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Fiscal Substitution in Spending for Highway Infrastructure

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Abstract

In this working paper, the Congressional Budget Office provides estimates of how much state and local governments that receive federal grants for highway capital projects substitute that funding for their own spending on highway capital. We find that state and local governments reduce their own per capita spending on highway capital by 26 cents for an additional dollar of annual federal formula grants; that finding is toward the lower end of a broad range of estimates in the existing literature. The rate of substitution decreases as state and local governments run larger deficits, such that, all else being equal, those governments spend more of their own funds on highways when federal grants increase. In response to grants provided under the American Recovery and Reinvestment Act, state and local governments increased their own spending on highway capital relative to what they would have spent otherwise. Requirements in that legislation that states maintain planned levels of spending on highways or face reductions in future federal aid may have contributed to that positive relationship between grants and spending.

Keywords: grants, highways, infrastructure, state and local government, transportation

JEL Classification: E22, E62, H54, H72, H76, H77

Note

Unless otherwise noted, years refer to state fiscal years and are designated by the calendar year in which they end. In most states, the fiscal year runs from July 1 through June 30.

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Summary

Most federal spending for highway infrastructure takes place through grants to state and local governments. Understanding whether and how much those governments substitute that federal funding for spending they would otherwise undertake using their own resources is important for evaluating the economic effects of federal spending. To do that, we analyzed two decades of federal, state, and local spending on highways.

Effect of Federal Formula Grants on Highway Spending by State and Local Governments

Under typical conditions, after receiving an additional dollar in federal highway grants, state and local governments spent 26 cents less of their own funds on highway capital projects than they would have otherwise. In our assessment, two-thirds of the time, the reduction from a similar increase in grants would be between 14 cents and 38 cents. Those results fall toward the lower end of a broad range of estimates reported in the literature (see Table 1), and the range is narrower than CBO's previous assessment (based on that literature) of 20 cents to 80 cents.¹ The rate of substitution was smaller in magnitude when state and local governments ran budget deficits, decreasing by about half a cent for each percentage point of deficit.

Additional analysis indicates that some of the state and local funds that would otherwise have been used for highway capital projects were instead used for other highway-related (noncapital) purposes, such as highway operations and maintenance. A decomposition of the analysis into state spending changes and local spending changes further suggests that the substitution away from capital spending occurred at the state level and that spending shifted more toward local spending for operations and maintenance.

Effect of ARRA Grants on Highway Spending by State and Local Governments

During the 2007–2009 recession, state and local governments faced severe fiscal pressures. The federal government provided additional funding for highway grants through the American Recovery and Reinvestment Act (ARRA). Those grants had terms different from those of the usual federal highway grants, and the legislation also authorized and subsidized the issuance of Build America Bonds for highway projects. In response, state and local governments spent more on highway capital than they would have spent otherwise. Specifically, they increased their own spending by 13 cents for each dollar of ARRA highway grants.

That result differs from key estimates reported in the literature that focused on ARRA highway grants: a decrease in state and local spending in response to ARRA grants, and an increase nine times the size of our estimate. Unlike those analyses, our model accounted for state issuance of Build America Bonds, which were available at the same time as ARRA grants and provided state

¹ For a discussion of CBO's previous assessment, see Congressional Budget Office (2020). For further discussion of the literature on state and local fiscal substitution for federal highway grants, see Campbell (2018).

and local governments a larger federal subsidy than typical municipal bonds. We estimate that, for each dollar of Build America Bond issuance, state and local governments increased their capital spending for highways by 60 cents over three years.

Endogeneity Concerns

One of the main issues identified in the literature with this kind of analysis is that it can be difficult to determine the extent to which state and local spending changes in response to an independent change in federal grants. The difficulty (which in economics parlance is called endogeneity) occurs because federal grants for highways are paid to states as reimbursements for part of their highway capital spending, which means that state and local highway spending can influence the amount of the federal highway grants paid to states. Whereas most analyses in the literature have relied on instrumental variable approaches to estimate the independent effect of federal grants on state and local spending, our primary measure of federal grants is the set of annual state-level limitations on obligations for highway formula grants as determined by the Congress. We use that measure because it represents the federal resources available to state and local governments but is not influenced by those governments' spending decisions.

State and Local Highway Spending and Its Determinants

In our model, we estimate the sum of spending for highway capital projects by state and local governments as a function of the amount of federal grants made available to those governments, other financing and funding sources available to those governments, and measures of the demand for highway services in the state. Within that framework, we account for several factors that have not typically been included in the literature. We differentiate among three different types of federal grants. We include measures of federally subsidized bond financing. And we account for the fiscal pressures that state and local governments face.

As is the custom in the literature, we adjust our data to take into account the size of the population in each state. We estimate the following equation using panel data for 50 states from 1994 to 2015:

$$S_t^i = \alpha + \sum_{m=1}^3 \sum_{j=0}^J \beta_{m,j} G_{t-j}^{m,i} + \delta R_t^i + \gamma X_t^i + u_t^i,$$

where

- S_t^i is per capita spending by the state and local governments of state i in year t on highways, net of federal grants;
- $G_t^{m,i}$ is per capita federal grant payments to state and local governments of state i in year t for highways, with lags of j up to $J = 2$ and three types m of highway grants;

- R_t^i includes measures of the financial resources available to state and local governments to spend on highways;
- X_t^i includes measures related to demand for highways, the extent of a state's existing highway infrastructure, and state and year fixed effects; and
- u_t^i is an error term.

State and Local Highway Spending

The dependent variable in our analysis is per capita spending by state and local governments for highway capital projects net of federal grants received. That variable differs from the dependent variable used in much of the literature in two ways. First, we include spending by both state and local governments, whereas much of the literature refers only to spending by state governments. Like the Government Accountability Office (2004), we recognize that states share the burden of highway spending with local governments differently. Some states keep spending decisions largely centralized at the state level, whereas others transfer more of the responsibility to local governments. Considering the sum of state and local spending together allows us to look past those different spending arrangements, but it means that we cannot capture different responses to federal grants across localities within states.

A second way that our analysis differs from analyses in much of the existing literature is that our primary interest is in spending on highway capital projects. To inform its projections of macroeconomic conditions, CBO seeks to capture spending that contributes to future economic activity.² Because most federal highway grants are intended to support capital projects, and because capital projects are those that contribute most to future economic activity, a focus on spending for capital projects can provide a clearer sense of the net investment that results from federal highway grants.

By contrast, most of the existing literature considers the effect of federal grants on total state and local government spending for highways—not only capital spending but also operation and maintenance costs and the costs of other highway-related programs, such as educational programs focused on highway safety. Capital spending includes outlays for new structures (such as highways and bridges) and equipment as well as expenditures that extend the service life of (or otherwise improve) structures and equipment already in place. Operation and maintenance

² See Congressional Budget Office (2016, 2021).

costs include the costs of providing necessary operating services (such as snow removal) and maintaining and making minor repairs to existing capital (such as filling potholes).³

Federal Grants

The federal government has many programs that distribute highway grants to state and local governments. Our treatment of federal grants differs from that in much of the literature in two important ways. First, most prior analyses have treated all federal grants the same. In fact, programs differ in terms of their criteria for distributing funds, rules on project eligibility, state and local matching rates, and how easily funds can be shifted to other transportation-related priorities. We distinguish among three types of federal grants: formula grants, ARRA grants, and allocated grants. Second, we take a different approach to addressing the endogeneity of federal grants with state and local highway spending. Federal grants are generally paid to reimburse states for the federal portion of construction costs once those costs have been incurred. As a result, federal grant payments are jointly determined with state and local spending from nonfederal resources. To account for that endogeneity, models in the existing literature have often used instrumental variables such as political variables, lagged grants, or lagged highway system information. We address the endogeneity issue by using the amount of money the federal government has made available to a state in a given year but has not yet committed to a project or paid to the state. Those amounts, called obligation limits, are highly correlated with federal grant outlays but are determined independently of states' spending decisions.

