Road to Ruin? A Spatial Analysis of State Highway Spending

DONALD BRUCE, DEBORAH A. CARROLL, JOHN A. DESKINS, and JONATHAN C. RORK

Do states engage in infrastructure expenditure competition to attract new economic activity? Economic theory is inconclusive on the matter. States might respond to increased infrastructure spending in competitor states by increasing their own infrastructure spending. Conversely, states may decrease spending in the presence of positive spillovers from competitor states' infrastructure investment. Using spatial econometric techniques and focusing specifically on highway spending, we demonstrate that states expend less on highways when spending in neighboring states increases. We explore this possibility further by modeling state personal income growth as a function of own-state and neighbor-state highway spending. Our findings suggest positive spillovers influence interstate relationships for highway spending rather than race-to-the-top competition for economic activity.

Donald Bruce is an Associate Professor in the Center for Business and Economic Research (CBER) and the Department of Economics at the University of Tennessee, Knoxville. He specializes in policy research, focusing primarily on the economic and behavioral effects of tax policies. Recent work has also considered the effects of tax policies on small business activity, the volatility of state revenue sources, and the sales tax implications of electronic commerce. He can be reached at *dbruce@utk.edu*.

Deborah A. Carroll is an Assistant Professor in the Department of Public Administration within the School of Public and International Affairs at The University of Georgia. With a specialization in public financial management, her research focuses on fiscal policy issues pertaining to state and local governments with an emphasis on taxation, revenue diversification, and urban economic development. She can be reached at *dcarroll@uga.edu*.

John A. Deskins is an Assistant Professor in the Economics and Finance Department at Creighton University. His research is focused primarily on the behavioral effects of state tax policy. Recent research topics include the effects of state tax policy on corporate tax planning activity, the effect of small business activity on state economic growth, and the effect of state tax policy on entrepreneurship. He can be reached at *johndeskins@creighton.edu*.

Jonathan C. Rork is an Assistant Professor in the Department of Economics within the Andrew Young School of Policy Studies at Georgia State University. His research interests are in issues of interjurisdictional competition, the economics of state gaming, and the economics of the elderly. He can be reached at *jrork@gsu.edu*.

INTRODUCTION

State governments invest in infrastructure for a variety of reasons. At the most basic level, state infrastructure spending provides the necessary framework for a functioning economy. Roads, utility systems, and other forms of public infrastructure have public good attributes and are perhaps best provided by governments rather than private entities. In this light, state infrastructure spending is merely a response to voters' service demands.

States might also spend more on infrastructure to attract additional economic activity. Indeed, infrastructure spending can go hand-in-hand with measures like tax incentives as states compete with each other to attract business activity.[1] The theoretical relationship between infrastructure spending in competing states is not unambiguous, however. On the one hand, states might respond to infrastructure spending in their competitor states by increasing their own infrastructure spending. On the other hand, if positive spillovers exist, states might respond to higher spending in competitor states by scaling back their own spending.

In this paper, we use panel data to estimate the effects of intergovernmental competition on a specific component of state government infrastructure provision, namely state highways. We feel that the high visibility of highways makes them a more likely target for competition than other aspects of public infrastructure, such as sewer lines and water systems, as it will be easier for states to observe investment activity in other states. We explore interstate highway spending by modeling a state's own spending as a function of the weighted average of spending in neighboring states and a variety of other state-specific characteristics and factors related to resource availability and demand for public infrastructure provision. Four different weighting strategies are employed to assess the robustness of our results, in keeping with typical spatial econometric practices. We address the potential endogeneity of state spending decisions by lagging these independent variables by one year.

Our baseline findings reveal that states expend less on highways when spending in neighboring states increases, thereby suggesting that positive spillovers exist. We take this possibility a step further by subsequently modeling a state's personal income growth as a function of own-state and neighbor-state highway spending. This exercise reveals a positive effect of neighbor-state highway spending on own-state personal income growth, further suggesting that positive spillovers can drive interstate relationships in terms of infrastructure spending rather than race-to-the-top competition for economic activity.

Our paper continues with a discussion of the wealth of findings from the literature on the determinants of public infrastructure provision and the implications of interstate competition. This review of the earlier literature motivates our basic empirical strategy and specification, which we describe in detail before presenting our main findings and

1. Leon Taylor, "Infrastructural Competition among Jurisdictions," *Journal of Public Economics* 49, no. 2 (1992): 241–259.

several sensitivity analyses. The paper concludes with a summary and a discussion of policy implications.

DETERMINANTS OF PUBLIC INFRASTRUCTURE SPENDING

It is appropriate to begin by acknowledging that there is no consensus on the definition of public infrastructure, which ranges from all governmental capital investment to specific investment in the construction, repair, and maintenance of fixed capital assets.[2] The term "infrastructure" implies recognition of productivity associated with the type of public expenditure.[3] Although several definitions and classifications of public infrastructure are used throughout the literature, two common characteristics distinguish public infrastructure investment from other types of investment: (1) public infrastructure provides the basic foundation for economic activity, and (2) public infrastructure investment generates positive spillovers.[4]

There are two conflicting views on the determinants of public infrastructure provision, the merit of each largely contingent upon the type of community.[5] One view contends that infrastructure spending is a function of myopic decision making by politically motivated local officials[6] responding to both external and internal demands and pressures.[7] An opposing view contends that investment in infrastructure is the result of rational reactions to changing economic and demographic conditions.[8] In particular, construction spending follows a pattern of forward-looking, rational planning[9] in which capital outlays are often in response to economic resources and demographic characteristics related to demand for public investment.[10] Based on these arguments and empirical evidence found within the extant literature, public infrastructure provision can mostly be

2. John M. Kamensky, "Budgeting for State and Local Infrastructure: Developing a Strategy," *Public Budgeting and Finance* 4, no. 3 (1984): 3–17.

3. Frank L. Hefner and Timothy E. Burson, "The Determinants of Regional Infrastructure Spending," *Regional Science Perspectives* 22, no. 2 (1992): 19–26.

