

Budget spillovers and fiscal policy interdependence

Evidence from the states

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This paper formalizes and tests the notion that states' expenditures depend on the spending of similarly situated states. We find that even after allowing for fixed state effects, year effects, and common random shocks among neighbors, a state government's level of per capita expenditure is positively and significantly affected by the expenditure levels of its neighbors. *Ceteris paribus*, a one dollar increase in a state's neighbors' expenditures increases its own expenditure by over 70 cents.

We do everything everyone else does.

– Arkansas State Senator Doug Brandon, describing his state's budgetary policies.¹

1. Introduction

State and local governments consume a significant part of the American economy's annual output, about 14 percent of GNP. At the same time, there is considerable cross-sectional variation: in 1986, per capita direct expenditures in the continental United States ranged from \$1,877 in Arkansas to

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¹Applebome (1989, p. L26).

\$4,472 in Wyoming.² An enormous amount of theoretical and empirical research has been devoted to explaining such differences. At present, however, there is no consensus concerning the process that generates government spending decisions. Following the work of Black (1948), many investigators have found the median voter model to be a useful framework. However, a number of other candidates also have their advocates. The 'Leviathan' model suggested by Brennan and Buchanan (1977), special interest group models [Mueller and Murrell (1986)], and general 'political economy' models [Craig and Inman (1986)] are just a few that come to mind.³

When it comes to estimating the parameters of the various models, there is a striking similarity regardless of the underlying theoretical framework. In a generic estimating equation, a jurisdiction's spending depends on *its* income, *its* grants from other levels of government, and *its* demographic and/or political characteristics. Such differences in characteristics obviously need to be taken into account. However, this paper proposes that there is another important determinant of the state and local government expenditures in the United States: the expenditures of neighboring governments.

Casual observation suggests that jurisdictions' spending levels do affect each other. For example, in April 1984 the governor of Texas called a special legislative session to consider a billion dollar increase in school expenditures. Part of the reason was that a few months earlier '...a study by the Federal Department of Education found that Texas ranked next to last among the states in the portion of income per capita spent on public education... These and other indicators ... spurred wide concern among Texans' [Reinhold (1984, p. 17)]. Indeed, documents prepared for state legislators commonly focus on their state's spending in a given category relative to other states. Thus, a 1988 report for the New Jersey legislature noted that 'Since 1976, New Jersey has ranked third or fourth nationally in per pupil expenditures' [Program for New Jersey Affairs (1988, p. 76)]. Similar documents are prepared by private interest groups. In January 1990, a study by the AIDS Policy Center sounded an alarm that while 'California and New York budgeted nearly \$3 per resident for AIDS in 1989, Texas spent at a rate of just 14 cents on state [AIDS] programs' [Lambert (1990, p. 18)].

In this paper, we formalize and test the notion that a state's spending depends on the spending of similarly situated states.⁴ Instead of the somewhat awkward construction 'similarly situated states', we will use the word 'neighbors'. It must be stressed, however, that *for our purposes*,

²U.S. Bureau of the Census (1989, p. 275).

³See Inman (1988) for a survey of various models of government expenditure determination.

⁴There is also anecdotal evidence that changes in a state's tax structure are influenced by those of its neighbors. Because of the difficulties involved in characterizing state tax structures [see Feenberg and Rosen (1986)], we prefer to attack the relatively simpler expenditure issue.

neighborliness does not necessarily connote geographic proximity. States that are economically and demographically similar may have more effect on each other than two dissimilar states that happen to share a border. Citizens of New York, for example, might find comparisons to Illinois more relevant than those to Vermont.

Section 2 lays out our theoretical framework. We construct a simple model in which the optimal level of expenditure by a state is affected by the expenditure levels of that state's neighbors. We discuss the empirical specification in section 3. Special attention is devoted to resolving the econometric problems that arise because various states' expenditure levels might be subject to common random shocks. The data, which consist of annual observations for the continental United States during the period 1970–1985, are described in section 4.

The results are presented in section 5. A major finding is that even after allowing for state individual effects, year effects, and correlated random shocks among neighbors, a state's level of per capita expenditure is positively and significantly affected by the expenditure levels of its neighbors. *Ceteris paribus*, a one dollar increase in a state's neighbors' expenditures increases its own expenditure by over 70 cents. We also analyze spending in specific categories such as education, and there too other states matter. Moreover, we find that failure to include neighbors' expenditures in the equation leads to substantially different estimated effects of other important explanatory variables such as federal grants and age structure of the population. In particular, failure to account for neighbor effects leads to a substantial upward bias in the estimate of a state's grants upon its expenditures. Section 6 concludes with a brief summary.

2. Theoretical considerations

There are several ways in which the expenditures of one state can affect the fiscal policies of other states. In this section, we explore one possibility that builds on traditional models of public expenditure determination.

In simple models of government choice, governments concerned with the well-being of their citizens choose expenditure levels that equate the sum of individual marginal benefits from public services to the marginal costs of providing those services.⁵ To illustrate, assume that all consumers in a state are identical, taxes are lump-sum, and that only one type of public good is provided by the government. Then the utility level of the (representative) consumer in state i can be expressed as

$$V^i = V^i[Y^i - T^i, G^i; \Psi^i], \quad (1)$$

⁵As in Samuelson (1954).

in which Y^i is per capita income in state i , T^i is the (lump-sum) tax burden of each consumer, G^i is the level of public services provided, and Ψ^i is a vector of exogenous conditions that affect the utilities of residents of the state. The price of private goods is the numeraire. If public services are measured in per-consumer cost units, budget balance requirements imply

$$T^i \geq G^i. \quad (2)$$

Suppose that the state government acts in the interests of its citizens, so that it chooses G^i and T^i to maximize (1) subject to (2). Then if preferences exhibit nonsatiation, the familiar first-order conditions imply that (2) holds with equality and

$$\partial V^i(\cdot)/\partial G^i = \partial V^i(\cdot)/\partial(Y^i - T^i). \quad (3)$$

The marginal utility of an additional dollar of expenditure on public goods equals the marginal utility of an additional dollar of after-tax private income. (Note that the price of public services is normalized to one.)

