)	16
(iv) Exclude revenues given (i)[4]	141.55	125.49	21.026(a = .05)	12
(iv) Exclude grants given (i)[5]	79.76	63.70	21.026(a = .05)	12

Source: Data are taken from annual issues of the *Report of the Public Schools of Missouri*. E = expenditures, R = property tax revenues, G = state grants, AV = property assessed valuation

[1]With two lags and eight years of data the system of equations takes the form:

$$E_{it} = a_t + \sum_{m=1}^{L+1} b_{mt}E_{it-m} + \sum_{m=1}^{L+1} c_{mt}R_{it-m} + \sum_{m=1}^{L+1} d_{mt}G_{it-m} + + \sum_{m=1}^{L+1} h_{mt}AV_{it-m} + v_{it}, \; i = 1, \ldots N, \; t = 5, \ldots 8$$

The parameter estimates are presented in Table 2

[2]Q = unrestricted chi-square statistic. Q_R = restricted chi-square statistic

[3]Parameter stationarity, $r_t = 1$, is imposed by restricting the intercepts, a_t, to equal to zero, for all t

[4]To check whether revenues cause expenditures, the restrictions $c_{1t} = c_{2t} = c_{3t} = 0$, t = 5, ... 8, are imposed

[5]To check whether grants cause expenditures, the restrictions $d_{1t} = d_{2t} = d_{3t} = 0$, t = 5, ... 8 are imposed

We check for stationarity of the individual effects and also check whether a shorter lag length would characterize the data sufficiently before testing the hypotheses concerning causality. The test for parameter stationarity allows us to infer whether regime changes due to changes in local school boards or innovations in grants, such as Proposition C, have an effect on underlying relationships between expenditures, revenues, and grants. We test for stationarity of the individual effects by testing whether Γ_t = constant for all t. If Γ_t is constant over time, then $r_t = 1$ and the intercepts of equation (4) are all zero. With the intercepts of equation (4) restricted to equal zero, the value of Q_R is 602.96 with K = 602.96 – 16.06 = 586.9 (Table 3). The critical chi-square with 5 percent significance and four degrees of freedom is 9.488. We therefore reject the model with stationary individual effects. When we restrict the model to only one lag, there are 16 fewer parameters to estimate. The value of Q_R is 233.96 with K = 233.96 – 16.06 = 217.9. The critical chi-square value with 10 percent significance and 16 degrees of freedom is 23.542. We therefore reject the model with only one lag and use the two lag model for causality tests.

In Missouri local school districts acquire local revenues for education primarily from the property tax. Total expenditures by each school district are a combination of local revenues and state grants to the school district. State grants to local school districts are derived from several sources. One source is a foundation plan that guarantees each school district a minimum level of aid per eligible pupil and is essentially a lump-sum grant.

The second source of state aid is from a district power equalization plan which takes the form of a matching grant to the school district, with the matching rate an inverse function of the property tax base per eligible pupil. If the property tax base rises with a constant tax rate, local revenues will rise but the school district will receive less state aid from the matching grant. On the other hand, if the property tax base in the local school district remains constant but property tax rates rise, local revenues increase and matching state aid also increases. The effect of a change in local revenues on expenditures, therefore, depends critically on whether changes in local revenues are caused by changes in the property tax base or by a change in tax rates.

We test the hypothesis that local revenues do not cause local expenditures by reestimating the two lag model and imposing the restriction that the coefficients for the lagged values of local revenue are zero. The test statistic, K = 125.49, leads us to reject the hypothesis that revenues do not cause expenditures. Local property tax revenues are statistically causing expenditures. That is, changes in local property tax revenues precede changes in local expenditures.