4. Randall W. Eberts, "Public Infrastructure and Regional Economic Development," *Economic Review* 26, no. 1 (1990): 15–28.

5. Douglas Holtz-Eakin and Harvey S. Rosen, "The 'Rationality' of Municipal Capital Spending," *Regional Science and Urban Economics* 19, no. 3 (1989): 517–536.

6. Robert P. Inman, "Anatomy of a Fiscal Crisis," *Business Review of the Federal Reserve Bank of Philadelphia* October (1983): 15–22.

7. Samuel Nunn, "Budgeting for Public Capital: Reinterpreting Traditional Views of Urban Infrastructure Provision," *Journal of Urban Affairs* 12, no. 4 (1990): 327–344.

8. Charles R. Hulten and George E. Peterson, "The Public Capital Stock: Needs, Trends, and Performance," *The American Economic Review* 74, no. 2 (1984): 166–173.

9. Douglas Holtz-Eakin and Harvey S. Rosen, "Municipal Construction Spending: An Empirical Examination," *Economics and Politics* 5, no. 1 (1993): 61–84.

10. Douglas Holtz-Eakin, "Bond Market Conditions and State-Local Capital Spending," *National Tax Journal* 44, no. 4 (1991): 105–120.

attributed to both resource availability and public service demands placed upon governments.

Resource Availability

There are three major sources of financing commonly associated with infrastructure, which also largely determine the levels of infrastructure spending undertaken by state and local governments at any given time. These sources and determinants include federal intergovernmental revenue,[11] the bond market and interest costs associated with issuing debt,[12] and own-source revenue[13] especially unanticipated increases in resources[14] and capacity to generate own-source revenue and carryovers from prior years.[15]

The single largest infrastructure investment program in the United States is the Transportation Equity Act for the 21st Century (TEA-21).[16] Federal assistance in public infrastructure provision is generally justified on the basis of benefit spillovers, in that citizens outside the jurisdiction receive some benefits from infrastructure projects; however, if these citizens' votes are not reflected in infrastructure financing decisions, then too little infrastructure capital will be supplied.[17] In addition, there is some evidence to suggest that the tax exemption on municipal bond interest subsidizes state and local capital spending.[18] Finally, states with separate capital budgets and without pay-as-you-go requirements for capital projects have been associated with higher levels of capital spending.[19]

Economic downturns and rapid growth often result in the decline of major financing sources for capital investments because own-source revenues get diverted toward operations, state aid to local governments is significantly reduced, and the use of debt decreases in response to declining bond ratings.[20] The elasticity of revenue sources, which includes the ability of governments to levy a sales and/or income tax, also affects revenue

11. Shama Gamkhar, "The Role of Federal Budget and Trust Fund Institutions in Measuring the Effect of Federal Highway Grants on State and Local Government Highway Expenditure," *Public Budgeting and Finance* 23, no. 1 (2003): 1–21.Kamensky (1984). Charles R. Hulten and Robert M. Schwab, "A Fiscal Federalism Approach to Infrastructure Policy," *Regional Science and Urban Economics* 27, no. 2 (1997): 139–159.

12. Kamensky (1984).

13. Ibid.

14. Holtz-Eakin and Rosen (1993).

15. Michael A. Pagano, "Municipal Capital Spending during the 'Boom'," *Public Budgeting and Finance* 22, no. 2 (2002): 1–20.

16. Len S. Brittain, "Financing Capital Expenditures," *Canadian Tax Journal* 50, no. 2 (2002): 552–575.

17. Edward M. Gramlich, "Infrastructure Investment: A Review Essay," *Journal of Economic Literature* 32, no. 3 (1994): 1176–1196.

18. Julia L. Coronado, "Tax Exemption and State Capital Investment," *National Tax Journal* 52, no. 3 (1999): 473–481.

19. James M. Poterba, "Capital Budgets, Borrowing Rules, and State Capital Spending," *Journal of Public Economics* 56, no. 2 (1995): 165–187.

20. Pagano (2002).

generation during economic downturns and expansions.[21] In addition, the distortionary effects of inflation often make it appear that sufficient amounts are spent on infrastructure when that really is not the case.[22] Finally, fiscally distressed jurisdictions typically engage in lower capital expenditures.[23]

Public Service Demands

Demand from new and expanding industry often places additional pressure on governments to provide public infrastructure. Infrastructure investment is largely a response to private sector pressure, expectations about future economic growth and development, and attempts to stimulate economic development.[24] For example, governments often provide new public capital in response to the demands of property entrepreneurs and private businesses for new or improved infrastructure in exchange for enhanced economic growth within the community.[25] In addition, governments have experienced changes in public demand for capital facilities as a result of innovations in technology.[26]

A number of management-related factors also influence demand for public infrastructure provision. In particular, infrastructure provision is affected by the use of better pricing mechanisms including greater reliance on user fees,[27] restrictions on whether and under what circumstances governments can impose and adjust user charges,[28] changes in the way services are delivered including shifting responsibility from public to private sectors for infrastructure provision,[29] and changes in resource management.[30] Some scholars have also identified a crowding-out effect from public welfare operating expenditures.[31] Public infrastructure spending might also be influenced by attempts to cut back on construction for purposes of maintaining balanced budgets, holding down the rate of tax growth, and financing greater demand for social services.[32]

21. Ibid.

22. Hefner and Burson (1992).

23. Mary Bumgarner, Jorge Martinez-Vazquez, and David L. Sjoquist, "Municipal Capital Maintenance and Fiscal Distress," *The Review of Economics and Statistics* 73, no. 1 (1991): 33–39.

24. Michael A. Pagano and Richard J. T. Moore, *Cities and Fiscal Choices: A New Model of Urban Public Investment* (Durham, NC: Duke University Press, 1985).

25. Samuel Nunn, "Public Capital Investment and Economic Growth in Fort Worth: The Implications for Public Budgeting and Infrastructure Management," *Public Budgeting and Finance* 11, no. 2 (1991): 62–95.