Suppose now that the benefits of public expenditures in one state 'spill over' into another. An obvious example of spillovers is that one state's expenditures on roads may provide benefits to the residents of neighboring states who can use the roads. Somewhat less obviously, the school expenditures of one state may influence the utilities of residents of other states either because children grow up and move outside the state in which they once attended school, or because well-educated workers in one state compete with workers in other states through the product markets in which they sell their outputs. A third type of spillover might arise in the context of welfare payments to poor residents. As Pauly (1973) notes, citizens of one state might care about poverty levels in other states, and hence derive utility from other states' welfare expenditures.⁶

There is a substantial theoretical literature that *assumes* the existence of these types of spillovers and analyzes their consequences. See, for example, Williams (1966), Brainard and Dolbear (1967), Pauly (1970), Arnott and Grieson (1981) and Gordon (1983). The theoretical implications of such spillovers for optimal federal government policy are considered by Breton (1965), Oates (1972) and Boskin (1973). In terms of our model, spillovers can

⁶Alternatively, states might want to offer large welfare payments to their own poor, but are worried about a possible influx of indigent people from other states. If welfare payments in other states rise, then it becomes possible to offer higher welfare benefits without fear of attracting too many takers. This is the type of mechanism that Gramlich and Laren (1984) have in mind when they estimate a model in which a state's welfare expenditures are influenced by those of surrounding states. However, their model does not incorporate the feature that surrounding states' expenditures are affected by a given state's spending.

be incorporated by allowing expenditures in other states to enter the utility functions of residents of state i . Such a modification of eq. (1) leads to

$$V^i = V^i(G^i, Y^i - T^i, \bar{G}^i, \Psi^i), \quad (4)$$

in which \bar{G}^i represents the average level of government expenditures in other states, or (more likely) a subset of other states, chosen on some basis to be specified, and Ψ^i represents the remaining exogenous characteristics influencing utilities in state i .

The presence of spillovers can greatly complicate the analysis of expenditure choice, since a state government may want to choose a fiscal package that encourages other states to provide public goods from which the first state can benefit. For the moment we rule out strategic interactions of this kind by assuming that states make Nash assumptions about the expenditures of other states.⁷ Then eq. (3) will still characterize the efficient choice of expenditure by state i , but with utilities as described in (4), \bar{G}^i is an argument of the functions on both sides of (3). The influence of other states' expenditures on the expenditures of state i is obtained by totally differentiating (3), collecting terms, and imposing from (2) that $dT^i = dG^i$, yielding:

$$\frac{dG^i}{d\bar{G}^i} = \frac{\frac{\partial^2 V^i}{\partial \bar{G}^i \partial G^i} - \frac{\partial^2 V^i}{\partial \bar{G}^i \partial C^i}}{2 \frac{\partial^2 V^i}{\partial G^i \partial C^i} - \frac{\partial^2 V^i}{\partial (G^i)^2} - \frac{\partial^2 V^i}{\partial (C^i)^2}}, \quad (5)$$

in which C^i is private consumption ($= Y^i - T^i$). From the second-order condition characterizing the optimal choice of G^i , the denominator of the right-hand side of (5) must be positive. Hence the impact of a change in \bar{G}^i on the level of G^i has the same sign as the difference of the two second partial derivatives in the numerator of the right-hand side of (5). If \bar{G}^i is more complementary with G^i than it is with C^i , then G^i increases with \bar{G}^i . Inasmuch as the patterns of complementarity cannot be known a priori, the sign of $dG^i/d\bar{G}^i$ must be determined empirically.

This brings us to the issue of testing for the presence of spillover effects. Despite the substantial theoretical literature that posits the existence of spillovers, there has been little documentation of the importance of spillovers of public service benefits among subnational governments. Weisbrod (1964, 1965) estimates the extent to which local school expenditures provide benefits to other communities via the migration of educated population. In addition,

⁷See Johnson (1988) and Bell (1989) for analyses of non-Nash fiscal behavior of subnational governments. In the context of our model, introducing more general strategic interactions would not change the implied procedure for estimating responses to changes in neighbors' spending, though it would modify the interpretation somewhat.

he hypothesizes that school expenditures are lower in communities that encounter high rates of out-migration, and offers some evidence that is consistent with this view. Greene et al. (1974) estimate the magnitudes of benefit spillovers in the Washington, DC, area, concluding that public expenditures in the District of Columbia provide significant net spillover benefits to Maryland and Virginia. But there is no study that we know of that analyzes the impact of state budgets on the expenditures of other states.

Any such study must confront the elusive, very interesting question of what value \bar{G}^i takes in (5). It seems restrictive and unpersuasive to choose \bar{G}^i to be something like a national average, the same for every state. Instead, \bar{G}^i represents the spending of states whose expenditure benefits spill into state i . As mentioned earlier, spillovers may originate in states that are not geographic neighbors. For example, education expenditures in one state are likely to have the most impact on labor markets of states with similar economic or demographic characteristics. In this context, it should be noted that since one can observe only the behavior of governments and not the underlying benefit spillovers to consumers, eq. (5) would also describe the actions of governments that respond to spillovers that they perceive but that do not really exist. Alternatively, legislators may better identify and react to spillovers from states they perceive as sufficiently 'similar' in some other important respect. There is some evidence for this view in the political science literature. In his classic study of state government innovations, Walker (1969, p. 897) found

the likelihood of a state adopting a new program is higher if other states have already adopted the idea. The likelihood becomes higher still if the innovation has been adopted by a state viewed by key decision makers as a point of legitimate comparison. Decision makers are likely to adopt new programs, therefore, when they become convinced that their state is relatively deprived, or that some need exists to which other states in their 'league' have already responded.

In section 5 we use state expenditure data to infer the composition of the 'leagues', with perhaps surprising results.