Because most local school districts derive their revenue from the property tax, interschool district differences in property values can lead to differences in local school district revenues. The landmark 1971 *Serrano v. Priest* case caused researchers and state legislatures to focus their attention on equalizing interschool district differences in the property tax base. Much of the research has been an outgrowth of Feldstein's (1975) seminal paper on wealth neutrality, which shows how interschool district differences in property values could be equalized through a system of lump-sum and matching grants provided by the state. State grants to local school districts can be defended on efficiency grounds if education expenditures generate external benefits in addition to private benefits. If local spending by school districts generates external benefits to citizens outside the district, school districts that do not account for the external benefits will tend to underallocate resources for the provision of education. While state grants can be defended on either equity or efficiency grounds, problems may arise in setting up the optimal grant. If citizen voters are constrained by how much they can spend from their own sources by the grant policy, they may seek refuge in private schools or move to school districts that provide expenditure levels more in line with their preferences. Another problem may arise with grants that seek to stimulate expenditures if school districts substitute the grant for spending from their own revenue sources. Although Cohn (1987) found that state grants to local school districts in South Carolina partially stimulated local spending for education, the grant also reduced local tax effort.

We test the hypothesis that grants do not cause spending for education by reestimating the model with two lags imposing the restriction that the coefficients for the past values of grants are zero. The test statistic is K = 63.70. The critical chi-square with a significance level of 5 percent and 12 degrees of freedom is 21.026. Therefore, we reject the hypothesis that grants do not cause spending. This is an important result that helps confirm the existence of flypaper effects over time and is consistent with past evidence of a flypaper effect for cross-section data. While our results indicate that changes in grants and revenues both cause changes in expenditures, it also may be true that changes in expenditures cause changes in revenues. That is, there may be bidirectional causality which would be consistent with the hypothesis that policy makers (or a median voter)

compare the marginal benefits and the marginal costs of a proposed change and implement those changes where the benefits outweigh the costs.

Interchanging the variables E and R in equations (4), so that revenues now serve as the dependent variable, allows us to answer the questions of whether expenditures cause revenues and whether grants cause revenues. Final parameter estimates of the system are provided in Table 4. With respect to the effect of expenditures on revenues, it can be argued that school districts that increase their spending for education can attract future revenues. This argument can be supported if education expenditures yield net marginal benefits that are capitalized into housing values and raise the property tax base or if the net marginal benefit attracts new capital into the property tax base. It also can be supported if the increased expenditures enhance the human capital stock, leading to higher future incomes coupled with a willingness to pay more for future expenditures. Though we have not measured human capital directly, it is proxied by our individual effect, f_i and AV_{it}. An opposing argument to this hypothesis can be defended if citizen voters feel they are not getting their money's worth from education expenditures or if graduating students with their enhanced human capital migrate from the school district.

Table 4—Parameter Estimates for the Revenue Equations[1,2]

Variable[3]	Parameter	1984 to 1985 Estimates	1985 to 1986 Estimates	1986 to 1987 Estimates	1987 to 1988 Estimates
Intercept	a_t	0.548	2.170	2.630	2.709
		(1.281)	(1.108)	(1.074)	(2.709)
E_{t-1}	b_{1t}	0.036	0.056	0.057	-0.123
		(0.107)	(0.105)	(0.106)	(0.387)
E_{t-2}	b_{2t}	-0.321	-0.222	-0.204	-0.178
		(0.123)	(0.108)	(0.107)	(0.132)
E_{t-3}	b_{3t}	0.578	0.279	0.197	0.263
		(0.166)	(0.279)	(0.105)	(0.117)
R_{t-1}	c_{1t}	0.428	0.428	0.434	0.673
		(0.038)	(0.037)	(0.037)	(0.167)
R_{t-2}	c_{2t}	0.119	0.099	0.104	-0.003
		(0.045)	(0.040)	(0.039)	(0.075)
R_{t-3}	c_{3t}	0.007	0.022	0.024	-0.003
		(0.051)	(0.041)	(0.037)	(0.044)
G_{t-1}	d_{1t}	.	.	.	.
G_{t-2}	d_{2t}	.	.	.	.
G_{t-3}	d_{3t}	.	.	.	.
AV_{t-1}	h_{1t}	-0.147	-0.124	-0.119	-0.165
		(0.061)	(0.058)	(0.058)	(0.124)
AV_{t-2}	h_{2t}	0.121	0.082	0.094	0.141
		(0.073)	(0.062)	(0.061)	(0.081)
AV_{t-3}	h_{3t}	0.025	0.021	0.000	-0.007
		(0.077)	(0.064)	(0.057)	(0.071)