26. Pagano (2002). Roger J. Vaughn, *Rebuilding America: Financing Public Works in the 1980s, Volume 2* (Washington, DC: Council of State Planning Agencies, 1983).

27. Kamensky (1984).

28. Gramlich (1994).

29. Kamensky (1984).

30. Vaughn (1983).

31. Hefner and Burson (1992).

32. Pat Choate and Susan Walter, *America In Ruins: Beyond the Public Works Pork Barrel* (Washington, DC: The Council of State Planning Agencies, 1981).

Finally, a number of demographic factors have influenced demand for public infrastructure provision. Capital expenditures often occur to expand service delivery in response to increased demand from population growth.[33] In addition, demographic shifts[34] including population changes in age[35] and residential location[36] have significantly influenced capital spending.

Interstate Competition

Lost in this discussion of infrastructure provision is the potential for interstate competition to occur in the public infrastructure arena. To date, most interstate competition research has focused on tax setting[37] and program adoption.[38] However, there has been some work finding competition on the expenditure side, mostly in the specific categories of state spending on health and public welfare.[39] An exception is Case, Hines, and Rosen, who found evidence of competition in aggregate state expenditures as well as in the individual categories of education, health and human services, and highway spending.[40]

Why would competition exist within public infrastructure expenditures? One explanation is that public infrastructure is part of a package put forth to help states recruit new industry,[41] as well as improve economic competitiveness and overall quality

33. Robert L. Bland and Samuel Nunn, "The Impact of Capital Spending on Municipal Operating Budgets," *Public Budgeting and Finance* 12, no. 2 (1992): 32–47.

34. Kamensky (1984), Vaughn (1983).

35. Hulten and Peterson (1984).

36. Pagano (2002).

37. Anne Case, "Interstate Tax Competition after TRA 86," *Journal of Policy Analysis and Management* 12, no. 1 (1993): 136–148. Bruno Heyndels and Jef Vuchelen, "Tax Mimicking among Belgian Municipalities," *National Tax Journal* 51, no. 1 (1998): 89–101. Jan Brueckner and Luz Saavedra, "Do Local Governments Engage in Strategic Property-Tax Competition?" *National Tax Journal* 54, no. 2 (2001): 203–229. Theiss Buettner, "Local Business Taxation and Competition for Capital: The Choice of the Tax Rate," *Regional Science and Urban Economics* 31, nos. 2–3 (2001): 215–245. Federico Revelli, "Spatial Patterns in Local Taxation: Tax Mimicking or Error Mimicking?" *Applied Economics* 33, no. 9 (2001): 1101–1107. Jonathan Rork, "Coveting Thy Neighbors' Taxation," *National Tax Journal* 56, no. 4 (2003): 775–787. Karen Smith Conway and Jonathan Rork, "Diagnosis Murder: The Death of State 'Death' Taxes," *Economic Inquiry* 42, no. 4 (2004): 537–559.

38. Jan Brueckner, "Testing for Strategic Interaction among Local Governments: The Case of Growth Controls," *Journal of Urban Economics* 44, no. 3 (1998): 438–467. Per Fredrikkson and Daniel Millimet, "Strategic Interaction and the Determination of Environmental Policy across US States," *Journal of Urban Economics* 51, no. 1 (2002): 101–122.

39. David Figlio, Van W. Koplin, and William Reid, "Do States Play Welfare Games?" *Journal of Urban Economics* 46, no. 3 (1999): 437–454. Luz Saavedra, "A Model of Welfare Competition with Evidence from AFDC," *Journal of Urban Economics* 47, no. 2 (2000): 248–279. Katherine Baicker, "The Spillover Effects of State Spending," *Journal of Public Economics* 89, nos. 2–3 (2005): 529–544.

40. Anne Case, James Hines, and Harvey Rosen, "Budget Spillovers and Fiscal Policy Interdependence," *Journal of Public Economics* 52, no. 3 (1993): 285–307.

41. Taylor (1992).

of life.[42] However, it is indeterminate whether jurisdictions build infrastructure to accommodate recent growth or to attract new business.[43] In the latter case, some have suggested that private companies often exploit governments' willingness to finance infrastructure in competition with other regions for private sector jobs and potential tax base enhancements.[44] And, given that firms have been argued to be a form of mobile capital,[45] the parallels between firm recruitment/competition and tax competition become even clearer.

Alternatively, infrastructure may be an arena through which states engage in yardstick competition. Yardstick competition involves voters looking to conditions in neighboring states to judge how their elected officials are performing at home. Given that infrastructure has been found to be a major issue for local elections,[46] it is plausible to suggest that it might also be an important issue at the state level. Because the mechanism for discovering the presence of either tax or yardstick competition is the same, not knowing the source of interstate competition with certainty is not a hindrance for our estimation techniques. Our approach is most similar to that of Case, Hines, and Rosen with two key differences.[47] First, our data include the years 1986–2000, which appends perfectly to their work spanning from 1970 to 1985. More importantly, however, our model includes a much richer set of covariates that addresses resource availability, public service demands, and demographics.[48] This approach enables us to combine all of the major competing theories of public infrastructure provision into one model, thereby avoiding potential omitted variable concerns.

ECONOMETRIC MODEL AND ESTIMATION ISSUES

Identifying the Competition

To model the effect of interstate competition on state infrastructure provision, we begin by determining which states are in competition with each other. For the purposes of this paper, we limit our definition of a competitor to geographically contiguous states.[49]

42. Brittain (2002).

43. Taylor (1992).

44. Nunn (1991).

45. Peter K. Eisinger, *The Rise of the Entrepreneurial State* (Madison, WI: The University of Wisconsin Press, 1988). Jonathan Rork, "Getting What You Pay For: The Case of Southern Economic Development," *Journal of Regional Analysis and Policy* 35, no. 2 (2005): 37–53.

46. Susan A. MacManus, '"Bricks and Mortar' Politics: How Infrastructure Decisions Defeat Incumbents," *Public Budgeting and Finance* 24, no. 1 (2004): 96–112.