3. Empirical implementation

3.1. *Econometric model*

Our theoretical model implies that state i 's per capita expenditures in year t , E_{it} , depend on its own characteristics (a vector X_{it}) and the expenditures of

its neighbors.⁸ For simplicity, assume for the moment that each state has only one neighbor, with per capita expenditure E_{jt} . Then in a linear specification we can write

$$E_{it} = X_{it}\beta + \phi E_{jt} + u_{it}, \quad (6)$$

where β and ϕ are parameters, and u_{it} is a random error.⁹

Several econometric studies of sub-federal government expenditure have suggested that a state's public expenditures are characterized by an individual effect – an unobserved characteristic of the state that influences its fiscal decisions and does not change over time (for example, 'climate' or 'political make-up') [see Holtz-Eakin (1986)]. Hence, we use pooled cross-section time series data, and augment eq. (6) with an individual effect. In addition, we allow for 'time effects.' (This amounts to including a series of year specific intercepts.) The time effects are intended to control for variables that might have a common effect on the states in a given year, such as business cycle conditions, the 'national mood' toward government, etc. Also, year-to-year changes in federal matching rate programs that change the effective price of spending for all states are subsumed in the year effects. Including time effects is particularly important in the context of our problem, because we do not want to attribute behavioral significance to any across-state correlations in spending that are really due to common national influences.

In short, our estimation equation takes the form

$$E_{it} = X_{it}\beta + \phi E_{jt} + f_i + h_t + u_{it}, \quad (7)$$

where f_i and h_t are the individual and year effects, respectively.

As stressed above, the unique aspect of eq. (7) is the presence of the neighbor's expenditure as a right-hand-side variable. The inclusion of E_{jt} raises several related issues that have to be addressed.

⁸It could be argued that population movements among states in response to fiscal differentials render the states' 'own characteristics' endogenous [see Tiebout (1956)]. The evidence suggests that interstate movement for any reason is relatively uncommon: in 1985, only 8.7 percent of Americans lived in states that differed from their 1980 residences [U.S. Bureau of the Census (1986, p. 25)]. The fraction of the population that moved for tax or spending reasons is presumably much smaller than that. This is not to suggest that it is *impossible* for people to change states in response to fiscal changes, only that such movement is rare, and that in the state context, it is reasonable to follow the conventional procedure and view demographic characteristics as exogenous.

⁹Eq. (6) assumes that the neighbor effects are transmitted concurrently, which is reasonable given that the data are yearly observations. We also analyzed a model in which $E_{j,t-1}$ appeared on the right-hand side, and found that it did not perform as well as (6) – with $E_{j,t-1}$, the value of the log likelihood was substantially lower than with E_{jt} .

3.1.1. Multiple neighbors

As indicated in section 2, a state may have more than one neighbor. Legislators in a given state are concerned with spillovers from those states whose expenditures affect them. In New Jersey, for example, the government might be concerned about developments in both New York and Michigan. This does not imply that all neighbors have equal influence. The impact of state j on state i 's spending depends on the complementarity of the states' spending in generating utility for residents in state i . This complementarity may, in turn, depend on the extent to which their populations are similar. As suggested earlier, a state that is very much 'like' Wisconsin will have more of an impact on Wisconsin's decisions than one that is less so. We assume that the impact of other states' spending on state i depends on a weighted average of all other states' spending, where the weights depend on the 'degree of neighborliness'. Specifically, we allow for the possibility of multiple neighbors by replacing E_{jt} in eq. (7) with

$$\sum_{j=1}^n w_{ij} E_{jt}, \quad (8)$$

where $\sum_j w_{ij} = 1$, and $w_{ij} = 0$ if state j is not a neighbor of state i .¹⁰

Every state is associated with a vector of w 's that indicates the relative importance of its neighbors' expenditures. We take note of this fact by writing the system of expenditure equations for all the states in year t in matrix form:

$$E_t = \phi W E_t + X_t \beta + u_t, \quad (9)$$

where E_t is a (48×1) vector of state expenditures for the continental United States in year t ; X_t is a $(48 \times k)$ matrix of explanatory variables that includes year and state effects; and W is a (48×48) weighting matrix that assigns neighbors to every state. That is, the i th row of W assigns to E_{it} a weighted average of neighbors' spending: $\sum_j w_{ij} E_{jt}$. In principle, it would be desirable to estimate the elements of the W matrix along with the other parameters. In practice, such an approach is out of the question because of insufficient degrees of freedom. We discuss below strategies for specifying W a priori, and the problems associated with each. For the moment, however, we will put this issue aside and assume that the W matrix is known.

3.1.2. Correlated random shocks

While the presence of time effects in the model controls for systematic influences common to all states in a given year, neighbors might be subject

¹⁰That weights sum to one for each state's neighbors imposes the restriction that these neighbors taken together have the same amount of influence on every state.

to correlated random shocks. The presence of such shocks produces a correlation between neighbors' levels of spending that could lead one to 'find' causal influences of one state's spending on another's that are not actually present. To avoid drawing such incorrect conclusions, we allow for potential correlation among the errors of neighbors by writing

$$u_t = \rho W u_t + \varepsilon_t, \quad (10)$$

where ε is an idiosyncratic error, uncorrelated between states: $E(\varepsilon_{it} \varepsilon_{jt}) = 0$ for i not equal to j . We cannot tell, a priori, what sign ρ will take. After state fixed effects and year effects absorb much of the variation left unexplained by the X variables, it becomes an empirical question whether and to what extent remaining state shocks are correlated.

Analogous to the time series phenomenon in which the presence of a lagged dependent variable [$Y_t = f(Y_{t-1})$] and serial correlation [$u_t = f(u_{t-1})$] mimic each other, in this work there is potential for dependence on neighbors through spending (E) and through errors (u) to mimic each other. As with time series, the presence of other right-hand-side variables (X) can be used to identify the effects separately.

3.1.3. Simultaneous estimation of expenditures across states

As eq. (9) stands it cannot be estimated consistently with ordinary least squares, since the errors are correlated with the right-hand-side dependent variables. But inverting the system¹¹ allows us to remove the dependent variables from the right-hand-side:

$$E = (I - \phi W)^{-1} X \beta + (I - \phi W)^{-1} (I - \rho W)^{-1} \varepsilon. \quad (11)$$

In (11), where the potential correlation among errors of neighbors has also been incorporated, expenditure is now written as a nonlinear function of exogenous variables X . Note that ignoring the presence of correlation in neighbors' errors would not bias estimation of β , but would reduce the efficiency of the estimation and produce biased estimates of standard errors. Ignoring the influence of neighbors' level of E can cause more severe problems. If state i 's neighbors' expenditures belong in (11), but are ignored, state i 's right-hand-side variables (X_i) are correlated with state i 's errors, leading to inconsistent estimates of β .