Formula grants. Formula grants are the primary form of federal grants to state and local governments for highways; 92 percent of the funds for highways authorized under the Fixing America's Surface Transportation Act were provided through formula grants. The formula grants made available to states each year depend in part on formulas set out in authorizing legislation that are based on population, lane miles, gas tax collections, historical grant amounts, and other criteria. The formulas determine the portion of the total amount of money available that is directed to each state. Formula grants also depend on an aggregate national obligation limit for federal highway funding that is set in annual appropriations law. Once the national obligation limit has been set, the Federal Highway Administration (FHWA) applies the formulas and announces the state- and program-level formula amounts. State and local governments then can commit those federal funds to eligible projects and receive payments for the federal share as the projects are built out. (Most federal highway grant programs require state and local governments to contribute between 10 percent and 20 percent of a project's costs.)

³ The word "maintenance" can cause confusion in discussions of federal highway spending. Although guidance on what kinds of maintenance activities qualify for the use of federal funds has evolved over the years, qualifying activities have been those determined to extend the life of a facility (preventive maintenance) rather than regularly reoccurring activities to address damage or deterioration (routine maintenance). FHWA allows federal funds to be used for preventive maintenance only. See Waidelich (2016) and Carlson (1993).

In this analysis, formula grant amounts are represented by state-level obligation limits, which specify the amount of federal formula highway grants that state and local governments have available to commit, or obligate, to eligible highway capital projects in their jurisdiction.

Allocated grants. We consider grants for allocated programs, which are not generally distributed according to formulas, separately. The mix of allocated grant programs has changed over time, as have the methods used to determine which state and local governments receive the grants.⁴ Before the passage of the Moving Ahead for Progress in the 21st Century surface transportation authorization law in 2012, some of those grants were designated for specific states or regions as the result of directions included in legislation (often referred to as “earmarks”). Other grants have been awarded following applications to and administrative decisions by the Department of Transportation for a variety of programs over the years. Despite that potential endogeneity, allocated grants are small, and their estimated effects are statistically insignificant (as discussed below).

ARRA grants. We also consider the effects of the highway grants provided through ARRA, which funded highway capital projects as part of a broader economic stimulus program in response to the 2007–2009 recession. ARRA highway grants were distributed to states on the basis of formula grant amounts made in prior years, with state-level amounts announced in March 2009.

We consider ARRA grants separately because their terms differed in some ways from those of the usual formula grants. Although ARRA grants could be spent on the same types of capital projects as the formula grants offered each year, they had to be spent much more quickly than typical highway grants. ARRA grants also came with a requirement that states maintain their previously planned level of spending for highways in the year they received the grants.

In another departure from the standard highway formula grants, ARRA grants did not require states to contribute their own funds to pay for eligible projects. As a result, the analysis of ARRA grants is not subject to the endogeneity concerns associated with standard formula grants. Moreover, because ARRA grants were made as part of an appropriation from the general fund, they were not subject to obligation limits.⁵

Interactions between federal grants and state and local budgets. State and local budget constraints may affect the way in which those governments substitute federal grants for their own spending. Most state governments have some form of legislated or constitutional mandate to

⁴ State-by-state data on allocated grants currently extend only through 2009. For subsequent years, we approximated state-level allocated grants by applying states’ historical shares of allocated program grants to the national totals for allocated programs.

⁵ See Federal Highway Administration (2009).

maintain a balanced budget for current expenditures, suggesting that running a deficit could limit the ability of those governments to spend on highways. To examine the effect of budget constraints on substitution, we construct measures that interact state and local government surpluses or deficits, as a share of revenues, with federal formula grants and with ARRA grants.

State and Local Government Resources

We rely on a number of different measures to address state and local governments' capacity to spend on highways. Following much of the existing literature, we include states' per capita income and fuel and vehicle tax collections in our model. Personal income indicates the extent of the resources available for governments to tax to raise revenues. Almost all states dedicate some or all fuel and vehicle tax revenues to transportation, including roads.⁶ In addition, after early specifications of our model showed that it did not predict state and local spending for highways in certain resource-dependent states as well as it did elsewhere, we added the share of a state's gross domestic product (GDP) arising from oil- and gas-extraction industries as another measure of the resources available to states, expecting that tax revenues in those states would depend on those industries' profits.

State and local governments issue municipal bonds to finance capital spending for highways and other public investments, then pay back those bonds over a number of years. We include two measures of bond financing in our analysis: the amount of long-term debt issued by state and local governments and the amount of Build America Bonds issued by those governments for highway purposes in 2009 and 2010 (when the program was active). We also include lagged values of both measures, recognizing that the projects financed by such debt issues may have required more than one year to complete.

Other Considerations

The existing literature recognizes several other factors that may affect state and local spending, including differences in demand for highways, the size of the highway system in a state, and other differences in federal resources available to a state. Controlling for those influences allows for more accurate estimates of the effects of federal grants and state and local government resources.

Vehicle registrations per capita account for demand for highways, and the number of public lane miles per capita controls for the size of a highway system in a state. In addition, over the period examined, Atlanta, Georgia, hosted the 1996 Summer Olympics and Salt Lake City, Utah, hosted the 2002 Winter Olympics. In preparation for both events, the host cities and states undertook additional investments in infrastructure, including highways. To reflect that, we include dummy variables for each state for the years leading up to its respective Olympic Games. Finally, a series

⁶ See Sigritz (2020, p. 70) and Feigenbaum and Hillman (2020).

of year and state dummy variables accounts for any year- or state-specific effects that are not otherwise controlled for.

Data Sources and Estimation Process

To assess the effects of the determinants of state and local highway spending, the analysis uses state-level data across 22 years drawn from several government data sources. The regression analysis methods take into account some of the statistical implications of using those data.

Data Sources

Our data sources include the Census Bureau’s Annual Survey of State and Local Finances, the FHWA, and the Bureau of Economic Analysis (BEA; see Table 2).⁷ Although state and local highway spending data are available from both the Census Bureau and FHWA, Census Bureau data are preferred for this analysis (see Appendix A for a discussion of the differences). Grant amounts are compiled from the notices issued periodically by FHWA to announce state-level grants. FHWA also provides data about state highway systems and users. Most other economic data come from BEA.

Data are compiled for the 50 states over the 1994–2015 period. Though Washington, DC, receives highway grants through the same set of programs considered here, we excluded it from our analysis because spending decisions in Washington, DC, are subject to federal control in ways that the spending decisions of the 50 states are not. (From 1995 to 2001, a federally appointed board oversaw the finances of the Washington, DC, government, and the Congress still has the authority to change budgeting decisions made by the Washington, DC, government.)

To make the data more comparable across states and years:

- State and local spending measures are aggregated to create one state-level measure for each state;
- Population counts are used to transform dollar amounts to per capita measures;
- Dollar values are converted to 2017 dollars using the GDP price index; and
- Where necessary (typically for federal measures), values are converted to state fiscal years (July through June). For Alabama, Michigan, New York, and Texas, whose fiscal years do not begin on July 1, state-level spending variables are adjusted to match the standard July-to-June fiscal year.

⁷ Census data for some years were obtained through the Urban Institute’s State and Local Finance Initiative Data Query System, available at <https://slfdqs.taxpolicycenter.org/index.cfm>.

Over the 1994–2015 period, state and local governments spent an average of \$441 per person each year on highways from their own revenues and borrowing (see Table 3). Of that, more than one-third, or \$163, was devoted to capital projects on average. The average annual obligation limit for formula grants made available to states over the period was slightly smaller, at \$147 per capita. The ARRA grants to states were of a similar size: On average, grants issued in 2009 gave states access to \$128 per person.

Estimation Process

We used regression analysis to assess the effects of the determinants and their statistical significance. After controlling for state and year fixed effects in the regressions, the residuals show correlation over time (autocorrelation) as well as correlation within states.