47. Case et al. (1993).

48. Case et al. (1993) were limited in their independent variables to age and income demographics along with federal grants.

49. Geographic definitions of competition are the standard choice in most spatially based studies, because spatial techniques require the modeler to impose competition rather than estimate the true competitor. While other definitions of competitors have been used in the literature (e.g., race-based competitors in Case et al. [1993]; competitors based on elderly migration patterns in Conway and Rork [2004]),

Thus, if we were examining Georgia's infrastructure expenditures, its competitors would be the states of Alabama, Florida, North Carolina, South Carolina, and Tennessee.

Once the competitors are identified, it is necessary to assign weights to capture the relative importance one state may wield over another. We employ four different weighting schemes to assess the sensitivity of our results. The first is *contiguity*, in which all neighboring states are considered to wield equal influence. For the case of Georgia, observations from Alabama, Florida, North Carolina, South Carolina, and Tennessee would be given equal weights. Observations from California would be assigned a weight of zero, because Georgia does not share a common border with California. However, because Florida has a larger population than Alabama, it may be the case that Georgia would be more influenced by expenditures from Florida than Alabama. To account for this, our second weight is *population-contiguity*, in which the weights are based on the populations of the bordering states. Thus, Florida would be given a greater weight than Alabama. Our remaining measures, *center* and *city*, depend on the physical distances between states. *Center* measures the distance from the center of one state to the center of a neighboring state. It effectively measures the average distance a resident of the home state would need to travel to cross borders. Because population is not uniform, we also employ the weight *city*, which measures the distance between neighboring states' largest cities in terms of population.

It is common in the spatial literature to use row-standardized weights, meaning the sum of weights equals one. In the case of the contiguity weights for Georgia, each competitor would be given a weight of 1/5, because five states border Georgia. In creating population-contiguity weights, we take the bordering state's population and divide it by the population of all bordering states. For both center and city, we want to ensure that states closer together get a greater weight; therefore, we assign the inverse of the distance as the weight for each state before row-standardization.[50]

Econometric Model

We apply the specification of Case, Hines, and Rosen and assume that infrastructure spending in a state is a function of state characteristics (Z_{it}) and the expenditures in neighboring states.[51] Denoting H_{it} to be per capita highway expenditures in state i at time t yields a linear specification of

$$H_{it} = Z_{it}\beta + \theta H_{jt} + \xi_i + \rho_t + u_{it} \quad (1)$$

(footnote Continued)
we limit ourselves to geographic definitions rather than attempt to impose a structure that may or may not exist.

50. Like Case et al. (1993), we estimated our models using various polynomial forms of distance, including the inverse of the square root of distance. Because our results remained essentially unchanged, we present the simplest version of our distance weights.

51. Case et al. (1993).

where ξ_i and ρ_t are state and year fixed effects, respectively, and u_{it} is a zero-mean, normally distributed error term. As described above, states have more than one neighbor, hence we replace H_{jt} with $\sum_j w_{ij}H_{jt}$ where w_{ij} refers to the weight assigned to state j. Because each state has a set of weights, we can rewrite the specification in equation (1) using matrix notation:

$$H_t = \theta WH_t + Z_t\beta + \xi + \rho_t + u_t \quad (2)$$

where W is a matrix that assigns weights to values of H_t from every state.

One econometric issue to be addressed relates to the inclusion of H_t on the right-hand side of equation (2). OLS estimation will lead to inconsistent parameter estimates due to correlation with the error term and/or simultaneity bias. If states are indeed competing with one another in determining infrastructure spending, then the expenditures of one's neighbors will be simultaneously determined with one's own policy. Thus, Georgia's expenditures will be affected by what Florida has chosen and Florida will respond, in turn, to Georgia's decision. To deal with this endogeneity, we estimate equation (2) using a one-year lag of the neighbors' per capita highway expenditures.[52]

Other Explanatory Variables

To estimate the impact of interstate competition on infrastructure spending, we control for several factors, in addition to interstate competition, that may also influence state infrastructure expenditures. These explanatory variables are grouped into three categories: resource availability, public service demands, and other state characteristics that may affect public infrastructure provision. These categorizations are consistent with findings from the extant literature presented above.

Resource Availability. We begin with those variables that affect the availability of resources to the state to provide public infrastructure, particularly spending dedicated to highway provision. First, we include the motor fuel tax rate. This particular tax is especially important since motor fuel taxes are often earmarked for highway projects and should, therefore, provide states with a larger pool of resources to provide highway infrastructure. To control for market-based cost factors in providing public infrastructure, we include a measure of the interest expense borne by state governments. Specifically, we include spending on interest payments relative to total debt to arrive at an effective interest rate measure.

52. Alternatively, we could estimate equation (2) using the instrumental variables approach outlined in Kelejian and Prucha (1998) in which weighted values of the exogenous variables (WZ_t) are used as instruments for the spatial lag, WH_t. Although our results remain essentially unchanged when using contemporaneous timing for neighboring states, we thought it was more realistic for there to be a delay in responding to infrastructure expenditures. Hence, we report lagged results throughout the paper and include the contemporaneous results in Appendix C. Harry Kelejian and Ingmar Prucha, "A Generalized Spatial Two-Stage Least Squares Procedure for Estimating a Spatial Autoregressive Model with Autoregressive Disturbances," *Journal of Real Estate Finance and Economics* 17, no. 1 (1998): 99–121.

Federal transfers per capita are included because the federal government is a major source of highway financing for the states. We also include the per capita amount of long-term debt issued by the state over the fiscal year. This is especially important because states often use debt as a means of financing their highway expenditures. In addition, per capita amounts of debt outstanding at the end of the fiscal year are included to control for a state's ability to issue more debt. Last, we include per capita state personal income to account for the overall income of the state and, correspondingly, the overall ability of the state to raise tax revenue. Furthermore, state personal income per capita also has the potential to affect the demand for public highway expenditures.

