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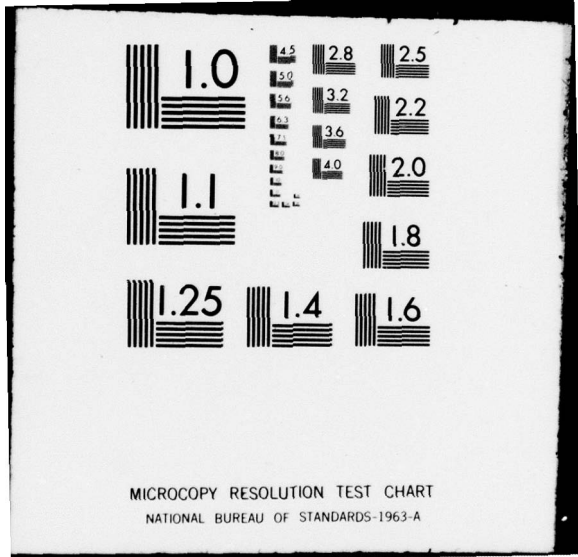
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Does Federal Expenditure Displace State and Local Expenditure: The Case of Construction Grants

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James Jondrow
and
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DOES FEDERAL EXPENDITURE DISPLACE STATE AND LOCAL EXPENDITURE: THE CASE OF CONSTRUCTION GRANTS

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James Jondrow and Robert A. Levy

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DOES FEDERAL EXPENDITURE DISPLACE STATE
AND LOCAL EXPENDITURE: THE CASE
OF CONSTRUCTION GRANTS

James Jondrow
and
Robert A. Levy

It is well known that expenditure by the federal government can displace expenditure by private citizens and by state and local governments. There are a number of possible mechanisms for displacement, but one is particularly direct: federal expenditures are made in order to provide services to recipients; the services then substitute for what the recipients would have purchased on their own. Food stamps, for example, increase the income of recipients, but not necessarily their food purchases. A substantial part of the aid simply pays for food the recipient would have bought on his own.¹ The same kind of displacement can occur when the recipient is a state or local government.

In this paper we examine the Construction Grants Program administered by the Environmental Protection Agency. This program supports the construction of sewer lines and sewage treatment plants. The stated purpose is to eliminate the pollution

¹For evidence on the displacement and effect of food stamps, see [1, p. 49-50, and [16].

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generated by municipal wastewaters, a task the municipalities themselves are considered unwilling or unable to accomplish.²

Applications for grants are made by municipalities, since they are the ones who operate the sewer system. Nevertheless, the funds pass through the state governments and the allocation criteria refer to how much each state gets, not how much each community gets. The allocation between states is based, in part, on the states' own estimates of "needs" for sewer system construction, a procedure which has implications for displacement. If these "needs" refer to what would have been built without federal aid, the allocation criteria will tend to encourage displacement.³

Construction grants is a major program. In fact, it is only slightly smaller than was the Interstate Highway Program,

²"Implicit...is the notion that State/local action to finance wastewater treatment would be somewhat limited in the absence of Federal participation. That is, without financial incentives, many State and local governmental units could not afford or would not choose to construct sufficient wastewater facilities to meet the national goals for clean water...It is incumbent on the Federal government to step in to promote the national welfare in cases where State and local efforts alone might not achieve this objective." [8, p. A-6].

³The 1972 legislation authorizing construction grants (the Federal Water Pollution Control Act) based allocations on the Survey of Needs. Since this survey was to be the basis for grants, there was a widely recognized tendency for the states to overstate their requirements. As a consequence, the original legislation was amended to specify that population, as well as "needs," be considered in allocating grants.

The state government has an important voice in determining which of its communities receives grants. The state draws up a list of potential projects and passes the list on to EPA. The projects are then funded more or less in the order in which they appear on the list. The list is put together by the state from informal applications submitted by municipalities. More formal applications are then submitted to EPA. The formal applications proceed in stages, some of which require a major effort. EPA provides special grants for the application process.

the major federal public works effort of the 1960s.⁴ Since the EPA program began in 1973, it has grown steadily toward the authorized level of \$5 billion per year.