[1]Standard errors in parentheses. Data are taken from annual issues of the *Report of the Public Schools of Missouri*. E = local education expenditures, R = local property tax revenues, G = state grants, AV = property assessed valuation

[2]With two lags, and eight years of data, the system of equations takes the form:

$$E_{it} = a_t + \sum_{m=1}^{L+1} b_{mt}E_{it-m} + \sum_{m=1}^{L+1} c_{mt}R_{it-m} + \sum_{m=1}^{L+1} d_{mt}G_{it-m} + + \sum_{m=1}^{L+1} h_{mt}AV_{it-m} + v_{it}, \; i = 1, \ldots N, t = 5, \ldots 8$$

[3]Parameters for lagged values of grants restricted to zero because the hypothesis that grants do not cause revenues could not be rejected

The causality results from estimating the system of equations (4) with revenue as the dependent variable are reported in Table 5. In this table, the unrestricted chi-square statistic, Q = 16.7, implies that the model with two lags of the right-side variables sufficiently characterizes the data. Also notice that the model with stationary individual effects and the model with one lag are rejected.

Table 5—Do Expenditures and/or Grants Cause Revenues? Revenue Equation Test Results $R_t = g(R_{t-1}, \ldots R_{t-L}, E_{t-1}, \ldots E_{t-L}, G_{t-1}, \ldots G_{t-L})$[1,2]

Restriction	Q	$K = Q_R - Q$	X^2	d.f.
(i) Two lags, L = 2	16.70	--	25.989(a = .10)	18
(ii) Stationarity[3], $r_t = 1$	32.00	15.30	9.488(a = .05)	4
(iii) One lag, L = 1	77.40	60.70	18.549(a = .10)	12
(iv) Exclude expenditures given (i)[4]	38.07	21.37	21.026(a = .05)	12
(iv) Exclude grants given (i)[5]	32.43	15.73	21.026(a = .05)	12

Source: Data are taken from annual issues of the *Report of the Public Schools of Missouri*. E = expenditures, R = property tax revenues, G = state grants, AV = property assessed valuation

[1]With two lags, and eight years of data, the system of equations takes the form:

$$E_{it} = a_t + \sum_{m=1}^{L+1} b_{mt}E_{it-m} + \sum_{m=1}^{L+1} c_{mt}R_{it-m} + \sum_{m=1}^{L+1} d_{mt}G_{it-m} + + \sum_{m=1}^{L+1} h_{mt}AV_{it-m} + v_{it}, \; i = 1, \ldots N, \; t = 5, \ldots 8$$

The parameter estimates are presented in Table 4

[2]Q = unrestricted chi-square statistic, Q_R = restricted chi-square statistic, d.f. = degrees of freedom

[3]Parameter stationarity implies, $r_t = 1$, for all t, implying that the intercepts $a_t = 0$, for all t

[4]To check whether revenues cause expenditures, the restrictions $c_{1t} = c_{2t} = c_{3t} = 0$, for t = 5, ... 8, are imposed

[5]To check whether grants cause expenditures, the restrictions $d_{1t} = d_{2t} = d_{3t} = 0$, for t = 5, ... 8, are imposed

To test the hypothesis that expenditures do not cause revenues, the model with two lags is reestimated with the restriction that the coefficients for the lagged values of expenditures are zero. The minimized chi-square statistic takes a value of 38.07, with the test statistic K = 38.07-16.7 = 21.37. The critical chi-square value with 12 degrees of freedom and a 5 percent significance level is 21.026. Therefore, we reject the hypothesis that expenditures do not cause revenues, implying that changes in expenditures precede changes in revenues. Coupled with our previous result of revenues causing expenditures, the result that expenditures cause revenues implies the existence of bidirectional causality between revenues and expenditures for local school districts.

The existence of bidirectional causality implies that spending and tax decisions for local education are determined simultaneously. An important implication of this finding is that those who seek to limit property taxes must accept lower educational spending. In

addition, those who seek to expand local spending for education must find ways to increase revenues to support the expansion.