Demand for Public Infrastructure. Our second category of control variables captures the public's demand for public infrastructure provision, namely highway expenditures. Our first indicator of demand is total vehicle miles traveled within the state. We also include the percentage of the population that has a driver's license. Both of these are likely to be positively correlated with the demand for public highway spending. As a final, less-direct measure of demand, we include the percentage of the population that owns their own home to capture the general trend toward suburbanization within states. As more people own homes and relocate to the suburbs, the average commuting distance to one's place of employment might increase, thus raising the demand for highways.[53]

Other State Characteristics. Regarding other determinants of state infrastructure provision, we begin with a consideration of the political environment of the state in accordance with the arguments of Besley and Case, who assert that politics can influence interstate tax competition.[54] Here we include three variables to account for the potential relationship between politics and highway spending. First are two dummy variables indicating whether or not the governor and the majority of the state legislature are from the same political party, making the distinction between Republicans and Democrats. Because cooperation is more likely when all political bodies are from the same political party, we posit that it may be easier to increase highway spending when that occurs. In addition, we include a dummy variable for whether the year is a gubernatorial election year. If reelection is tightly contested, a governor may alter highway expenditures as a means to sway voters.

State demographic data are also included. We include the percentage of the population that is of school age (ages 5–17) to control for the education needs of a state, as education and highways are often in direct competition for financing within the state budget. In addition, we include the percentage of the population that is age 65 or older because they are likely to log relatively few highway miles.

As mentioned previously, our primary model includes both state and year fixed effects. The state fixed effects control for unobserved time-invariant characteristics within each state while the year fixed effects control for variables that impact all states in each particular year, such as national macroeconomic conditions, federal tax law

53. An additional factor that may affect the demand for highway provision is whether a state lies within the geographic interior of the country or whether it lies on the coast, the argument being that geographically internal states receive more through-traffic on the Interstate system and thus have a greater demand for highways. However, because this parameter is largely constant for each state across the time period covered by our data, any effect it may have is captured by state fixed effects.

54. Timothy Besley and Anne Case, "Incumbent Behavior: Vote-Seeking, Tax-Setting, and Yardstick Competition," *The American Economic Review* 81, no. 1 (1995): 25–45.

changes, etc.[55] Our data include observations for all U.S. states (except Alaska and Hawaii) for 1986–2000, yielding 720 observations. Table A1 provides summary statistics for all variables for the first and last years of our data set. Table B1 provides data descriptions and source notes for all variables.

RESULTS AND DISCUSSION

Table 1 reports the results of our baseline econometric model (equation [2]) of state highway expenditures per capita on lagged state highway expenditures per capita in neighboring states, as well as other control variables. Columns 1–4 present the various models using the four competitor definitions outlined above. The model in column 1 uses contiguity weights, the model in column 2 uses population-contiguity weights, and those in columns 3 and 4 use our distance-based weighting schemes of center and city, respectively. All specifications also contain both state and year fixed effects.

Our key finding across all specifications is that our variable of interest, the lagged weighted average of neighbors' per capita highway expenditures, has a negative and statistically significant (at the 99 percent level) effect on a state's own per capita highway expenditures. The coefficient estimates range from a low of -0.455 for the contiguity weights to a high of -0.290 for the population-contiguity weights. Thus, an increase in neighboring per capita highway expenditures of 10 percent will result in a 3–4.6 percent *decrease* in the home state's expenditures the following year.[56] It should be noted that this result contradicts what has been found in the extant literature examining other types of state expenditures. Case, Hines, and Rosen found a positive response in state highway expenditures from 1970 to 1985,[57] while others have also found a positive response in Medicaid and welfare expenditures to spending by competitors.[58] Our contradictory result suggests that there are positive spillovers to be gained from infrastructure provision in neighboring states. We believe that the potential for positive spillovers in highway expenditures is driving the difference between this spending category and other categories studied previously. We explore the possibility of positive spillovers further in the next section.

Several of the remaining control variables in our baseline models are found to have consistent effects on state highway spending, and those factors relate to both resource

55. In keeping with most panel data analyses, results for these effects are suppressed but are available upon request from the authors. The inclusion of state and year fixed effects into the panel regression greatly improved the model's fit over ordinary least squares analysis of the pooled cross-section time-series data. Unsurprisingly, we were easily able to reject the two separate null hypotheses that all state fixed effects and all year fixed effects are equal to zero.

56. Our basic model is estimating the slope of a Nash reaction function; hence, it has the interpretation of responsiveness even though it is not estimated in natural logs.