Eq. (11) indicates that despite the constancy of the β vector across states, the ultimate effect of a change in an exogenous variable differs across states. When one of the X 's changes exogenously in state i , the induced change in E_i then affects spending by state i 's neighbors. These changes feed back to

¹¹The matrix $(I - \phi W)$ is invertible if ϕ lies strictly between $(-1, 1)$. See Case (1987, Appendix 2) for a proof and discussion of this result.

state i through ϕW and induce a tertiary effect on E_i . Because two neighbors may weight each other differently, the diagonal elements of $(I - \phi W)^{-1}$ vary among states, and the ultimate effects of changes in X differ. Algebraically, a change in state i 's level of a single exogenous variable X_k , after allowing for reverberations between state i and its neighbors, can be written

$$\frac{\partial E_i}{\partial X_k} = A^{ii} \beta_k, \quad (12)$$

where A^{ii} is the (i, i) element of $(I - \phi W)^{-1}$. Intuitively, one expects the derivatives in (12) to differ substantially from β in the presence of large neighbor effects (ϕ) for those states with close neighbors.

We estimate (11) using maximum likelihood methods. Defining $A = (I - \phi W)^{-1}$ and $C = (I - \rho W)^{-1}$, the likelihood function (L) for (11) is

$$L = \text{constant} - N/2 \ln(E' C' A' M A C E) + \ln |A| + \ln |C|, \quad (13)$$

where the likelihood has been concentrated with respect to β and σ^2 ; where $[\ln |A| + \ln |C|]$ is the log of the Jacobian of the transformation between ε and E ; M is the matrix $[I - AX(X' A' AX)^{-1} X' A']$; and N is the total number of observations. Maximum likelihood estimates can be obtained using standard nonlinear estimation techniques. See Case (1987) for details.

3.2. Specifying the weighting matrix

Estimation of the system requires that we determine which states are neighbors. We indicated earlier that estimating the parameters of the W matrix is infeasible, so that its elements must be specified a priori. According to the theory outlined in section 2, state j is a neighbor of state i if benefit spillovers from state j influence fiscal choices in state i . Unfortunately, this does not give us much guidance with respect to observable variables that would tell us whether two states are neighbors. An obvious possibility is geographical proximity. If states share a common border, for example, their road networks may be complementary. However, it is not obvious that geography is the most relevant factor. States with similar demographics may exert the most powerful mutual influences because their populations are most likely to compete in national markets. If so, then states with similar racial compositions would view themselves as neighbors. In short, as the political science work cited in section 2 suggests, states may regard as neighbors other states that are similar to them economically or demographically, regardless of geographical proximity.

These considerations suggest that we explore several alternative criteria for neighborliness, and see which one is most consistent with the data. We

construct W matrices based on geography, per capita income, and percentage of the population that is black.¹²

This procedure is somewhat arbitrary. However, we stress that the typical practice of ignoring neighbor effects also amounts to an arbitrary assumption: that parameters describing the relationships among neighbors are equal to zero. There is no reason why the arbitrary assumption that $\phi = \rho = 0$ should have primacy over all other values of ϕ and ρ . In addition, we reduce the arbitrariness of our neighbor selection process by nesting potential candidates for neighborliness in order to test the strengths of various measures. For example, in order to test whether income or geography is a better way to characterize neighborliness, we can nest these two criteria:

$$W = \alpha W^{\text{Income}} + (1 - \alpha) W^{\text{Geography}}$$

and estimate the model, varying α between 0 and 1. By comparing the likelihoods of the models while varying α , we can assess the merits of different candidates for neighborliness.¹³

Once we have selected a criterion (or criteria) for neighborliness, we still face the problem of using it to compute the individual elements of W . This step requires that some assumptions be made. Consider the geographical criterion, for example. One possibility is to make this a dichotomous variable: to set $\omega_{ij} = 1$ if states i and j share a common border, $\omega_{ij} = 0$ otherwise, and specify $w_{ij} = \omega_{ij}/k$, where $k = \sum \omega_{ij}$. An alternative is to view proximity as a continuous variable. One could define d_{ij} as the distance between the capitals of states i and j , set $\omega_{ij} = 1/d_{ij}$, and construct w_{ij} from ω_{ij} as before. One might also try $\omega_{ij} = 1/d_{ij}^2$ or $\omega_{ij} = 1/d_{ij}^4$. This highlights another potential stumbling block in defining neighborliness: even after we have specified the qualitative nature of the criterion, a decision regarding functional form must be made. However, we found that in practice various measures of distance between neighbors yield similar results, as long as the measures are powerful enough to select a small number of states as a given state's neighbors.¹⁴

We estimated eq. (11) using combinations of the following alternatives for W :

¹²We also constructed W matrices based on proportion of population employed in agriculture, in manufacturing, in services, and in trade. None of these criteria improved the likelihood as much as geographic neighbors did, and further analysis was not carried out using these W matrices.

¹³This idea was suggested to us by James Poterba.

¹⁴For example, using q_i as the characteristic according to which neighbors are being measured, the distance measures $\omega_{ij} = 1/|q_i - q_j|$ and $\omega_{ij} = 1/(q_i - q_j)^2$ yield answers that are insignificantly different from one another. Other measures we tried (for example $\omega_{ij} = 1/[1 + \log(q_i/q_j)]^2$) did not single out any states as more neighborly than others. As a consequence, the algorithm for maximizing (13) did not converge.

W^G , neighbors with common borders. $w_{ij}=1/S_i$ if i and j share a border; $w_{ij}=0$ otherwise; and S_i =the number of borders state i shares.

W^I , neighbors with similar incomes. $w_{ij}=1/|INC_i-INC_j|/S_i$ where INC_i is per capita income in state i (mean over sample period);¹⁵ and S_i is the sum $\sum_j 1/|INC_i-INC_j|$.

W^B , neighbors with similar proportions of blacks in their populations. $w_{ij}=1/|BLACK_i-BLACK_j|/S_i$, where $BLACK_i$ is the proportion of state i 's population that is black (mean over the sample period); and S_i is the sum $\sum_j 1/|BLACK_i-BLACK_j|$.