To address those statistical issues, the estimating equation uses feasible generalized least squares and corrects for an autoregressive process and standard errors that are robust to clustering within states (see Appendix B for a specification that does not correct for autocorrelation in the error term).⁸ The main specification includes current-year observations for the formula grants and the allocated grants. Other variations include lagged grant variables for one and two years to test for delayed effects. ARRA grants, which were announced in March 2009, are included for 2009 and 2010 in the main specification and for 2011 in alternative specifications.

Estimates of the Determinants of State and Local Spending on Capital for Highways

State and local governments typically substitute some of the federal funding provided through annual formula grants for spending from their own resources on highway capital projects. ARRA grants, though, had the opposite effect on state and local spending for highway capital in our model, although not to the extent reported elsewhere in the literature. In addition, state and local surpluses and deficits influence the rate of substitution, and spending for highway capital projects is higher in states that collect more in related taxes and issue certain types of bonds.

Federal Grants

State and local governments substitute some of the federal funding provided through annual formula grants for spending from their own resources on highway capital projects. That result does not hold for all types of federal grants though. In particular, ARRA grants led state and local governments to spend more of their resources on highway capital than they would have spent without the grants. When state and local governments run a joint deficit, they reduce the rate at which they substitute federal funds for state and local funds—in other words, all else

⁸ Our specification follows the example set out by Cameron and Miller for state-year panel data (2015, pp. 364–367).

being equal, they continue to spend more of their own funds on highways even if federal grants increase.

Formula grants. In our primary specification, an additional dollar of federal-aid highway formula grants leads state and local governments to reduce their combined spending on highway capital projects from nonfederal funds by 26 cents. That result is the combination of two effects in the regression. The coefficient for formula grants is -0.24 (see Table 4). We estimate that state and local spending decreases by an additional 2 cents at the mean state and local government surplus, relative to a balanced budget. That 2 cent difference arises from the coefficient of -0.53 we estimate for the variable that interacts formula grant obligation limits with state and local surplus or deficit ratios. Across our entire sample, state and local governments averaged a surplus of 3 percent of revenues.⁹

That effect is on the smaller side of a broad range of estimates in the relevant literature (see Table 1), though our dependent variable differs in some ways from the dependent variables in much of the existing literature, given our focus on capital spending instead of all highway spending and our inclusion of spending by both state and local governments.¹⁰ Based on our result, the range of values that captures two-thirds of the probability distribution is from -14 cents to -38 cents.

Because state and local governments typically spend federal grants over several years, federal grants announced in one year could continue to affect spending for a number of years. In actuality, including lagged values of the formula grant obligation limits did not produce results that were statistically different from zero, so we exclude those values from our final specifications. (In general, formula grant obligation limits are fairly stable from one year to the next, so prior-year amounts may not provide much additional information.)

ARRA grants. State and local governments increased their own spending on highway capital in response to the highway grants provided through ARRA. Specifically, in 2009, an additional dollar of ARRA highway grants prompted state and local governments to spend 13 cents more than they otherwise would have. That value reflects two factors: a direct increase in spending of state and local resources and the influence of state deficits on that spending. State and local governments increased their spending on highway capital from their own resources by 30 cents per capita for a dollar in ARRA grants. Our variable interacting ARRA grants with state fiscal status (measured as joint state and local revenues net of joint expenditures) as a share of revenues

⁹ The fiscal-status measure is positive when state and local governments combined run a surplus. About a quarter of the time, state and local governments have a joint deficit. Among those cases, the mean deficit is 12 percent of revenues, and the median is 7 percent.

¹⁰ See Appendix B for the results of regressions that consider state and local government spending separately and estimate the effect of federal grants on capital spending, noncapital spending, and total spending for highways.

returns a coefficient of 0.48. All states ran deficits in 2009, and states that ran larger deficits increased their spending by a smaller amount in response to ARRA grants. For a state with the average deficit of 35 percent of revenues in 2009, the deficit would reduce the additional state and local spending by 17 cents.

ARRA grants led to crowding in of state and local spending, but the crowding in was smaller when states had budget deficits. That could mean that states generally prefer to spend more on highways when times are tough, but with things as bad as they were during the ARRA time frame, states in worse financial condition were less willing (or able) to increase their spending in response to ARRA grants. With the ARRA and formula grant interaction coefficients being roughly the same but opposite in sign, the ARRA interaction with the state fiscal measure offsets much (but not all) of the formula grant interaction with the state fiscal measure when ARRA grants were issued.

Factors affecting ARRA grant results. Several factors are likely to have produced the positive effect on spending from ARRA and accounted for the difference between the average effects of formula grants and ARRA grants, including the tough fiscal environment faced by state and local governments, the size and timing of the grants, and the terms of the ARRA program.

As mentioned, state and local governments averaged a deficit of 35 percent of revenues in 2009. Using the coefficient of -0.53 for the interaction of formula grant obligation limits with state and local surplus or deficit ratios, that suggests that for each additional dollar in regular formula grants, state and local governments would have substituted 20 cents less than they would have if they were running their typical 3 percent surplus. That amount would account for about half of the 39-cent difference between the typical formula grant effect and the ARRA effect in 2009.

Another possible reason for ARRA grants' positive effect on state and local spending is that those governments may have found it difficult to substitute federal funds for their own when they received a large infusion of federal funds in the latter part of the state fiscal year. Allowing the size of an increase in federal grants to directly influence the substitution rate did not yield a significant result in the regressions. Categorizing the size of the increase into ranges or capturing specific years with large increases did provide evidence that larger grants resulted in less substitution (see Appendix B for alternative regressions). Only a portion of roads in a state are eligible for projects using federal-aid highway funds—in 2018, for example, federal-aid highways accounted for 28 percent of all public lane miles.¹¹ For the remaining roads, state and local governments must pay for improvements from nonfederal resources. Therefore, states that continued with such projects as planned would not reduce their own spending as a result of larger federal grant amounts.

¹¹ See Federal Highway Administration (2019).

Moreover, the timing of the grants may have made it difficult for state and local governments to cut back on already planned spending. ARRA was enacted in February 2009, and in early March 2009 FHWA announced the amounts that each state would receive. Because that was during the third quarter of most states' fiscal years, which typically end on June 30, much of the state spending that would take place in 2009 either had already taken place or was underway. Had states known the amounts they would receive earlier in their fiscal years, they might have made different decisions about how to spend those funds. Some alternative regression specifications suggested that states did reduce their spending from their own funds in 2010 in relation to the amount of ARRA grants they received (see Appendix B).

States moved quickly to obligate the newly available ARRA funds. By the end of June 2009, states had obligated more than \$13 billion, or about 70 percent of the funds that were not specifically allocated to urban or other geographic areas within states. But states could not spend the funds that quickly; outlays for highways from ARRA accounts totaled only \$266 million through June 2009. From July 2009 through June 2010, highway-related ARRA outlays rose to nearly \$10 billion. Over the same period, outlays from the Highway Trust Fund, which is the typical funding source for regular highway grants, decreased by nearly \$5 billion from the previous year. That combination of factors suggests that state and local governments may have temporarily shifted their federally funded road-building activities away from those funded by traditional grants toward projects that were funded by ARRA grants. State and local governments may have then shifted some spending from their own funds away from federal-aid highways and toward capital projects on roads not eligible for federal aid.

The terms of the ARRA program may also have discouraged state and local fiscal substitution. To avoid penalties, state and local governments had to attest to the amount they had intended to spend on highway capital over the coming months before ARRA's passage and then meet that spending target (a form of maintenance-of-effort requirement). Although the same types of projects were eligible for ARRA grants and regular federal grants, states were not generally permitted to replace federal funds already obligated to a project with the newly available ARRA funds. Given the costs involved in delaying or suspending projects that were already underway or already had funds committed to them, states may have judged it better to proceed with those projects in state fiscal year 2009 than to abandon or delay them. In addition, if states continued to spend their funds on those projects already underway, that spending would count toward the amounts included in their maintenance-of-effort declaration. States were required to spend ARRA grants more quickly than regular formula grants (within about a year and a half). They also faced the redistribution of their grants to other states if minimum amounts were not obligated within one year and 120 days of their apportionment to the states.