Among recent studies of displacement of state and local spending are Gramlich and Galper [2], and Johnson and Tomola [4]. Gramlich and Galper investigate the demand for several broad categories of state and local spending. Of particular interest to us is the demand for state and local construction and how this responds to federal grants. They find that grants lead to little displacement. In a more recent paper, Gramlich [3] notes that state and local construction has recently been below the estimates implied by his model. He speculates that the authorizations under the Local Public Works program may have led communities to postpone planned expenditure in hopes of getting a grant, and that this temporary displacement was strong enough to more than offset the program's countercyclical effect.

Johnson and Tomola [4] investigate the effect of federal grants to states and localities for public service employment. They find that after several quarters, there is total displacement, i.e., that the federal grants do no more than pay for employees the states and localities would have hired anyway.

⁴In 1965, the year in which expenditure on the Interstate program was greatest in constant dollars, federal subsidies were about \$4.3 billion in 1972 dollars. In 1978, the Construction Grants Program is expected to be about 3.5 billion (1972) dollars.

In investigating the possibility that the construction grants program displaces state and local spending on sewer system construction, we consider two kinds of displacement: temporary and permanent. Temporary displacement is due to deferral of spending while communities consider whether to apply for a grant and wait for decisions on their applications. Permanent displacement is created by the substitution of grants (after they are authorized by the federal government) for local expenditures that would have served the same purpose.

THE MODEL

Displacement is defined in reference to the demand for specific state and local services, in our case the demand for sewer system structures. Therefore, we begin by describing a model of this demand. Sewer systems are clearly not a consumption good. Instead, we consider them as an input into the production of a consumption good, which we term housing services. The demand for sewer system structures is then derived as the demand for an input, directly from the production function. As a means of simplifying the production function and also enabling us to concentrate on the variable of interest, all other inputs used to produce housing services are combined into a single input, X. The production function relating housing services, H, to the two inputs, S and X is:

$$(1) \quad H = f(S, X), \quad f_i^1 > 0 \quad f_i^2 < 0 \quad i = S, X$$

where f is assumed to be a constant elasticity of substitution (CES) production function of which the Cobb-Douglas and fixed

coefficient production functions are special cases. The possibility of substitution is included for completeness, not because we consider it likely that sewers substitute for other inputs.

To move from the production function to the demand for sewer system structures, we assume that households minimize their cost of obtaining a given flow of housing services.⁵ The municipal government serves simply as their agent in this process allowing them to contract for the purchase of a large facility such as a sewage treatment plant. Optimization involves minimizing the Lagrangian:

$$(2) \quad L = P_S S + P_X X + \lambda [\bar{H} - f(S, X)]$$

where P_S is the "user cost" of sewer system structures

P_X is the price of other inputs

and the production function has the CES form:

$$(3) \quad f(X, S) = \alpha (aS^{-\rho} + (1-a)X^{-\rho})^{-\frac{1}{\rho}}$$

The minimum with respect to S occurs where

$$(4) \quad P_S = \lambda \cdot MP_S$$

where MP_S is the marginal product of S

and λ is the Lagrangian multiplier, which can also be interpreted as marginal cost.

⁵ The assumption of cost minimization rather than utility maximization simplifies the analysis without giving up much descriptive ability. What is not described is the response of housing services to the cost of sewer systems, which would probably be impossible to measure, given the small share of sewer costs in the total cost of housing.

We now substitute for λ and MP_S in equation (4). To substitute for λ , we use the fact that the production function is homogeneous. Let (S^0, X^0) be the optimum input combination for the production of one unit of H and the corresponding production cost be represented by

$$(5) \quad C = P_S S^0 + P_X X^0 .$$

The expression for marginal cost is [6, p. 84]:

$$(6) \quad MC = \frac{C}{v} H^{\frac{(1-v)}{v}}$$

where v is the degree of homogeneity.

To substitute for MP_S , we differentiate the production function (3) with respect to S to obtain:

$$(7) \quad MP_S = kH^{\frac{v\sigma+1-\sigma}{\sigma v}} S^{-\frac{1}{\sigma}}$$

where $\sigma = \frac{1}{1+\rho} > 0$

and $k = a v \alpha^{\frac{\sigma v + \sigma - 1}{\sigma v}}$

Making these substitutions in equation (4) and solving for S , we obtain the expression for the desired value of S , which we denote S^* .

$$(8) \quad S^* = k_1^\sigma \left(\frac{C}{P_s} \right)^\sigma H^{1/\nu}$$

where $k_1 = \frac{k}{\nu}$.