4. Data

We estimate the model using annual data on the continental United States over the period 1970–1985. All dollar figures are put on a per capita basis, and deflated using the personal consumption expenditure deflator. (The base year is 1982.) Our measure of government expenditures for state i in year t , E_{it} , is the sum of the direct expenditures of state and local governments, exclusive of expenditures for interest, state-run liquor and utility concerns, and insurance. An alternative strategy would have been to analyze state but not local government expenditure. However, wide cross-sectional variation in the division of spending responsibilities between state and local jurisdictions, along with the possible substitutability of state and local spending in response to exogenous changes, make the approach of aggregating state and local expenditures less likely to run afoul of features of political hierarchy.

The following variables comprise the X_{it} vector of eq. (7): real per capita income, income squared, real per capita total federal grants to state and local governments, population density, proportion of the population at least 65 years old, proportion of the population between 5 and 17 years old, and proportion of the population that is black. This selection of conditioning variables is fairly uncontroversial. Income and grants are measures of the resources available for state and local spending. The square of income picks up possibly nonlinear effects of changing resources and also the effect of federal deductibility on the cost to citizens of state and local taxes.¹⁶ Population density captures the possibility that there are potentially conges-

¹⁵Because W^I depends on *between*-state differences in mean income while the X vector depends on *within*-state differences in income, elements of the weighting matrix are, by construction, orthogonal to the right-hand-side variables. There is no induced correlation between the X vector and the error term.

¹⁶For a taxpayer who itemizes deductions, the cost of an additional dollar of state and local tax payments is only one minus his or her marginal federal tax rate. Since marginal federal tax rates (and the propensity to itemize) are nonlinear functions of income, we include income squared to proxy for the price effect of federal deductibility. As a consequence, we are unable to disentangle the resource effect and the tax price effect of income changes, but this is not necessary for our purposes.

tion effects or scale economies in the provision of state and local government services. States with different age and racial structures may have different demands for publicly provided goods – hence the presence of the demographic variables. In addition, the conditioning matrix X contains state and year indicator variables. Federal matching rate programs exert potentially important influences on state and local spending. Year-to-year changes in the structure of these programs affect all states similarly; hence, their impact is subsumed in the time effects.¹⁷

We also estimate our basic equation for selected categories of spending. The categories studied are: expenditures on health and human services (health and hospital spending plus public welfare expenditures); expenditures on administration (financial administration and general control); expenditures on highways; and expenditures on education.

Table 1 presents descriptive statistics for these data; the numbers represent unweighted averages of state means, so they differ slightly from national averages. Of the average annual total state and local expenditure of \$1,865 per person, 40 percent is spent on education (\$746); 20 percent on health and human services (\$367); and 12 percent on highways (\$220). The coefficients of variation for these expenditure categories reveal that there is a great deal more variation in per capita spending on various components than there is in total spending.

5. Results

5.1. Total expenditure

5.1.1. Testing the neighbor model

Table 2 presents the results of estimating model (11) for state and local expenditures. The first column presents conventional OLS results; these can be estimated in our framework by constraining $\phi = \rho = 0$. The results are not dissimilar to those found in the literature. Here, we see a significant negative effect of population density on per capita spending, suggesting economies of scale in the provision of public goods. Both state per capita income and income squared are significant. As mentioned earlier, these represent both resource effects and tax price effects; we do not attempt to distinguish between them. The coefficient on grants (1.02) suggests that, *ceteris paribus*, states spend roughly one dollar for each dollar obtained in grants. This is an enormous effect compared with the derivative of spending with respect to

¹⁷One might argue that some measure of the cost of providing public services belongs on the right-hand side. However, such a variable might well be endogenous – as public sector expenditure increases, so might the costs of factors employed by the public sector. Nevertheless, for the sake of experiment, we estimated a variant of the basic model that included the earnings per public sector worker. While the coefficient on this variable was statistically significant ($t = 13.1$), its inclusion did not affect materially any of the results reported below.

Table 1
Variables used in analysis of state spending.

| Variable | Mean | S.D. | Minimum value | Maximum value | Standard error of mean | C.V. |
|---------------------------|--------|-------|---------------|---------------|------------------------|--------|
| Total expenditure | 1,865 | 304.7 | 1,363 | 2,826 | 43.97 | 16.33 |
| Health and human services | 367.3 | 96.49 | 235.7 | 745.5 | 13.93 | 26.26 |
| Highway | 219.7 | 74.71 | 117.2 | 520.5 | 10.78 | 34.01 |
| Administration | 81.77 | 22.37 | 51.01 | 157.1 | 3.229 | 27.36 |
| Education | 745.8 | 123.7 | 561.2 | 1,180 | 17.86 | 16.59 |
| Population density | 156.9 | 230.5 | 4.38 | 995.7 | 33.27 | 146.93 |
| Income | 100.50 | 12.74 | 73.50 | 128.37 | 1.839 | 0.1267 |
| Grants | 430.1 | 90.13 | 285.0 | 770.0 | 13.01 | 20.95 |
| Prop. elderly | 0.109 | 0.017 | 0.076 | 0.168 | 0.003 | 15.72 |
| Prop. school age | 0.228 | 0.012 | 0.201 | 0.261 | 0.002 | 5.187 |
| Prop. Black | 0.112 | 0.088 | 0.006 | 0.362 | 0.013 | 78.70 |

Sources: Expenditure, grant, and state per capita income data are from the Bureau of Census, Government Finance Series, General Revenue Tables. Data on demographic characteristics of the population are from Current Population Reports and unpublished data from the Bureau of the Census consistent with the Current Population Reports. State land area, used in computing population density, is from U.S. Bureau of the Census (1989).

Notes:

(1) All dollar figures are in real per capital terms. Population density is in units of persons per square mile. Income is measured in hundreds of dollars.

(2) Total expenditure is the sum of direct expenditures of state and local governments, exclusive of expenditures for interest, state-run liquor and utilities concerns, and insurance.

(3) Health and human services expenditure includes spending on health and hospital expenditures plus public welfare expenditures.

changes in personal income (0.07 at mean income). This 'flypaper effect' – the apparent proclivity of subnational governments to spend much more out of their grant income than personal income of their residents – has been observed by several researchers.¹⁸ The results in the first column of table 2 also suggest that a 0.01 increase in the proportion of elderly in the state population, *ceteris paribus*, reduces state per capita spending by about \$63, and a 0.01 increase in the proportion black reduces state per capita spending by about \$18.