Our final concern is with the effect of grants on revenues. There is some theoretical support that state grants, especially state matching grants, may cause local revenues. Matching grants lower the tax price of local education and make it cheaper to raise local revenues. Still, citizen voters may realize that increased matching grants can result only if the state raises additional revenue or reduces the amount of money available for other state-financed goods and services. This may make citizen voters unwilling to allow their taxes to increase, even if they can obtain more matching funds. We test the hypothesis that grants do not cause revenues by reestimating system of equations restricting the coefficients for the lagged values of grants to equal zero. The test statistic, K = 15.73, indicates that we cannot reject the hypothesis that grants do not cause revenues.[8]

CONCLUSION

While previous researchers have examined revenue-expenditure causality for the federal government and for the aggregate 50 states, our data set allows an examination of revenue-expenditure causality for a specific category of spending, education, for school districts in Missouri. We combine cross-section data for 541 Missouri school districts for the period 1980/1981 to 1987/1988 to test for causality between revenues, expenditures, and grants. Using chi-square tests, we find that a model with two lags is sufficient to characterize the data and that the parameter estimates are not stationary over time. We also find the existence of bidirectional causality between local school district revenues and total expenditures for education.

The existence of bidirectional causality implies that those who are interested in increasing expenditures for education will have to find ways of raising local property tax revenue. In addition, those seeking to control local property tax growth will be forced to confront the prospect of less spending for local education. We are not able to reject the hypothesis that grants do not cause revenues. The existence of flypaper effects in the expenditures equation, however, is confirmed by rejecting the hypothesis that grants do not cause spending. The existence of flypaper effects suggests that voters are subject to some kind of fiscal illusion or that monopoly school boards with a taste for educational spending have control over the local agenda. Given our finding of flypaper effects, the passage of Proposition C in 1982 provided a greater boost to local school district spending than would have occurred solely because of an increase in local income of the same amount. Our rejection of parameter stationarity also provides evidence that Proposition C did provide an innovation in grant delivery and affected the underlying relationship between expenditures, revenues, and grants.

As is the case with most empirical studies, several qualifications are in order. Our data set allowed us to test for causality at a disaggregated level, local school districts, but

[8] Table 1 suggests that there may have been substitution between state grants and local property tax revenues over the time period with revenues declining in real terms $120 and grants increasing $364. To investigate further why grants were insignificant in the revenues equation, we also ran vector autoregressions with grants as the dependent variable and tested the hypothesis that revenues do not cause grants. Our results indicate that we could reject this hypothesis. We speculate that this may be due to property taxes changing passively (due to changes in property valuation) and grants changing actively as states increase grants in response to local revenue declines.

the informational content of the results would seem to be dominated by the cross-section variation in the variables because 541 school districts were observed at only eight different points of time. In addition, while vector autoregressions are useful in examining issues relating to causality, important behavioral relationships generating the data are ignored. Future research can be expected to combine cross-section and time series data with models emphasizing the utility-maximizing behavior of the median voter and the behavior of local school boards taken into account.

REFERENCES

1. Anderson, William, Wallace, Myles S., and Warner, John T., "Government Spending and Taxation: What Causes What?" *Southern Economic Journal*, 52, no. 3 (January 1986), pp. 630-639.

2. Blackley, Paul R., "Causality Between Revenues and Expenditures and the Size of the Federal Budget," *Public Finance Quarterly*, 14, no. 2 (April 1986), pp. 139-156.

3. _____, "Asymmetric Causality Between Federal Spending and Tax Changes: Avoiding a Fiscal Loss," *Public Choice*, 66 (1990), pp. 1-13.

4. Cohn, Elchanan, "Federal and State Grants to Education: Are They Stimulative or Substitutive?" *Economics of Education Review*, 6, no. 4 (1987), pp. 339-344.

5. Cohn, Elchanan, and Terry G. Geske, *The Economics of Education*, 3rd edition (New York: Pergamon Press, 1990).

6. Craig, Steven G., and Robert P. Inman, "Federal Aid and Public Education: An Empirical Look at the New Fiscal Federalism," *The Review of Economics and Statistics* (1987), pp. 541-552.