Comparison with results from the literature. Our results for ARRA grants differ from those obtained by other researchers who found either large substitution effects or large increases in

state spending (see Table 1).¹² Some of the fiscally stimulative effects attributed to ARRA could be the result of the generous subsidies offered through Build America Bonds, a limited-time, federally subsidized financing option for state and local governments that was authorized in the same ARRA legislation that provided the additional highway grants to state and local governments. Those direct-pay tax credit bonds, which state and local governments could issue in 2009 and 2010, required the federal government to make cash payments to the bonds' issuer equal to a portion of the interest that the issuer paid to bondholders. The credit rate was set at 35 percent, meaning that an issuer would get \$35 from the federal government for every \$100 it paid in interest to bondholders. That credit rate translated into lower net financing costs for state and local governments to issue Build America Bonds than to issue traditional tax-exempt bonds at the prevailing rate.¹³

In states that issued Build America Bonds in 2009 and 2010 for highway projects, state and local governments increased their spending on highway capital projects net of federal grants. In the year they issued a grant, state and local governments' per capita spending on highway capital increased by 25 cents for each dollar of Build America Bonds issued for highway purposes. That effect persisted, increasing state and local highway capital spending by another 22 cents the following year and by 14 cents two years after issue. Over three years, state and local spending on highway capital increased by 61 cents for each dollar of Build America Bonds issued (see Appendix B for results of a regression that excludes Build America Bonds from the analysis).

Other notable differences between our and others' analyses are the treatment of state population and the inclusion of local spending in the spending measure. Studies (such as this one) that have included population controls have not found the same kind of increases in state and local spending in response to ARRA grants as studies that did not. The reasons why population would make a difference in the analysis are unclear.¹⁴ As for the inclusion of local spending in the spending measure, in an additional analysis of separate state spending and local spending, the positive ARRA effect appears at the local level but not the state level (see Appendix B). Prior research, which has generally found a significant positive effect of ARRA grants on spending, has included transfers to local governments; one study that found a negative effect examined only state spending.

Allocated grants. Allocated grants, distributed to state and local governments through methods that do not rely on formulas, do not have a statistically significant effect on state and local

¹² See Leduc and Wilson (2017) and Dupor (2017).

¹³ See Congressional Budget Office (2018).

¹⁴ See Ramey (2020).

spending. Allocated grants are also relatively small, averaging \$30 per capita in our sample, compared with \$147 for formula grants.

State and Local Government Resources

Overall, when state and local governments have more funds at their disposal from highway-specific sources (such as bond issues or dedicated fuel and vehicle taxes) or more resources available to them generally through the personal income of their constituents, they spend more on highway capital projects.

Bond issues. Although Build America Bonds had a positive effect on state and local government spending on highway capital, the results are not as definitive for other long-term debt issued by state and local governments. The analysis suggests a positive effect on spending for highway capital projects from those other long-term debt issues, but the effect is not statistically different from zero. Other long-term debt is not limited to debt issued for highway purposes, so a more muted effect on highway spending is not unexpected. In addition, the federal subsidy offered for traditional tax-exempt municipal bonds is smaller than the subsidy that accompanied Build America Bonds.

Personal income. Personal income serves as a proxy for the ability of a state or local government to raise revenues that could be used for highway capital spending. We estimate a coefficient for per capita personal income of about 0.01, such that an additional dollar of per capita personal income in a state would increase state and local governments' combined spending on highway capital by about one cent.

Fuel and vehicle taxes. State and local spending for highway capital increases by about 34 cents for an additional dollar of revenues from fuel and vehicle taxes. Capital accounts for 35 percent of total per capita state and local spending on highways net of federal grants in our sample, a share that is within the range of the standard error of the coefficient. Some states use those road-related revenues to help fund other modes of transportation. In 47 states, some or all motor fuel tax collections are deposited in the state's transportation fund, which goes to both capital and operations spending for highways, as well as other modes of transportation. Fewer states dedicate revenues from vehicle license and registration fees or vehicle sales and use taxes to the transportation fund.¹⁵

Oil and gas industry. States where oil and gas industries account for a relatively large share of state GDP are likely to have additional resources available to them that could be used for, among other things, state and local highway spending. In most states, the oil and gas industry is small enough that the measure is close to zero. In states where oil and gas industries account for a larger share of GDP, such as Alaska, the effect on capital spending for highways would be

¹⁵ See Sigriz (2020, p. 70).

larger. At the mean industry share for Alaska in our sample, 20 percent, the oil and gas share would increase spending by about 22 cents per person, all else being equal.

Estimates of the Determinants of Total State and Local Spending on Highways

When state and local governments reduce their spending on capital projects after receiving federal grants, they may direct some of the funds they would have otherwise spent on highway capital to operating and maintaining highways—functions for which they are solely responsible. Those funds may also be directed to other spending priorities for state and local governments or used to reduce taxes. Estimating the effect of federal grants for highways on state and local governments' total spending for highways is consistent with the way these issues have been addressed in much of the existing literature (see Appendix B for an analysis of the effect of federal grants on state and local government spending on highways for noncapital purposes). Increases in other state and local resources tend to increase total highway spending more than capital spending.

Federal Grants

In general, the effects of federal grants on total state and local spending for highways from nonfederal resources are smaller than the effects on capital spending, although not by very much. Statistically speaking, the two kinds of estimates have overlapping confidence intervals, but many of the effects on total spending are not significantly different from zero. Because most federal grants are designated for capital projects, we expect that those grants would be more closely linked to capital spending than to overall spending for highways.

The increase in total highway spending in response to ARRA grants is smaller than the increase in state and local spending on highway capital (although, again, not by a statistically significant amount), suggesting that state and local governments may have redirected spending from operating and maintaining roads to building them. Such a shift would have helped states to meet the maintenance-of-effort requirement for ARRA grants, which specified that recipients had to spend at least as much on highway capital as they had planned to before the grant amounts were announced.

State and Local Government Resources

State and local governments appear to adjust their mix of capital and other highway spending when they face deficits. Though for both types of spending the economic effects of such adjustments are likely to be small, state and local governments running a joint deficit increased their total highway spending by less than they increased their spending on highway capital in response to a federal grant. Specifically, state and local governments reduced their spending on operating and maintaining highways in order to increase their capital spending. In states that experienced a surplus, the opposite was true, such that their spending on capital decreased more than their total spending on highways.

State and local governments rely on a variety of resources other than federal grants to pay for highway spending. States that issued Build America Bonds increased both their spending on highway capital and their overall highway spending, with slightly larger increases in overall spending. With a larger federal subsidy than traditional tax-exempt municipal bonds, Build America Bonds may have freed up state and local resources that would otherwise have gone to capital spending to be spent instead on operating and maintaining highways.

Personal income, dedicated fuel and vehicle-related taxes, and oil and gas industry share of GDP also have larger effects on total spending for highways than capital spending. In all three cases, state and local governments with more available resources spend more on highway building and on highways overall.

Appendix A: Sources of Spending Data

Both the Census Bureau and the Federal Highway Administration (FHWA) offer data on spending by state and local governments for highways and the amount of federal grants received by those governments. The Congressional Budget Office chose to rely on the spending data provided by the Census Bureau for several reasons. State and local governments report spending data in a more consistent manner to the Census Bureau, both across states and over time. In addition, the Census Bureau has reviewed some outlier observations and offered corrections where possible. By contrast, in many cases, it is not clear whether the FHWA data apply to calendar years or to federal or state fiscal years. In addition, in a number of cases, variables in the FHWA data have the same values over several years, which raises questions about the reliability of the data collection and reporting.