Columns (2), (3), and (4) present the results using geographic proximity, per capita income, and proportion black, respectively, to define neighborliness. A striking result is that all of these specifications suggests that neighborliness matters. For W^1 and W^B , one can reject by a wide margin the joint hypothesis that $\phi = \rho = 0$.¹⁹

¹⁸See, for example, the papers surveyed by Inman (1979).

¹⁹The joint hypothesis is examined by using a likelihood ratio test: twice the difference in log likelihoods is distributed chi-square with two degrees of freedom. The 95 percent critical value is 5.99.

Table 2
 Estimation of state expenditures 1970–1985 using different measures of neighbor characteristic.

| Explanatory variables | Model | | | |
|---|-------------------|-------------------|-------------------|-------------------|
| | | W^{Geog} | W^{Income} | W^{Black} |
| Coefficient of spatial correlation in dep.var. (ϕ) | – | –0.225 (0.101) | 0.096 (0.097) | 0.701 (0.035) |
| Coefficient of spatial correlation in errors (ρ) | – | 0.294 (0.087) | –0.288 (0.098) | –0.753 (0.051) |
| Population density | –0.023 (0.006) | –0.027 (0.006) | –0.021 (0.006) | –0.013 (0.005) |
| State income per capita | 0.137 (0.032) | 0.128 (0.033) | 0.114 (0.030) | 0.165 (0.025) |
| State income per capita squared | –32.20 (13.93) | –29.04 (14.29) | –21.99 (13.02) | –47.76 (10.82) |
| Grants | 1.02 (0.08) | 1.04 (0.08) | 0.997 (0.078) | 0.648 (0.068) |
| Prop. population above age 65 | –62.66 (8.44) | –66.82 (8.44) | –63.12 (7.51) | –20.28 (8.81) |
| Prop. population aged 5–17 years | –7.84 (6.87) | –7.56 (7.27) | –7.68 (6.79) | 2.04 (5.53) |
| Prop. population Black | –17.53 (7.18) | –17.52 (6.41) | –25.75 (7.26) | 5.38 (5.23) |
| Chi-square test | – | 5.95 | 13.41 | 69.59 |
| No. of observation | 768 | 768 | 768 | 768 |

Notes:

- (1) Standard errors in parentheses.
- (2) Coefficients on state income per capita squared are multiplied by 10^5 for readability.
- (3) For column j , the chi-square test statistic is twice the difference in log likelihoods between models in column j and column (1). It is distributed chi square with 2 degrees of freedom.
- (4) All equations include year and state indicators.

Given the success of all the W matrices exhibited in table 2, a skeptical reader might wonder whether there is something inherent to the econometric procedure that produces significant results regardless of how ‘neighbors’ are defined. In order to investigate this possibility, we re-estimated the model with an intentionally absurd W matrix. Specifically, we set $w_{ij} = 1$ if state j followed state i in the alphabet, and zero otherwise.²⁰ The estimates of ϕ and ρ were both less than 10^{-4} in absolute value, and the log likelihood did not change measurably. Of course, there is an infinite number of silly criteria

²⁰The last state, Wyoming, was assigned the second to the last state, Wisconsin, as a neighbor.

that one could use to construct a W matrix. This experiment with an alphabetical criterion, along with a few others, convinced us that the results in columns (2) through (4) are not merely artifacts of the statistical procedure. As an additional check on the model, we ran OLS regressions of state expenditure on exogenous variables X and neighbors' exogenous variables WX . In terms of the notation from section 2, if states' spending is correlated either because $\partial^2 V^i / \partial G^i \partial G^i$ or $\partial^2 V^i / \partial C^i \partial G^i$ is nonzero, then neighbors' variables, WX , should be significant in a given state's spending equation. This is a fairly robust test of neighbor interdependence, as it does not rely heavily on functional form. We found neighbors' X 's to be jointly significant; using W^B as the weighting matrix, the significance level was 0.999. Finally, noting that $(I - \phi W)^{-1} X\beta$ can be expanded: $(I - \phi W)^{-1} X\beta = [X\beta + \phi WX\beta + \phi^2 W^2 X\beta + \phi^3 W^3 X\beta + \dots]$, we also estimated (9) by using higher orders of neighbors' X [$WX, W^2 X, W^3 X$, etc.] directly on the right-hand side of the equation to identify ϕ . Specifically, we chose β and ϕ to minimize the sum of squared differences:

$$\begin{aligned} \min_{\beta, \phi} \{ & E - [X\beta + \phi WX\beta + \phi^2 W^2 X\beta + \phi^3 W^3 X\beta + \phi^4 W^4 X\beta \\ & + \phi^5 W^5 X\beta + \phi^6 W^6 X\beta] \}' \\ & \times \{ E - [X\beta + \phi WX\beta + \phi^2 W^2 X\beta + \phi^3 W^3 X\beta \\ & + \phi^4 W^4 X\beta + \phi^5 W^5 X\beta + \phi^6 W^6 X\beta] \}. \end{aligned}$$

The estimates of ϕ from (14) were essentially identical to those obtained using (13).

It could be argued that the reason neighbors' X 's (or expenditures) are statistically significant is that the states' own X 's are measured with error, and the neighbors' X 's (or expenditures) just happen to be proxying for the true values of the own X 's. Of course, such an interpretation can be given to virtually any right-hand-side variable in any regression model. As always, one must make a judgment as to which interpretation is more plausible. Is it really believable that Michigan's expenditures affect New Jersey's expenditures because Michigan's expenditures are helping to improve the measurement of New Jersey's per capita income? We think not. The interpretation suggested by the spillover model is more persuasive.

The increase in the log likelihood is most marked in the case in which neighbors are defined as states with similar racial compositions. The use of W^B increases the log likelihood a full 35 points above the case in which both coefficients of correlation are constrained equal to zero. The chi-square test for significance is 70; ϕ and ρ are jointly significant with a probability of 0.9999.