57. Case et al. (1993).

58. Figlio et al. (1999), Saavedra (2000), Baicker (2005).

TABLE 1
Regression Results—State Per Capita Highway Expenditures

Independent variable	Weight			
	[1] Contiguity	[2] Population	[3] Center	[4] City
Neighbors' highway expenditures per capita $(t-1)$	**−0.455*** [−5.06]**	**−0.290*** [−3.62]**	**−0.443*** [−5.20]**	**−0.368*** [−4.57]**
Motor fuel tax rate	0.335 [0.43]	0.239 [0.30]	0.398 [0.51]	0.379 [0.48]
Interest cost	**8.936*** [2.87]**	**8.408*** [2.67]**	**8.822*** [2.84]**	**8.652*** [2.77]**
Federal transfers per capita	**0.050** [2.46]**	**0.054*** [2.62]**	**0.050** [2.47]**	**0.049** [2.37]**
Long-term debt issued per capita	0.227 [1.13]	0.188 [0.93]	0.223 [1.11]	0.207 [1.03]
Long-term debt outstanding per capita	0.002 [0.55]	0.004 [0.89]	0.002 [0.43]	0.001 [0.26]
State personal income per capita	0.001 [0.21]	−0.001 [−0.43]	0.001 [0.37]	0.000 [0.03]
Miles driven	**−0.002*** [−4.74]**	**−0.001*** [−4.55]**	**−0.002*** [−4.95]**	**−0.002*** [−4.92]**
Driver's license (%)	0.316 [0.57]	0.172 [0.31]	0.299 [0.54]	0.371 [0.67]
Home ownership (%)	0.544 [0.63]	0.390 [0.78]	0.503 [0.58]	0.464 [0.53]
Governor and legislative majority are Democrat	−2.101 [−0.46]	−3.053 [−0.66]	−1.995 [−0.44]	−2.641 [−0.58]
Governor and legislative majority are Republican	**−11.839** [−2.23]**	**−13.929** [−2.57]**	**−12.212** [−2.30]**	**−13.447** [−2.51]**
Election year	−4.610 [−1.18]	−4.934 [−1.25]	−4.454 [−1.14]	−4.574 [−1.17]
Age 5–17 (%)	−3.705 [−1.43]	−3.402 [−1.29]	−3.464 [−1.33]	−3.901 [−1.50]
Age 65 and over (%)	**−9.158*** [2.95]**	**−8.671*** [−2.90]**	**−9.438** [−3.20]**	**−9.448** [−3.18]**
Constant	**411.413*** [4.36]**	**385.819*** [4.05]**	**408.459*** [4.33]**	**416.594*** [4.39]**
$F(28, 596)$	29.85	28.760	29.970	29.440
Prob > F	0.000	0.000	0.000	0.000
Adjusted R^2	0.874	0.873	0.875	0.873

Entries are fixed effects regression coefficients with t-statistics in brackets.
Regressions include state and year fixed effects.
*, **, and ***denote statistical significance at the 10%, 5%, and 1% levels, respectively.
Bold denotes significance at the 10% level.

availability and public service demand. The percentage of the population that is age 65 and over is estimated to have a large negative impact, indicating that older residents either prefer state spending to be directed to nonhighway purposes or that they prefer less state spending overall. Per capita federal transfers have a positive and significant impact, which is consistent with the fact that a major source of highway funding comes from the federal government.

States with both Republican Governors and Republican legislative majorities spend less on highways than other states, again perhaps reflecting a preference for lower government spending overall. The small but negative effect of the number of vehicle miles traveled may be capturing the geographic size of the state. A final consistent finding is that states with higher interest costs (interest payments as a fraction of total long-term debt) spend much more on highways. While this probably reflects greater interest payments on debt related to the highway projects themselves, it might also reveal that states making higher interest payments are able to spend more on all forms of public services.

Robustness Checks

We estimated several variants of our baseline models to assess the robustness of our main results. These partial results can be found in Table C1.[59] For the first two of these exercises, we reestimated equation (2) after replacing per capita highway expenditures with two alternative definitions of our dependent variable: total highway expenditures and direct highway expenditures[60] to ensure that the way we measure our dependent variable is not driving the results. Results from the total expenditures models again indicate that increases in the highway expenditures of neighboring states significantly reduce a state's own highway expenditures. Here coefficient estimates range from -0.165 to -0.368. Results from the direct expenditures models also continue to reveal a negative relationship, but within a range of -0.336 to -0.557.

In our next robustness check, we replaced our measure of *total* per capita federal transfers with a more limited measure of transfers received from the Department of Transportation. Doing so has a negligible impact on our estimated coefficient of interest as shown in Table C1. Perhaps more importantly, the coefficient on the per capita transfer variable (not reported) remains positive and significant at the one percent level, with estimates ranging from 0.437 to 0.442. Interestingly, transfers from the U.S. Department of Transportation are not necessarily more stimulative to state highway spending than federal transfers overall. It could also be the case that federal transfers for highway purposes do not necessarily pass through state Departments of Transportation.

59. Table C1 only includes results pertaining to our main variables of focus. Other results, which did not change dramatically across the various specifications, are suppressed for brevity. Full results from all robustness checks are available from the authors upon request.

60. Direct expenditures are those that come from a state's own resources, whereas our aggregate measure of total expenditures includes funding from intergovernmental sources as well.

Our final alternative approach is to use the instrumental variable approach outlined by Kelejian and Prucha, thereby eliminating the need to use lagged values of neighboring highway expenditures.[61] Doing so yields slightly lower estimates, although they still remain both negative and statistically significant at the one percent level. These results are reported in the last rows of Appendix C and increase our confidence in the baseline findings in Table 1.

In summary, by applying our knowledge of the determinants of public infrastructure spending to a specific subset, namely highway expenditures, we find consistent evidence that state highway spending decreases when spending within neighboring states increases. While this finding contradicts earlier research, we attribute this result to differences in data and methods as well as a fundamental difference between highway spending and other categories of spending. Specifically, we posit that states enjoy positive cross-border spillovers from highway spending—and from infrastructure spending more generally—in other states, and that these spillovers are not necessarily observable from other types of state spending. We now turn to an empirical exploration of this hypothesis.

POSITIVE SPILLOVERS OF INFRASTRUCTURE SPENDING

Because all of the above specifications of our baseline model consistently suggest that states respond negatively to one another in choosing their level of highway expenditures, our next step is to gain insight as to why such a situation might arise. We hypothesize that there may be positive spillovers related to infrastructure provision. For example, an improved highway in New Hampshire may make it easier for goods and workers to commute into neighboring Massachusetts. Because Massachusetts gains from New Hampshire's expenditures, the state may decide to spend its money elsewhere, resulting in the negative relationship reflected in the above results.

To test the plausibility of such an explanation, we estimate a state personal income growth model in which highway expenditures (both own-state and neighboring-state) are included as independent variables as follows:

$$\gamma_{it} = \beta y_{it-1} + H_{it-1} + \varphi W H_{jt-1} + Z_{it-1} + \zeta_i + \rho_t + u_{it} \tag{3}$$

In equation (3), γ_{it} represents the growth in personal income (y) between time $t-1$ and time t. In addition, y_{t-1} (personal income at time $t-1$) is included separately to control for the convergence hypothesis and should have a negative coefficient in the estimation. As was the case previously, H_{it} represents per capita highway expenditures in state i and year t. The matrix Z contains the remaining explanatory variables: the state unemployment rate, the average manufacturing wage, and human capital measured as the percent of the population with a college degree. We also run an alternative specification in which the percentage of the population that is school-aged (age 5–17) and the percentage of the

61. Kelejian and Prucha (1998).

population that is elderly (age 65 and over) are also included. While not commonly included in growth models, these age groups often attract certain types of state spending (e.g., health spending for the elderly, education spending for the young) that may spur growth. As with our highway spending models, all independent variables are lagged one year.