Some of the differences between the data sources may arise from the different ways the two agencies collect spending data from state and local governments. The Census Bureau collects a wide range of information about the breadth of state spending and revenues from states. States are obligated to provide those data, which come from states' central accounting systems. The Census Bureau also surveys a sample of local governments each year to obtain similar spending and revenue information on a voluntary basis. FHWA relies on state highway or transportation officials to provide spending data at the state level and to collect similar data from local governments (or a sample of them) in their state. Reporting to FHWA is voluntary for both state and local governments.

The existing literature has relied on both sources. For example, Knight (2002) estimated his model using both Census Bureau and FHWA data and obtained largely similar results. At that time, the spending and grant amounts from the two sources largely tracked each other. Over the past decade, differences in the amounts reported by the two sources have grown. The reason for that divergence is unclear.

The differences between those data series in recent years may have contributed to differences in results in two recent studies, even though they examined state and local spending for highways over a similar time period when ARRA grants were made to states. Leduc and Wilson (2017) relied on spending data from the Census Bureau, whereas Dupor (2017) used FHWA spending data.

Appendix B: Alternative Regressions

This appendix presents the results of additional analyses performed to address possible concerns about the econometric approach used in the estimation (clustering on states and excluding outlier states), to investigate the effects on the main results of other influences (excluding Build America Bonds and accounting for the size of the change in formula grants), and to explore the results for different measures of state and local spending (separately considering spending for noncapital purposes and state and local spending).

Clustering on States

To ensure that correcting for autocorrelation in the error structure does not bias our results, we compare them with a specification that does not make such an adjustment (see Table B-1). The results of an ordinary least squares regression, clustering on states, suggest that autocorrelation correction does not cause biased estimates, given that the estimates from the regression for our primary results fall within a 95 percent confidence interval of the results in Table 4.

Excluding Outlier States

Plotting actual levels of per capita state and local government spending for highway capital against the levels predicted by our model reveals several outlier years for Alaska and North Dakota, where actual spending levels exceeded the spending predicted by our model. Similar outlier results from earlier regressions not reported here prompted the inclusion of the oil and gas industry share of gross domestic product (GDP), based on the theory that the relative importance of that industry in those states would influence the resources available to their state and local governments. Including that variable did not resolve the issue.

Estimating our model while excluding Alaska and North Dakota from the analysis changes the results (see Table B-2). The coefficient for the obligation limits for the annual federal-aid highway grants decreases in magnitude from the estimates based on all 50 states, from -0.24 to -0.04 , and is not statistically different from zero. Our ARRA grant coefficients mostly maintain, nonetheless, with a positive effect on state and local capital spending in 2009 and a negative effect in 2010. Without Alaska and North Dakota, the coefficient for oil and gas as a share of GDP falls to 0.62 but remains statistically significant. The rest of our results from the models including and excluding the two states are generally similar.

Excluding Build America Bonds

State and local governments were permitted to issue Build America Bonds for highway and other infrastructure projects in 2009 and 2010, at the same time ARRA highway grants were made available to them. With the two programs in effect for the same short period of time, concerns that they are correlated could arise. To address those concerns, we present the results of our main specifications with Build America Bond issues excluded (see Table B-3). Excluding Build

America Bonds leaves the point estimates for the main variables of interest—including, most notably, the ARRA grant results—largely unchanged.

Accounting for the Size of Changes in Formula Grants

The positive effect of the highway grants provided under ARRA on state and local spending for highway capital projects raises the question of whether the spending response of state and local governments differs with the size of the grants. Two different specifications controlling for year-over-year changes in formula grant amounts suggest that large changes in grant amounts can affect the amount of substitution that occurs (see Table B-4).

In the first specification, the year-over-year percentage change in formula grants was categorized into one of four groups: less than zero (47 percent of state-year observations), zero to 5 percent (28 percent of observations), 5 percent to 10 percent (14 percent of observations), and greater than 10 percent (12 percent of observations). Interacting those indicator variables with formula grant amounts and excluding the zero-to-5-percent interacted variable increased the magnitude of the coefficient for formula grants. For states that saw a year-over-year increase of zero to 5 percent, a one-dollar increase in federal formula grants would see state and local governments decrease their own spending on highway capital by 69 cents. In states that experienced larger increases in federal grants, state and local governments would reduce their own spending by smaller amounts, by 61 cents for a 5 percent to 10 percent increase and by 48 cents for a greater increase. We found no statistically significant difference between the rate of substitution in states that received less in formula grants from one year to the next and those that received increases of less than 5 percent.

To account for more gradual changes in the amount of formula grants, the second specification interacts annual formula grant amounts with the year-over-year percentage change. The coefficient for formula grants is larger (-0.33) than in the regressions without interactions (-0.24). The point estimate is positive for the variable that interacts formula grants with the year-over-year percentage change but is not statistically different from zero. Together with the results from the previous regression, that result suggests that state and local governments may reduce their own spending on highway capital by a smaller proportion when they receive larger increases in formula grants.

State and Local Spending on Highways for Noncapital Purposes

Federal grants for highways are almost entirely for state and local governments to use for capital projects. If state and local governments reduce spending for highway capital from their own resources in response to federal grants, some of those funds may be used instead to pay for the costs involved with operating and maintaining highways. We estimated the results of a variation on the primary specification, with state and local government spending on highways for noncapital purposes replacing capital spending by those governments for highways as the dependent variable.

In the noncapital-spending regression, relative to the capital-spending regression, the estimated coefficients for most of the federal grant variables take the opposite sign (see Table B-5). In addition, most of those grant coefficients in the noncapital-spending regression are not statistically different from zero. The point estimate for the coefficient for annual formula grants is positive and similar in magnitude to the negative coefficient in the capital-spending regression, suggesting that state and local governments may redirect a portion of the spending that would otherwise have gone to highway capital projects toward operating and maintaining those roads. With the data available here, it is not possible to determine where else that would-be capital spending is redirected.

Spending by state and local governments to operate and maintain highways also responds differently to the interaction of federal formula grants for highways with state and local surpluses and deficits. In the primary regression, in years when state and local governments run a unified deficit, their own spending on highway capital increases. The noncapital-spending regression suggests that when state and local governments face deficits, they spend less on operations and maintenance than they otherwise would have. That reduction in spending is smaller than the increase in spending on capital above what they otherwise would have spent.

State and Local Spending Considered Separately

In all of the other specifications, we combine state and local government spending amounts because CBO's macroeconomic modeling does not differentiate the effects of spending between those levels of government and because different states assign highway spending responsibilities to the state government and localities differently.

Analyzing state spending separately from local spending suggests that in response to federal formula highway grants, state governments reduce their spending on highway capital but local government spending on capital remains largely unchanged (see Table B-6). The reverse is true with respect to spending for noncapital purposes, such that local governments increase their spending on operating and maintaining highways but state spending for those purposes does not change in a statistically significant way. The positive capital-spending response to ARRA grants obtained in the combined analysis holds for local governments but not state governments. Build America Bond issues appear to prompt more spending at the state level, but not at the local level.

Tables

Table 1.
Substitution-Rate Estimates From the Literature on Highway Grants

Study	Estimate	Period Studied	Dependent Variable
Pre-ARRA or Non-ARRA Grants			
Meyers (1987)	-0.63	1976–1982	State spending for highways (all 50 states)
Knight (2002)	-0.91	1983–1997	State spending for highways (47 states—continental states excluding Nebraska)
Gamkhar (2003)	-0.22 ^a	1976–1990	State and local spending for highways (45 states—continental states excluding Arizona, Connecticut, and Massachusetts)
Government Accountability Office (2004)	-0.50	1983–2000	State and local spending for highways (all 50 states plus the District of Columbia)
Nesbit and Kreft (2009)	-0.24	1974–2002	State spending for highways (48 continental states)
Campbell and Shirley (2021)	-0.26	1994–2015	State and local capital spending for highways (all 50 states)
ARRA-Era or ARRA Grants			
Dupor (2017)	-0.81 ^b	2008–2010	State capital spending for highways (47 states excluding Illinois, Indiana, and Montana)
Leduc and Wilson (2017)	1.32 ^b	2008–2012	State spending for highways, including transfers to local governments (48 states excluding Alaska and Nebraska)
Campbell and Shirley (2021)	0.13	1994–2015	State and local capital spending for highways (all 50 states)

Source: Congressional Budget Office.