Equation (8) represents demand in the absence of federal grants, so that all of S^* comprises a stock built with the community's own funds. We now introduce the stock built with grants by adding it to demand. However, we do not add the entire stock built with grants, but only that fraction (γ) which serves the same function as would the corresponding stock built with municipal funds.⁶ The parameter, γ , can be interpreted as a measure of the "value" the community places on the stock of sewer structures built with federal funds. It will approach 1 when this value is high so that federal expenditure displaces most of what the community would have built on its own. Similarly, when γ approaches 0 federal expenditure on sewer construction does not displace local spending. If γ is strictly greater than 0 and less than 1, the remaining fraction ($1-\gamma$) of the stock built with grants represents structures that the community would not have built, perhaps because the facility is of a different type or in a different location from one which the community would have chosen. The existence of this remaining fraction results from the community's inability to choose the type of structure it wants; the specifications are made by federal

⁶An alternative would be to adjust the price of sewer system construction. This alternative, however, would only be appropriate if the community's entire expenditure on sewer system construction were matched with federal grants. In fact, only a part of the expenditure is matched.

legislation. We make the simplifying assumption that this remaining fraction does not affect the stock of sewer system construction desired by households.

We define as the effective stock those structures built with the community's own funds (M) plus the share (γ) of the federal stock (G) which provides service to the community. The desired effective stock is:

$$(9) \quad S^* = (M + \gamma G)^* = k_1 H^{\frac{1}{v}} \left(\frac{C}{P_s}\right)^\sigma$$

We now incorporate partial adjustment by assuming that a fraction (η) of the total adjustment takes place during a single year. This assumption is written:

$$(10) \quad \frac{S}{S_{-1}} = \left(\frac{S^*}{S_{-1}}\right)^\eta$$

Combining (9) and (10) to eliminate S^* yields:

$$(11) \quad M + \gamma G = \left[k_1 H^{\frac{1}{v}} \left(\frac{C}{P_s}\right)^\sigma \right]^\eta (M + \gamma G)_{-1}^{1-\eta}$$

Equation 11 incorporates permanent displacement but not temporary displacement: the postponement of municipal construction in hopes of obtaining federal grants. To measure this displacement, we enter as an explanatory variable the funds authorized by Congress but not yet spent. This variable, (A), is added linearly so that an extra dollar will always have the same effect, regardless of the size of the unspent authorizations.

This way of entering the variable is superior to the obvious alternative, to enter it multiplicatively. The multiplicative form would require that a doubling of authorizations always have the same percentage effect, whether the doubling is from a very small or very large base.

Adding the authorizations variable and rearranging terms, we obtain the equation to be estimated:

$$(12) \quad M = \phi H^\omega \left(\frac{C}{P_s}\right)^\mu (M+\gamma G)^{\frac{1-\eta}{-1}} - \gamma G + \theta A$$

where $\phi = k_1^\eta$

$$\omega = \eta/\nu$$

$$\mu = \sigma\eta$$

Data Sources and Specification of Variables

To estimate the demand for sewer system structures requires data on the stock built with municipal funds, the stock built with federal funds, the user cost of structures, the average cost of housing services, and the quantity of housing services.

The stock built with municipal funds is derived by subtracting the stock built with grants from the total stock. The total stock is estimated using the perpetual inventory method, which involves defining a capital stock (K) in terms of investment (I), a rate of depreciation (δ), and the previous year's stock (K_{-1}) by the relation:

$$(13) \quad K = K_{-1}(1-\delta) + I .$$

Investment (I) is measured by new construction put in place (1972 dollars). Though the statistical estimation of demand uses only data from 1949 to 1977, the stocks in 1949 and later years include some undepreciated construction undertaken long before. The construction of modern sewer systems began about 1850, so we began the cumulation of stocks there. Data was not gathered that early, so we assumed that construction grew linearly until it reached the level of spending achieved in 1915, the first year for which published data are available.⁷

The stock of structures financed by federal grants is estimated by cumulating the constant dollar value of grants and adjusting for depreciation. Federal grants were assumed to be 0 until 1956, an assumption which seems accurate for the post-war period since grants immediately after 1956 are quite small. On the other hand, this assumption takes no account of any facilities built during the depression with federal grants. As a consequence, such facilities are included with those built with municipal funds.⁸

⁷From 1915 to 1946, data was from [14] and from 1947 to 1977 from [11]. Both sources rely on measurements made by the Department of Commerce.