The results of this estimation are presented in Table 2. Columns 1 and 2 do not include the age breakdowns, whereas columns 3 and 4 include these additional variables. Because the results in Table 1 were robust to all weighting schemes, we only present results from models with contiguity and population-contiguity weights in our growth specification for simplicity. Note that in columns 1 and 2, neighboring highway expenditures have a positive impact on state income growth, with the estimated coefficient found to be significant at the 10 percent level for the contiguity weights and the 1 percent level for the population-contiguity weights. These estimates indicate that a $1 increase in per capita highway spending in neighboring states will increase state growth by 0.007–0.009 percentage points. While this impact is small, in times of tight budgets it might be enough of a benefit to sway states to spend their limited finances elsewhere. In any case, this finding is consistent with the idea that there are positive spillovers associated with public infrastructure provision, namely state highway spending.

Our other variables behave in a way that is consistent with the state growth theory. The negative and significant sign on lagged per capita income is consistent with the theory of convergence in economic growth. The state interest cost also has a negative impact, which suggests that a state has to deflect more of its budget toward paying interest on outstanding debt rather than toward more productive uses. The unemployment rate also has a negative relationship with state growth as expected.

As shown in columns 3 and 4 of Table 2, none of our estimated coefficients change signs when we include our age demographics in the model. Both age categories have a significantly positive impact on state income growth. Although neighbor-state highway spending does not have a statistically significant effect when using simple contiguity weights, evidence of positive spillovers is still observed when we use population-contiguity weights. In the end, we take the results in Table 2 to suggest that states are capturing positive spillovers from neighboring states' expenditures on highways. As a result, states will lower their own infrastructure expenditures when neighbor-state expenditures increase. Such a scenario would give rise to the negative coefficient we consistently observed in Table 1 and Table C1.

SUMMARY AND CONCLUSIONS

Economic theory is inconclusive on the question of whether states engage in infrastructure expenditure competition with other states to attract new economic activity. While some states might increase their own spending in response to higher spending

TABLE 2
Regression Results—State Economic Growth

	Weight			
Independent variable	**[1] Contiguity**	**[2] Population**	**[3] Contiguity**	**[4] Population**
Highway expenditures per capita	−0.003	**−0.003***	−0.002	−0.002
	[−1.63]	**[−1.71]**	[−1.15]	[−1.24]
Neighbors' highway expenditures per capita	**0.007***	**0.009*****	0.005	**0.007****
	[1.66]	**[2.76]**	[1.37]	**[2.09]**
Interest cost	**−0.389*****	**−0.390*****	**−0.355*****	**−0.354*****
	[−2.91]	**[−2.95]**	**[−2.70]**	**[−2.73]**
State personal income per capita (y_0)	**−0.001*****	**−0.005*****	**−0.001*****	**−0.001*****
	[−4.99]	**[−4.93]**	**[−6.60]**	**[−6.47]**
Manufacturing wage	**−0.360***	**−0.385***	−0.277	−0.299
	[−1.70]	**[−1.83]**	[−1.32]	[−1.43]
Bachelor's degree or higher (%)	0.019	0.018	0.027	0.026
	[0.42]	[0.39]	[0.58]	[0.56]
Unemployment rate (%)	**−0.198*****	**−0.213*****	**−0.178*****	**−0.190*****
	[−2.87]	**[−3.10]**	**[−2.61]**	**[−2.81]**
Age 5–17 (%)	—	—	**0.514*****	**0.493*****
	—	—	**[4.74]**	**[4.51]**
Age 65 and over (%)	—	—	**0.339*****	**0.328*****
	—	—	**[2.66]**	**[2.58]**
Constant	**22.081*****	**21.799*****	**11.858*****	**12.144*****
	[6.04]	**[6.07]**	**[2.88]**	**[3.00]**
$F(20, 604)$	21.04	21.450	21.210	21.410
Prob > F	0.000	0.000	0.000	0.000
Adjusted R^2	0.426	0.451	0.431	0.454

Entries are fixed effects regression coefficients with t-statistics in brackets.
Regressions include state and year fixed effects.
*, **, and ***denote statistical significance at the 10%, 5%, and 1% levels, respectively.
Bold denotes statistical significance at the 10% level.
All explanatory variables are lagged one year.

in competitor states, other states might cut their own spending or leave it unchanged in the presence of positive spillovers from competitor states' infrastructure investment.

Our empirical analysis examining the impact of interstate competition on public infrastructure provision reveals that states tend to spend less on highways when highway spending in neighboring states increases. This general result, which is highly robust to several alternative specifications and estimation methods, contradicts earlier research on

highway spending[62] and more recent research on Medicaid and welfare spending.[63] Our rationale for the negative effect is that positive spillovers might exist in terms of highway spending that do not exist in other areas of public expenditures.

We confirm the existence of positive spillovers from highway spending by estimating state personal income growth regressions in which own-state and neighbor-state highway spending levels are included as control variables. Neighbor-state highway spending is almost always found to have a positive effect on own-state personal income growth, while own-state spending has little to no effect. This result provides further evidence that states gain from infrastructure spending in neighboring states and need not necessarily engage in counter-productive race-to-the-top competition.

Our results have important implications for the state budgeting process. Namely, states need not be overly concerned with keeping up with highway spending in other states if budget constraints dictate other uses of public funds. Indeed, if neighboring states make investments in highway spending, states can enjoy the positive spillovers while reducing their own spending. Another implication of our findings is that planners might wish to consider the spillover effects as they undertake cost–benefit analyses of prospective highway projects. They will also want to monitor highway spending in neighboring states, as reductions in those states can have negative spillovers in the form of lower personal income growth rates. This can have equally important impacts on state revenues, to the extent that income plays a direct or indirect role in the state's overall tax base.