ARRA = American Recovery and Reinvestment Act; GAO = Government Accountability Office.

- a. Substitution rate is calculated as the cumulative effect of a change in spending response over three years.
- b. Substitution rates are based on the cumulative change in state highway spending over the period.

Table 2.
Data Sources

Type of Data and Variable	Source
State and Local Spending Data	
Highway capital spending	Census Annual Survey of State and Local Finance
Highway noncapital spending	Census Annual Survey of State and Local Finance
Federal highway grants	Census Annual Survey of State and Local Finance
Grants Data	
Federal formula grant obligation limits	Federal Highway Administration Notices
Federal allocation amounts	Federal Highway Administration Highway Statistics Table FA-4D
Federal ARRA apportionments	Federal Highway Administration Notice N4510.705
State and Local Government Resources	
Long-term debt issued	Census Annual Survey of State and Local Finance
Motor vehicle and motor-carrier tax revenue receipts	Census Annual Survey of State and Local Finance
Fuel tax-revenue receipts	Census Annual Survey of State and Local Finance
Federal nonhighway grants	Census Annual Survey of State and Local Finance
Total expenditures	Census Annual Survey of State and Local Finance
Total revenues	Census Annual Survey of State and Local Finance
Income per capita	Bureau of Economic Analysis Table SAINC-1
Highway Build America Bonds issued	Treasury Department Recovery Act Build America Bonds Program Update
Control and Other Variables	
Vehicle registrations	Federal Highway Administration Highway Statistics Table MV-1
Public lane miles	Federal Highway Administration Highway Statistics Table HM-60
Price deflators	Bureau of Economic Analysis National Income and Product Accounts Table 1.1.4
Population	Bureau of Economic Analysis Table SAINC-1
Utah Olympics binary variable	1 for Utah in 1997 through 2000
Georgia Olympics binary variable	1 for Georgia in 1995 and 1996

Source: Congressional Budget Office.

Note: ARRA = American Recovery and Reinvestment Act.

Table 3.
Summary Statistics

Variable	Data Source	Unit	Mean	Standard Deviation
State and local total highway spending, net of federal highway grants, per capita	Census	2017 dollars per person	441	212
State and local capital highway spending, net of federal highway grants, per capita	Census	2017 dollars per person	163	115
State and local noncapital highway spending, net of federal highway grants, per capita	Census	2017 dollars per person	278	148
Federal highway grants to state and local governments per capita	Census	2017 dollars per person	181	120
Federal nonhighway grants to state and local governments per capita	Census	2017 dollars per person	1,676	599,595
Federal nonhighway grants to state and local governments as a share of state and local nonhighway spending	Census	Ratio	0.199	0.05
Federal obligation limit amount for formula grants per capita	FHWA	2017 dollars per person	147	88
Federal allocated grant amount per capita	FHWA	2017 dollars per person	30	37
Federal ARRA apportionment per capita ^a	FHWA	2017 dollars per person	128	59
Highway Build America Bonds per capita ^b	Treasury	2017 dollars per person	25	52
State and local long-term debt issued per capita	Census	2017 dollars per person	1,111	489
State and local net revenues as a share of total revenues	Census	Ratio	0.03	0.13
State and local fuel and vehicle tax-revenue receipts per capita	FHWA	2017 dollars per person	255	62.9
Income per capita	BEA	2017 dollars per person	41,060	7,724

Oil and gas industry share of state GDP	BEA	Ratio	0.015	.04
Vehicle registrations per capita	FHWA	Registrations per 1,000 people	840	140
Public lane miles per capita	FHWA	Public lane miles per 1,000 people	49	50

Source: Congressional Budget Office. For data sources, see Table 2.

For most variables, the number of observations is 1,100 (50 states across state fiscal years 1994–2015).

ARRA = American Recovery and Reinvestment Act; BEA = Bureau of Economic Analysis; FHWA = Federal Highway Administration; GDP = gross domestic product; PPI = producer price index.

- a. Number of observations = 50 (50 states for state fiscal year 2009; the variable takes a value of zero in all other years).
 - b. Number of observations = 150 (50 states for state fiscal years 2009–2011; the variable takes a value of zero in all other years).
-

Table 4.
Regression Results

Variable	Capital Spending for Highways	Total Spending for Highways
Grants Variables		
Federal obligation limit amount for formula grants per capita	-0.244** (0.120)	-0.009 (0.148)
State and local net revenues as share of total revenues \times federal obligation limit amount for formula grants per capita	-0.529*** (0.120)	-0.460*** (0.119)
Federal allocated grant amount per capita	0.566 (0.457)	0.614 (0.482)
Federal ARRA apportionment per capita	0.302* (0.177)	0.181 (0.157)
Federal ARRA apportionment per capita, lagged	-0.138 (0.086)	-0.085 (0.098)
State and local net revenues as share of total revenue \times federal ARRA apportionment per capita	0.484* (0.248)	0.471* (0.273)
State and Local Government Resources		
Highway Build America Bonds per capita	0.254*** (0.098)	0.261** (0.110)
Highway Build America Bonds per capita, lag 1	0.223** (0.108)	0.262** (0.129)
Highway Build America Bonds per capita, lag 2	0.135*** (0.050)	0.146** (0.062)
Long-term debt issued per capita	0.015 (0.013)	0.017 (0.018)
Long-term debt issued per capita, lag 1	0.013 (0.013)	0.013 (0.013)
Long-term debt issued per capita, lag 2	0.007 (0.006)	0.008 (0.007)

Income per capita	0.008* (0.005)	0.015*** (0.005)
State and local fuel and vehicle tax revenue receipts per capita	0.335** (0.163)	0.404** (0.176)
Oil and gas industry share of state GDP	1.107*** (0.411)	1.372*** (0.437)
Nonhighway federal grants' effective matching rate	0.015 (0.117)	-0.134 (0.110)
Nonhighway federal grants per capita	0.024 (0.016)	0.034 (0.018)
Other Variables		
Vehicle registrations per capita	0.051 (0.044)	0.095** (0.044)
Public lane miles per capita	-1.814 (2.577)	-3.837 (2.802)
Utah Olympics dummy	0.108*** (0.010)	0.094*** (0.009)
Georgia Olympics dummy	0.026*** (0.008)	0.028*** (0.008)
Number of Observations (states × state fiscal years)	1,100	1,100

Source: Congressional Budget Office. For data sources, see Table 2.

Standard errors are shown in parentheses.

ARRA = American Recovery and Reinvestment Act; GDP = gross domestic product.