⁸For 1957 to 1962, data on grants are from [8]; for 1963 to 1975 data are from [13] and for 1976 and 1977, from [10]. Since these grants are reported by fiscal year, estimates for calendar years were made by averaging the appropriate fiscal years. Fiscal years 1976 and 1977 were adjusted to reflect the fact that the federal government shifted from a July-June to an October-September accounting period.

The rate of depreciation differs depending on whether the sewer system structure built was a sewer line or a sewage treatment plant. For each type of structure, we derived the exponential rate of depreciation by doubling the linear rate, a procedure used in the Department of Commerce estimates of capital stock [12]. The linear rate of depreciation is the reciprocal of the economic lifetime. The lifetimes, 50 years for sewer lines and 20 years for treatment plants, were provided by R. L. Michels of EPA, and the corresponding exponential rates of depreciation are 4% and 10%. Separate stocks were estimated for sewer lines and treatment plants, then recombined. However, it was not feasible to carry out the complete analysis for sewer lines and treatment plants, because separate data have been available only since 1967.

The user cost (P_s) of sewer system structures is estimated by the sum of interest costs (Zr) and depreciation ($Z\delta$):

$$(14) \quad P_s = Z(r+\delta)$$

where r is the interest rate

Z is the price of sewer system construction

δ is the rate of depreciation.

Z is measured by the GNP deflator for sewer system construction and r is measured by the yield on high grade municipal bonds (Standard and Poor).

No obvious measures exist for the flow of housing service (H) or the portion of cost (C) of a single unit of housing service. We use as proxies the stock of housing and the GNP deflator for housing and household operation. In using the stock of housing we are making the standard assumption that the stock and its service flow are proportional. Less formally, the housing stock serves as a scale variable; it picks up factors such as the growth in population, the increase in per capita income, and the trend toward suburbanization.⁹

To measure the price of the service flow from housing, we use a GNP deflator in preference to a consumer price index, since the deflator is defined as the price of a flow while the CPI is not. More specifically, the deflator defines the price of owner-occupied housing as the imputed rental per unit while the CPI defines this price as the purchase price of the structure.

Results of Estimation

The demand for sewer system structures was estimated from annual time series data (1949-1977) using non-linear least squares.¹⁰ Parameter estimates of equation 12 are shown below:

⁹The housing stock is created using the perpetual inventory method. The depreciation rate (2.05% annually) and the initial stock in 1946 were from Musgrave [5]. New construction of housing (1972 dollars) used to increment the stock, was from [11].

¹⁰Calculations were performed on the TROLL system. This software package was formerly operated by NBER, and is now available from the Massachusetts Institute of Technology.

$$(12) \quad M = \phi H^\omega \left(\frac{C}{P_s}\right)^\mu (M+\gamma G)^{\frac{1-\eta}{-1}} - \gamma G + \theta A$$

<u>Parameter</u>	<u>Estimate</u>	<u>t-value</u>
ϕ	.436	1.4
ω	.304	2.6
$1-\eta$.680	5.8
γ	.703	9.9
θ	.046	-2.7
R^2	.998	
D.W.	1.67	

The coefficient of the price term (C/P_s) was virtually zero and was omitted. The lack of effect suggests that substitution between sewer construction and other commodities is unimportant, so that a fixed coefficient production function is an adequate description of production. The housing stock performs well as a scale variable. Its coefficient is significant and sums to almost unity when added to the coefficient of the lagged dependent variable, indicating that the dependence of the sewer system stock on the housing stock in the long run is almost exactly proportional. The implied estimate of the degree of homogeneity of the production function is about 1.05.