We hope to supplement this research with additional work in several areas. First, to provide a more complete picture of interstate relationships in expenditure decisions, we need to explore the possibility of positive (or negative) cross-border spillovers in other spending categories such as health care or education or total state spending. Second, it will be important to take a broader look at state spending decisions in light of development policies on the revenue side of state budgets. For example, we wonder whether states might trade off spending on infrastructure for an enhanced package of tax or nontax incentives to increase economic development. Taking this logic a step further, we would like to study the impacts of economic development activities (in the form of either incentive programs or spending) on infrastructure provision decisions.

62. Case et al. (1993).
63. Figlio et al. (1999), Saavedra (2000), Baicker (2005).

APPENDIX A

TABLE A1
Summary Statistics

	1986		2000	
Variable	**Mean**	**Standard deviation**	**Mean**	**Standard deviation**
Highway expenditures per capita	189.76	77.63	327.54	113.57
Highway expenditures total	752708	586953	1532269	1211608
Direct highway expenditures	619498	498561	1272620	1034397
Motor fuel tax	13.19	3.03	20.35	4.45
Interest cost	1.50	0.87	2.11	1.27
Federal transfers per capita	406.20	106.02	1068.02	325.25
Long-term debt issued per capita	316.50	248.98	318.55	203.20
Long-term debt outstanding per capita	1187.82	817.59	2113.84	1316.99
State personal income per capita	14513	2131	28186	4388
Miles driven	37929	39041	56881	56443
Driver's license (%)	67.60	4.24	69.69	5.16
Home ownership (%)	66.51	4.89	69.96	5.04
Governor and legislative majority are Democrat	0.35	0.48	0.15	0.36
Governor and legislative majority are Republican	0.13	0.33	0.25	0.44
Election year	0.71	0.46	0.25	0.44
Age 5–17 (%)	19.14	1.69	18.91	1.09
Age 65 and over (%)	12.07	1.88	12.66	1.66
Manufacturing wage	9.56	1.15	14.13	1.59
Bachelor's degree or higher	18.79	3.71	24.84	4.37
Unemployment rate (%)	6.92	2.21	3.84	0.88

APPENDIX B

TABLE B1
Data Descriptions and Source Notes

Variable	Definitions
Highway expenditures per capita	Total local expenditures on highways divided by state population[a]
Neighboring highway expenditures per capita	Equivalent measure—for neighboring states[a]
Motor fuel tax	State motor fuel tax rate[b]
Interest cost	Interest payments of local governments/total long-term debt[a]
Federal transfers per capita	Federal grants to local governments divided by state population[a]
Long-term debt issued per capita	Long-term debt issued by the state divided by state population[a]
Long-term debt outstanding per capita	Long-term debt outstanding by the state at end of fiscal year divided by state population[a]
State personal income per capita	Total state personal income divided by state population[a]
Miles driven	Number of state vehicle miles traveled[c]
Driver's license (%)	Number of licensed drivers divided by state population[d]
Home ownership (%)	Percentage of houses that are occupied by owners[e]
Governor and legislative majority are Democrat	1 if governor and majority in state legislature are Democrat[f]
Governor and legislative majority are Republican	1 if governor and majority in state legislature are Republican[f]
Election year	1 if gubernatorial election year[f]
Age 5–17 (%)	Share of state population between the ages of 5–17[a]
Age 65 and over (%)	Share of state population over the age of 64[a]
Manufacturing wage	Average hourly wage for manufacturing workers[g]
Bachelor's degree or higher (%)	Share of state population with a bachelor's degree or higher[a]
Unemployment rate (%)	State unemployment rate[e]

Notes:
[a]Author's calculations based on data from U.S. Census Bureau, various years.
[b]World Tax Database, Office of Tax Policy Research, University of Michigan, various years.
[c]International Transportation Database, Bureau of Transportation Statistics, U.S. Department of Transportation, various years.
[d]Authors' calculations based on data from Federal Highway Administration, U.S. Department of Transportation, and U.S. Census Bureau, various years.
[e]U.S. Census Bureau, various years.
[f]Statistical Abstract of the United States, various years.
[g]Employment and Wages, U.S. Bureau of Labor Statistics, various years.

APPENDIX C

TABLE C1
Robustness Checks—Regressions Using State Highway Expenditures

	Weight			
	[1] Contiguity	[2] Population	[3] Center	[4] City
Original results (from Table 1)				
Neighbors' highway expenditures ($t-1$)	-0.455^{***} [−5.06]	-0.290^{***} [−3.62]	-0.443^{***} [−5.20]	-0.368^{***} [−4.57]
With total state highway expenditures (not per capita)				
Neighbors' highway expenditures ($t-1$)	-0.354^{***} [−4.80]	-0.165^{***} [−4.31]	-0.368^{***} [−4.76]	-0.262^{***} [−3.97]
With direct highway expenditures per capita (not overall highway expenditures)				
Neighbors' highway expenditures ($t-1$)	-0.557^{***} [−6.16]	-0.336^{***} [−4.01]	-0.536^{***} [−6.23]	-0.477^{***} [−5.81]
Using per capita federal transfers received from the department of transportation only				
Neighbors' highway expenditures ($t-1$)	-0.454^{***} [−5.22]	-0.299^{***} [−3.96]	-0.458^{***} [−5.60]	-0.359^{***} [−4.63]
Using instrumental variable approach				
Neighbors' highway expenditures	-0.432^{***} [−5.36]	-0.303^{***} [−4.33]	-0.426^{***} [−5.64]	-0.270^{***} [−3.76]

Entries are fixed effects regression coefficients with *t*-statistics in brackets.
Regressions include state and year fixed effects.
***Statistical significance at the 1% level.