We can confirm the superiority of the W^B matrix by nesting neighbor assignment based on geographic proximity with W^B , and nesting assignment based on income with W^B . In both cases the maximum likelihood is obtained by assigning all weight to proportion black. Algebraically, if $W = \alpha W^B + (1 - \alpha)W^{\text{other}}$, the maximum likelihood is reached at $\alpha = 1$.

Several readers of an earlier draft of this paper suggested that proportion black 'must be proxying for something else', perhaps the income distribution or degree of urbanization of the population. In response, we constructed W matrices based on proportion of the population below the poverty line (in 1980), and on the proportion of the population living in metropolitan areas (in 1980). Neither of these criteria improved the log likelihood as much as W^B ; indeed, neither did as well as W^G . It was also suggested that the proportion black might be picking up interstate differences in the costs of providing public services. To test this hypothesis we constructed W matrices based on manufacturing wages in each state; state and local government earnings per employee; and the exportability of state taxes.²¹ Neither of the weighting matrices based on wage indices improved the likelihood as much as geographic neighbors. The tax exportability index increased the likelihood significantly, but was handily rejected when nested with W^B .

A final conjecture is that the success of the W^B matrix simply reflects the high correlation between spending and region of the country. Of the nine states with the highest proportion black, eight are in the south, and one (Maryland) is a border state. To investigate this possibility, we deleted these nine states from the sample and re-estimated a preliminary version of the model. With this smaller sample, $\phi = 0.7103$ (S.E. = 0.0367) and $\rho = -0.7732$ (S.E. = 0.0538).²² These results are essentially identical to those in column (4) of table 2. Hence, our results are not due to the dominance of a 'region effect'. Instead, the average expenditure of states in the appropriate racial reference group has a large and significant effect on state spending throughout our sample.

On the basis of these experiments, we feel that the results in table 2 should be taken at face value: racial composition has an important impact on state expenditure patterns, and states with similar racial compositions experience benefit spillovers. One should note that the importance of race in state and local public finance is well established: Craig and Inman (1986, p. 203), for example, show that proportion black is a statistically significant determinant of state spending; Gramlich and Rubinfeld (1982, p. 547) argue that micro demand equations for some public budget items are affected by race; and according to Aronson and Marsden (1980, p. 101), even Moody's municipal credit ratings of a jurisdiction are influenced by its racial composition, *ceteris paribus*.

²¹The measure of tax exportability is described in Metcalf (1991).

²²The chi-square test statistic for the joint significance of the two parameters is 63.80.

5.1.2. Interpreting the coefficients

Because our preferred specification is the one in column (4) of table 2, we discuss those coefficients. Note the strikingly large, positive significant degree of correlation in the level of expenditure between neighbors ($\phi=0.701$), and the negative and significant degree of correlation between neighbors' errors ($\rho=-0.753$). The correlation in states' expenditures suggests that the ultimate effect of a spending increase by state i 's neighbors is, *ceteris paribus*, to increase state i 's spending by 70 cents.

Furthermore, incorporation of neighbors' expenditures into our analysis substantially changes the parameter estimates for the explanatory variables, X . The effect of population density decreases in absolute value roughly by half, suggesting that if state population density increased by 100 persons per square mile, state spending per person would decrease by \$1.30. The increase in spending out of grants, *ceteris paribus*, drops from the dollar-for-dollar estimate in column (1) to 65 cents on the dollar in column (4), diminishing the impact of the 'flypaper' effect. One interpretation of this difference is that conventional estimates of the flypaper effect overstate its impact by ignoring simultaneous changes in other jurisdictions. Since federal grants are often made available to many states at the same time, each state's expenditure responses are magnified by its neighbors' spending changes, which are induced by the same federal grant program. The spending impact of proportion elderly also diminishes with the inclusion of state neighbor effects; its coefficient falls in magnitude from -63 in column (1) to -20 in column (4). Interestingly, the coefficient on proportion black becomes insignificant in column (4). This suggests that the influence of race found in conventional equations is not due to the fact that racial composition directly affects tastes for public expenditure. Rather, the channel through which race operates is the determination of states' neighbors.

The presence of neighbors changes not only the magnitudes of the β 's; it affects their interpretation as well. As suggested by eq. (12), the ultimate effect of a change in a right-hand-side variable on state expenditure differs from β , due to interactions among states. Specifically, to compute the effect of a conditioning variable on state i , one must multiply that variable's β by A^{ii} , the (i, i) element of the matrix $(I - \phi W)^{-1}$. In order to obtain a sense of the magnitudes involved, one must compute the diagonal elements of A corresponding to the estimates in column (4) of table 2, i.e. $W = W^B$ and $\phi = 0.701$. Doing so, one finds that in Vermont, for example, the ultimate effect of a change in one of Vermont's X 's equals 1.05 times the relevant β . Few values of A^{ii} exceeded 1.10. For most states, then, the change in expenditures induced by a change in X is not very different from β . The A matrix also can be used to calculate the *cross* effects of one state's X variables on the spending of other states. Specifically, suppose that the conditioning variables in state i change by dX_i . Then the ultimate effect of this change on state j is $A^{ij}\beta dX_i$. By the definition of the A matrix, the cross effects depend on how neighborly states are – the effect of state i on any state

j dies away if i is distant from j . Indeed, for most states, the cross effects appear to die away quite rapidly with 'distance'. Our computations for New Jersey, for example, suggest that $A^{ij}=0.56$ for its closest neighbor, but only 0.05 for its fourth closest neighbor.

5.2. *Categories of spending*

As suggested earlier, there is no reason to assume that patterns of expenditure interdependence are the same for all categories of spending. The sign and magnitude of the impact in state i of an expenditure change among state i 's neighbors may be positive for some spending categories and negative for others. In terms of the spillover model developed in section 2, it is possible that some expenditures exert complementarity and others substitutability, but that largely they cancel in the aggregate, so that examination of aggregate spending levels will downwardly bias the effects of spillovers on spending.