* $p < .10$; ** $p < .05$; *** $p < .01$

Table B-1.
Results for Ordinary Least Squares Regression Clustering on States

Variable	State and Local Spending for Highway Capital	State and Local Total Spending for Highways
Grants Variables		
Federal obligation limit amount for formula grants per capita	-0.208 (0.252)	0.0246 (0.228)
State and local net revenues as share of total revenues × federal obligation limit amount for formula grants per capita	-0.370** (0.140)	-0.275 (0.183)
Federal allocated grant amount per capita	0.679 (0.483)	0.908 (0.562)
Federal ARRA apportionment per capita	0.429 (0.330)	0.337 (0.397)
Federal ARRA apportionment per capita, lagged	0.0593 (0.335)	0.182 (0.350)
State and local net revenues as share of total revenues × federal ARRA apportionment per capita	0.216 (0.400)	0.208 (0.482)
State and Local Government Resources		
Highway Build America Bonds per capita	0.297** (0.136)	0.286* (0.151)
Highway Build America Bonds per capita, lag 1	0.246** (0.119)	0.275* (0.148)
Highway Build America Bonds per capita, lag 2	0.140* (0.0796)	0.131 (0.0834)
Long-term debt issued per capita	0.0340* (0.0173)	0.0305 (0.0225)
Long-term debt issued per capita, lag 1	0.0200 (0.0140)	0.0156 (0.0159)
Long-term debt issued per capita, lag 2	0.00395 (0.0104)	-0.00288 (0.0118)
Income per capita	0.00613 (0.00382)	0.0136*** (0.00408)

State and local fuel and vehicle tax revenue receipts per capita	0.740** (0.290)	1.058*** (0.297)
Oil and gas industry share of state GDP	1.668*** (0.517)	1.997*** (0.596)
Nonhighway federal grants effective matching rate	0.0414 (0.244)	-0.187 (0.236)
Nonhighway federal grants per capita	-0.00609 (0.0360)	0.00478 (0.0345)
Other Variables		
Vehicle registrations per capita	0.0955 (0.0594)	0.161** (0.0642)
Public lane miles per capita	-1.225 (2.109)	-3.342 (2.165)
Utah Olympics dummy	0.122*** (0.0160)	0.108*** (0.0173)
Georgia Olympics dummy	0.0163 (0.0154)	0.0180 (0.0175)
Number of Observations (states × state fiscal years)	1,100	1,100

Source: Congressional Budget Office. For data sources, see Table 2.

Standard errors are shown in parentheses.

ARRA = American Recovery and Reinvestment Act; GDP = gross domestic product.

* $p < .10$; ** $p < .05$; *** $p < .01$.

Table B-2.
Results for Regression Excluding Alaska and North Dakota

Variable	State and Local Spending for Highway Capital	State and Local Total Spending for Highways
Grant Variables		
Federal obligation limit amount for formula grants per capita	-0.0386 (0.151)	0.235 (0.189)
State and local net revenues as share of total revenues × federal obligation limit amount for formula grants per capita	-0.608*** (0.188)	-0.547*** (0.194)
Federal allocated grant amount per capita	-0.0199 (0.191)	0.0177 (0.217)
Federal ARRA apportionment per capita	0.394** (0.169)	0.176* (0.102)
Federal ARRA apportionment per capita, lagged	-0.181* (0.106)	-0.146 (0.136)
State and local net revenues as share of total revenues × federal ARRA apportionment per capita	0.744*** (0.258)	0.698*** (0.266)
State and Local Government Resources		
Highway Build America Bonds per capita	0.279*** (0.0908)	0.300** (0.101)
Highway Build America Bonds per capita, lag 1	0.218** (0.0993)	0.264** (0.121)
Highway Build America Bonds per capita, lag 2	0.113*** (0.0432)	0.114** (0.0516)
Long-term debt issued per capita	0.00632 (0.00469)	0.00103 (0.00659)
Long-term debt issued per capita, lag 1	0.0112*** (0.00311)	0.00555 (0.00414)
Long-term debt issued per capita, lag 2	0.00203 (0.00362)	-0.000296 (0.00454)
Income per capita	0.00172 (0.00191)	0.00875*** (0.00203)
State and local fuel and vehicle tax revenue receipts per capita	0.169* (0.0886)	0.284** (0.111)

Oil and gas industry share of state GDP	0.621*** (0.217)	0.524 (0.324)
Nonhighway federal grants' effective matching rate	-0.0145 (0.113)	-0.0774 (0.152)
Nonhighway federal grants per capita	0.0270 (0.0182)	0.0267 (0.0231)
Other Variables		
Vehicle registrations per capita	0.0571 (0.0420)	0.0959** (0.0451)
Public lane miles per capita	1.361 (0.830)	-0.277 (0.667)
Utah Olympics dummy	0.125*** (0.00645)	0.113*** (0.00540)
Georgia Olympics dummy	0.0320*** (0.00490)	0.0364*** (0.00458)
Number of Observations (states × state fiscal years)	1,056	1,056

Source: Congressional Budget Office. For data sources, see Table 2.

Standard errors are shown in parentheses.

ARRA = American Recovery and Reinvestment Act; GDP = gross domestic product.

* $p < .10$; ** $p < .05$; *** $p < .01$.

Table B-3.
Regression Results for Excluding Build America Bonds

Variable	State and Local Spending for Highway Capital	State and Local Total Spending for Highways
Grant Variables		
Federal obligation limit amount for formula grants per capita	-0.279** (0.117)	-0.047 (0.141)
State and local net revenues as share of total revenues × federal obligation limit amount for formula grants per capita	-0.545*** (0.121)	-0.476*** (0.122)
Federal allocated grant amount per capita	0.561 (0.458)	0.608 (0.483)
Federal ARRA apportionment per capita	0.298* (0.175)	0.180 (0.155)
Federal ARRA apportionment per capita, lagged	-0.162* (0.0903)	-0.108 (0.102)
State and local net revenues as share of total revenues × federal ARRA apportionment per capita	0.534** (0.254)	0.523* (0.282)
State and Local Government Resources		
Long-term debt issued per capita	0.0155 (0.0127)	0.0173 (0.0175)
Long-term debt issued per capita, lag 1	0.0134 (0.0125)	0.0141 (0.0131)
Long-term debt issued per capita, lag 2	0.00789 (0.00563)	0.00868 (0.00695)
Income per capita	0.00762 (0.00463)	0.0148*** (0.00493)
State and local fuel and vehicle tax revenue receipts per capita	0.330** (0.163)	0.399** (0.177)
Oil and gas industry share of state GDP	1.115*** (0.413)	1.382*** (0.437)
Nonhighway federal grants effective matching rate	0.0187 (0.118)	-0.130 (0.110)
Nonhighway federal grants per capita	0.0221 (0.0153)	0.0314* (0.0180)
Other Variables		

Vehicle registrations per capita	0.0378 (0.0458)	0.0796* (0.0466)
Public lane miles per capita	-1.901 (2.583)	-3.931 (2.812)
Utah Olympics dummy	0.105*** (0.00955)	0.0914*** (0.00921)
Georgia Olympics dummy	0.0265*** (0.00807)	0.0283*** (0.00754)
Number of Observations (states × state fiscal years)	1,100	1,100

Source: Congressional Budget Office. For data sources, see Table 2.

Standard errors are shown in parentheses.

ARRA = American Recovery and Reinvestment Act; GDP = gross domestic product.

* $p < .10$; ** $p < .05$; *** $p < .01$.

Table B-4.
Results From Two Model Specifications Accounting for the Size of Changes in Formula Grants

Variable	Specification 1		Specification 2	
	State and Local Spending for Highway Capital	State and Local Total Spending for Highways	State and Local Spending for Highway Capital	State and Local Total Spending for Highways
Grants Variables				
Federal obligation limit amount for formula grants per capita	-0.686* (0.401)	-0.491 (0.464)	-0.328* (0.194)	-0.192 (0.259)
Federal obligation limit amount for formula grants per capita × percentage change of less than 0%	0.0293 (0.0323)	0.0205 (0.0351)	—	—
Federal obligation limit amount for formula grants per capita × percentage change of 5% to 10%	0.0740** (0.0323)	0.0802** (0.0360)	—	—
Federal obligation limit amount for formula grants per capita × percentage change greater than 10%	0.205** (0.0879)	0.205** (0.0896)	—	—
Federal obligation limit amount for formula grants per capita × percentage change in obligation limit amount	—	—	0.00118 (0.00141)	0.00244* (0.00130)
State and local net revenues as share of total revenues × federal obligation limit amount for formula grants per capita	-0.487*** (0.106)	-0.416*** (0.111)	-0.524*** (0.117)	-0.449*** (0.119)
Federal allocated grant amount per capita	0.556 (0.431)	0.602 (0.452)	0.572 (0.453)	0.627 (0.479)
Federal ARRA apportionment per capita	0.324* (0.179)	0.203 (0.171)	0.305* (0.178)	0.186 (0.156)
Federal ARRA apportionment per capita, lagged	-0.165** (0.0799)	-0.113 (0.101)	-0.146* (0.0826)	-0.101 (0.0937)
State and local net revenues as share of total revenues × federal ARRA apportionment per capita	0.415* (0.242)	0.405 (0.274)	0.478* (0.246)	0.459* (0.273)