The coefficients of primary interest are those that measure permanent and temporary displacement (γ and θ). The estimate of γ has an extremely high t value. The estimate itself, .703, is interpreted to mean that for each dollar of federal expenditure municipal

expenditure is reduced by about 70¢. An alternative interpretation is that each dollar of federal expenditure is valued by the municipality at about 70¢. Of course, the total gain from the expenditure could be much larger; a primary rationale for legislation requiring wastewater treatment is that municipalities disregard externalities from untreated wastewater.

In addition to the permanent displacement, we also found evidence for temporary displacement, although the evidence was not quite so strong. We estimated that when one dollar of federal funds is authorized by legislation, municipalities postpone about 4.6¢ of their expenditure. The coefficient is significant but the t-value is not so strong as for permanent displacement. Still, the estimated temporary displacement is not trivial, for large amounts are authorized at a time. For example, in December 1977, Congress authorized almost \$25 billion in expenditures to be spent over 5 years. The estimated coefficient suggests that this authorization would displace over \$1 billion of municipal expenditures.¹¹

¹¹
In addition to our statistical findings about temporary displacement there is less formal evidence. A former official of the Office of Management and Budget told us that he had encountered it even before the EPA grant program began, when there were several other programs giving out water and sewer grants. In one year, only \$400 million in grants had been authorized. Over \$2.5 billion in applications were received from municipalities. He said that OMB and the White House were deluged with complaints from local officials and their Congressmen. The complaints were not so much about losing a grant as about not getting a decision at all. They felt unable to proceed with their own construction because, if they did, and lost the grant as a result, they would not survive the political repercussions.

An Alternative Estimate

After completing the results described above, we became aware of a major change in the definition of one of the data series. For 1975 to 1977, sewer system construction put in place included much construction that would formerly have been counted as highway construction. As a consequence, sewer system construction received a massive artificial boost in these three years. In 1975, a year in which data are available under both definitions, the change added 50% to reported sewer system construction [15, p. 23]. Since the exact adjustment is not obvious, we present both the unrevised estimates (above) and the revised estimates below.

Our adjustment involved decreasing the reported values for 1975-1977 to make them comparable to earlier years. We first deflated the 1975 difference between the new and old series, then subtracted it from the new series in 1975 to 1977.

The regression estimates were redone using this adjusted data and are shown below:

$$(12') \quad M = \phi H^{\omega} \left(\frac{C}{P_S}\right)^{\mu} (M+\gamma G)^{\frac{1-\eta}{-1}} - \gamma G + \theta A$$

<u>Parameter</u>	<u>Estimate</u>	<u>t-value</u>
ϕ	.503	3.2
ω	.237	2.8
$1-\eta$.755	8.9
γ	1.057	21.2
θ	-.027	-2.7
R^2	.999	
D.W.	2.03	

The results are similar to those discussed earlier, except that the parameter indicating permanent displacement is larger. The adjusted estimate suggests that federal expenditure is totally offset by displaced municipal expenditures.

The adjustment has a major effect on the estimate of permanent displacement because the adjustment itself is substantial and is concentrated in exactly those years when grants were the largest. The adjusted estimates are probably more accurate than the unadjusted estimates, since they result from an attempt to make the data series consistent.

SUMMARY AND CONCLUSIONS

This paper has investigated how municipal expenditures respond to large federal grants for the same activity. The evidence that federal expenditure permanently displaces much local expenditure is quite strong, and there is additional evidence that federal expenditure leads to temporary postponement of municipal expenditure.

The results indicate that construction grants do not greatly encourage sewer system construction. This evidence does not mean the grants are undesirable; the program may serve other functions. As Johnson and Tomola [4] point out, one possible objective of federal expenditure, even grants-in-kind, is pure revenue sharing, and this motive is best satisfied when

there is 100 percent substitution of federal expenditures for state and local. The reason is that in-kind grants are most valuable to recipients when they provide a service the community would have provided anyway. Indeed, Gramlich and Galper [2] interpret their parameter indicating displacement as a measure of the contribution of the federal grants to the community's utility. In a different context, Smeeding [7] uses displacement to construct a measure of the value to recipients of food stamps. Hence, the strong findings of displacement provide assurance that the program has value for those receiving the aid.

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