To explore this possibility, we estimate the model separately for four different types of expenditures: health and human services, administration, highways, and education. These categories account for 75 percent of total expenditure. Omitted categories include fire and police protection and expenditures on the environment. In order to keep down the number of computations, we use only the W^B matrix for estimation. That is, we assume that the reference group appropriate for total expenditures also is most suitable for the various categories.²³ We continue to analyze expenditures on a per capita basis, except for education, where we deflate expenditures by the number of school-aged children.²⁴

The results are presented in table 3. Chi-square test statistics for the joint significance of ϕ and ρ are presented at the bottom of each column. Strikingly, in each category one can reject the hypothesis that taking into account interdependence does not enhance the explanatory power of the equation. Apparently, the results for aggregate expenditures that we found in table 2 are not due to the dominating presence of a single spending category for which neighbor effects matter.

²³However, a persuasive case can be made that, for highway expenditures, geography is more relevant than demographics for determining neighborliness. We therefore estimated the highway equation using W^G as well as W^B . The chi-square test for the joint significance of ϕ and ρ using W^G is 50.82. This is more than twice the value obtained using W^B . (See the discussion of table 3 below).

²⁴In theory, one might want to use a separate deflator for every expenditure category – highway expenditures per automobile, for example. However, only for education is it fairly obvious what the appropriate deflator should be.

Table 3
 Estimation of state expenditures 1970–1985 using mean proportion black in state population as the neighbor characteristic.

| Explanatory variables | State administration | | Health and human services | | Highway | | Education | |
|---|----------------------|-------------------|---------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Coefficient of spatial correlation in dep. var. | – | 0.578 (0.052) | – | 0.419 (0.060) | – | 0.536 (0.054) | – | 0.701 (0.036) |
| Coefficient of spatial correlation in errors | – | –0.608 (0.074) | – | –0.565 (0.068) | – | –0.585 (0.067) | – | –0.774 (0.035) |
| Population density | –0.002 (0.000) | –0.001 (0.000) | –0.010 (0.002) | –0.007 (0.002) | –0.002 (0.003) | –0.002 (0.002) | –0.037 (0.015) | –0.009 (0.012) |
| State income per capita | –0.005 (0.002) | –0.002 (0.002) | 0.013 (0.012) | 0.018 (0.011) | 0.027 (0.010) | 0.026 (0.010) | 0.232 (0.075) | 0.303 (0.061) |
| State income per capita squared | 3.45 (1.02) | 2.30 (0.87) | –1.53 (5.30) | –3.08 (4.65) | –7.56 (4.73) | –7.44 (4.38) | –45.83 (32.02) | –87.35 (26.51) |
| Grants | 0.025 (0.006) | 0.014 (0.006) | 0.316 (0.029) | 0.278 (0.028) | 0.233 (0.024) | 0.202 (0.025) | 0.856 (0.180) | 0.266 (0.161) |
| Prop. population above age 65 | –5.43 (0.60) | –3.49 (0.64) | –1.26 (3.25) | –2.72 (3.32) | –4.33 (3.23) | –0.129 (2.609) | –153.3 (19.3) | –62.78 (18.07) |
| Prop. population aged 5–17 years | –1.95 (0.44) | –1.49 (0.37) | –2.31 (2.53) | 0.334 (2.151) | –4.68 (1.91) | –3.93 (1.65) | –104.0 (14.5) | –77.61 (10.47) |
| Prop. population black | –1.06 (0.54) | –0.173 (0.447) | –9.69 (2.70) | –6.08 (2.21) | 5.17 (2.60) | 5.89 (2.27) | –40.53 (18.86) | 11.29 (13.95) |
| Chi-square test | – | 36.24 | – | 16.40 | – | 21.94 | – | 68.12 |
| No. of observations | 768 | 768 | 768 | 768 | 768 | 768 | 768 | 768 |

Notes: See table 2.

6. Summary and conclusions

Subnational governments do not make their decisions in isolation. Citizens and public servants are likely to be influenced by the actions of neighboring states, to have information relating to governmental activity in neighboring states, and to use this information in choosing what they want their own state government to do. In this paper, we employ data on state and local spending in the continental United States to test a model that explicitly allows for such expenditure interdependence. We find that states' expenditures are indeed significantly influenced by their neighbors, a result that is

consistent with well-established theoretical models of benefit spillovers among jurisdictions. In our preferred specification, the impact effect of a dollar of increased spending by a state's neighbors increases its own spending by about 70 cents. This expenditure interdependence appears even though our model allows for individual effects on state spending, year effects that might affect all states in the same year systematically, and unobserved shocks that might induce spurious correlation in neighbors' expenditures.

The most difficult methodological problems in this study arise in the course of assigning neighbors. What is likely to be the most common factor among states that influence each other? Theory does not provide firm answers, so we experiment with several alternatives. One measure of neighborliness, similarity in racial composition as measured by percent of the population that is black, performs significantly better than any other. The selection of criteria for neighborliness inevitably introduces some arbitrariness into the analysis. We find it extremely encouraging, then, that each of several reasonable alternatives suggests that interdependence is present. Each does better (in the sense of statistical significance) than the conventional empirical assumption that no interdependence is present. We also showed that taking into account neighbor effects substantially changes the estimated impacts of various conditioning variables on state expenditures. This suggests that conventional estimates of the impact of grants on state and local expenditures might be wide of the mark. Moreover, the importance of neighbor effects casts doubt on the validity and usefulness of several popular models of government behavior that, unlike the spillover model, ignore reciprocal effects of spending.²⁵

Finally, we note that spillovers need not be confined to subfederal jurisdictions. For national governments, there is some anecdotal evidence that even apart from considerations of macroeconomic coordination, fiscal policies in one country are affected by changes in other countries. Andersson (1988, p. 2) notes that a 'factor precipitating the [recent Scandinavian] tax reforms was the tax reforms undertaken elsewhere in the 1980s. The Scandinavian countries ... have by tradition always carefully followed developments in other countries.' Similarly, McLure (1988, p. 28) states that one of the reasons that Colombia adopted income tax indexing was that indexing was being considered in countries that Colombia wanted to emulate. The extent to which nations' budgetary policies affect each other is an important topic for future research.

²⁵It may be useful in future research to postulate other theoretical models consistent with reciprocal spending effects and determine whether it is possible to distinguish among them empirically. For example, Case et al. (1989) discuss a model in which citizens with imperfect information use the expenditures of neighboring states as a basis for determining whether their legislators are providing optimal amounts of public expenditures.

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