7. Feldstein, Martin S., "Wealth Neutrality and Local Choice in Public Education," *American Economic Review*, LXV, no. 1 (March 1975), pp. 75-89.

8. von Furstenberg, George M., Green, R. Jeffrey, and Jeong, Jin-Ho, "Have Taxes Led Government Expenditures? The United States as a Test Case," *Journal of Public Policy*, 5, no. 3 (1985), pp. 321-348.

9. von Furstenberg, George M., Green, R. Jeffrey, and Jeong, Jin-Ho, "Tax and Spend, or Spend and Tax?" *The Review of Economics and Statistics*, LXVII, no. 2, (May 1986), pp. 179-188.

10. Gallant, A.R., and D.W. Jorgenson, "Statistical Inference for a System of Simultaneous, Nonlinear, Implicit Equations in the Context of Instrumental Variables Estimation," *Journal of Econometrics*, 11 (1979), pp. 275-302.

11. Gardner, David P. et al., A Nation at Risk: The Imperative for Educational Reform. A Report to the Nation and the Secretary of Education, United States Department of Education, by the National Commission of Excellence in Education (Washington, D.C.: Government Printing Office, 1983).

12. Gist, John R., "Fiscal Austerity, Grant Structures and Local Expenditure Response," *Policy Studies Journal*, 16, no. 4 (1988), pp. 687-712.

13. Hamilton, Bruce W., "The Flypaper Effect and Other Anomalies," *Journal of Public Economics*, 22 (1983), pp. 347-361.

14. Hamilton, Jonathan H., "The Flypaper Effect and the Deadweight Loss from Taxation," *Journal of Urban Economics*, 19 (1986), pp. 148-155.

15. Holtz-Eakin, Douglas, Whitney Newey, and Harvey Rosen, "The Revenues-Expenditures Nexus: Evidence From Local Government Data," *International Economics Review*, 30, no. 2 (May 1989), pp. 415-429.

16. Holtz-Eakin, Douglas, Whitney Newey, and Harvey S. Rosen, "Estimating Vector Autoregressions with Panel Data," *Econometrica*, 56, no. 6 (November 1988), pp. 1371-1395.

17. Joulfaian, David, and Rajen Mookerjee, "The Government Revenue-Expenditure Nexus: Evidence From a State," *Public Finance Quarterly*, 18, no. 1 (January 1990), pp. 92-103.

18. Logan, Robert R., "Fiscal Illusion and the Grantor Government," *Journal of Political Economy*, 94, no. 6 (December 1986), pp. 1304-1318.

19. Manage, Neela, and Michael L. Marlow, "The Causal Relation Between Federal Expenditures and Receipts," *Southern Economic Journal*, 52, no. 3 (January 1986), pp. 617-629.

20. Marlow, Michael L., and Neela Manage, "Expenditures and Receipts: Testing for Causality in State and Local Government Finances," *Public Choice*, 53 (1987), pp. 243-255.

21. Missouri Department of Education, *Report of the Public Schools of Missouri*, annual issues, 1980 to 1981 to 1988 to 1989.

22. Peacock, Alan T., and Jack Wiseman, "Approaches to the Analysis of Government Expenditure Growth," *Public Finance Quarterly*, 7, no. 1 (1979), pp. 3-23.

23. Ram, Rati, "Additional Evidence on Causality Between Government Revenue and Government Expenditure," *Southern Economic Journal*, 54 (January 1988), pp. 763-769.

24. U.S. Bureau of the Census, *Statistical Abstract of the United States: 1992*, 112th edition (Washington, DC, 1992).

25. Weber, William L., "Fiscal Neutrality and Local Choice in Education," *Economics of Education Review*, 10, no. 1, (1991), pp. 37-44.

26. Winer, Stanley L., "Some Evidence on the Effect of the Separation of Spending and Taxing Decisions," *Journal of Political Economy*, 91, no. 1 (1983), pp. 126-140.