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Highway Build America Bonds per capita	0.266*** (0.0994)	0.275** (0.111)	0.254*** (0.0982)	0.262** (0.110)
Highway Build America Bonds per capita, lag 1	0.217* (0.115)	0.256* (0.136)	0.222** (0.109)	0.258** (0.131)
Highway Build America Bonds per capita, lag 2	0.117** (0.0489)	0.127** (0.0624)	0.133*** (0.0495)	0.140** (0.0621)
Long-term debt issued per capita	0.0138 (0.0130)	0.0157 (0.0178)	0.0151 (0.0128)	0.0168 (0.0176)
Long-term debt issued per capita, lag 1	0.0119 (0.0133)	0.0125 (0.0138)	0.0121 (0.0128)	0.0122 (0.0136)
Long-term debt issued per capita, lag 2	0.00567 (0.00489)	0.00649 (0.00636)	0.00667 (0.00540)	0.00692 (0.00657)
Income per capita	0.00763 (0.00482)	0.0149*** (0.00510)	0.00789* (0.00475)	0.0151*** (0.00508)
State and local fuel and vehicle tax-revenue receipts per capita	0.329** (0.168)	0.397** (0.183)	0.337** (0.164)	0.407** (0.177)
Oil and gas extraction share of state GDP	1.281*** (0.415)	1.555*** (0.482)	1.118*** (0.412)	1.394*** (0.439)
Nonhighway federal grants effective matching rate	-0.0167 (0.0939)	-0.168 (0.126)	0.00818 (0.118)	-0.148 (0.113)
Nonhighway federal grants per capita	0.0194 (0.0182)	0.0292 (0.0188)	0.0249 (0.0158)	0.0351* (0.0183)
Other Variables				
Vehicle registrations per capita	0.0576 (0.0454)	0.102** (0.0460)	0.0531 (0.0434)	0.0988** (0.0442)
Public lane miles per capita	-1.941 (2.473)	-3.973 (2.698)	-1.859 (2.548)	-3.932 (2.775)
Utah Olympics dummy	0.112*** (0.00897)	0.0968*** (0.00873)	0.108*** (0.00957)	0.0934*** (0.00927)
Georgia Olympics dummy	0.0282*** (0.00758)	0.0295*** (0.00717)	0.0265*** (0.00805)	0.0285*** (0.00756)
Number of Observations (states × state fiscal years)	1,100	1,100	1,100	1,100

Source: Congressional Budget Office. For data sources, see Table 2.

Standard errors are shown in parentheses.

ARRA = American Recovery and Reinvestment Act; GDP = gross domestic product.

* $p < .10$; ** $p < .05$; *** $p < .01$.

Table B-5
Regression Results for State and Local Noncapital Spending for Highways

Grant Variables

Federal obligation limit amount for formula grants per capita	0.219*** (0.0764)
State and local net revenues as share of total revenues × federal obligation limit amount for formula grants per capita	0.0698* (0.0411)
Federal allocated grant amount per capita	0.0294 (0.0398)
Federal ARRA apportionment per capita	-0.124 (0.119)
Federal ARRA apportionment per capita, lagged	0.0503 (0.0393)
State and local net revenues as share of total revenues × federal ARRA apportionment per capita	-0.0154 (0.0802)

State and Local Government Resources

Highway Build America Bonds per capita	0.0084 (0.0251)
Highway Build America Bonds per capita, lag 1	0.0396 (0.0343)
Highway Build America Bonds per capita, lag 2	0.0126 (0.0316)
Long-term debt issued per capita	0.00322 (0.00549)
Long-term debt issued per capita, lag 1	0.00231 (0.00373)
Long-term debt issued per capita, lag 2	0.00170 (0.00232)
Income per capita	0.00680*** (0.00130)
State and local fuel and vehicle tax revenue receipts per capita	0.0612 (0.0492)
Oil and gas industry share of state GDP	0.308 (0.208)

Nonhighway federal grants effective matching rate	-0.139 (0.0968)
Nonhighway federal grants per capita	0.00756 (0.0147)
Other Variables	
Vehicle registrations per capita	0.0402** (0.0186)
Public lane miles per capita	-1.897*** (0.587)
Utah Olympics dummy	-0.0135*** (0.00319)
Georgia Olympics dummy	0.00121 (0.00235)
Number of Observations (states × state fiscal years)	1,100

Source: Congressional Budget Office. For data sources, see Table 2.

Standard errors are shown in parentheses.

ARRA = American Recovery and Reinvestment Act; GDP = gross domestic product.

* $p < .10$; ** $p < .05$; *** $p < .01$.

Table B-6.
Separate Regression Results for State and Local Spending for Highways

Variable	State Spending for Highways			Local Spending for Highways		
	Capital Spending	Total Spending	Noncapital Spending	Capital Spending	Total Spending	Noncapital Spending
Grants Variables						
Federal obligation limit amount for formula grants per capita	-0.292*** (0.102)	-0.187* (0.103)	0.0949 (0.0585)	0.0845 (0.0592)	0.188** (0.0871)	0.113** (0.0449)
State and local net revenues as share of total revenues × federal obligation limit amount for formula grants per capita	-0.198 (0.160)	-0.107 (0.142)	0.0832*** (0.0319)	-0.155*** (0.0299)	-0.158*** (0.0481)	-0.0415** (0.0187)
Federal allocated grant amount per capita	0.569 (0.388)	0.604 (0.413)	0.00645 (0.0310)	0.0417 (0.0906)	0.0675 (0.108)	0.0163 (0.0234)
Federal ARRA apportionment per capita	0.118 (0.103)	-0.00784 (0.0885)	-0.134 (0.0927)	0.264** (0.125)	0.267* (0.140)	0.00248 (0.0383)
Federal ARRA apportionment per capita, lagged	-0.0870 (0.0813)	-0.100 (0.0884)	-0.0180 (0.0267)	-0.0137 (0.0840)	0.0476 (0.0766)	0.0608** (0.0274)
State and local net revenue as share of total revenue × federal ARRA apportionment per capita	0.182 (0.190)	0.0955 (0.173)	-0.0788* (0.0430)	-1.018 (0.661)	-1.406* (0.838)	-0.344 (0.214)
State and Local Government Resources						
Highway Build America Bonds per capita	0.225** (0.106)	0.239** (0.114)	0.0115 (0.0225)	0.0310 (0.0267)	0.0262 (0.0263)	-0.00477 (0.0110)
Highway Build America Bonds per capita, lag 1	0.183* (0.107)	0.214* (0.113)	0.0285 (0.0274)	0.0431* (0.0230)	0.0571* (0.0316)	0.0135 (0.0204)

Highway Build America Bonds per capita, lag 2	0.0887** (0.0432)	0.104** (0.0442)	0.0142 (0.0221)	0.0360* (0.0205)	0.0369 (0.0317)	-0.000514 (0.0177)
Long-term debt issued per capita	0.00783 (0.0165)	0.0101 (0.0188)	0.00363 (0.00381)	0.00614* (0.00357)	0.0105** (0.00441)	0.00444* (0.00233)
Long-term debt issued per capita, lag 1	0.00720 (0.0128)	0.00352 (0.0106)	-0.00188 (0.00380)	0.00525 (0.00341)	0.00632 (0.00491)	0.00107 (0.00200)
Long-term debt issued per capita, lag 2	0.00902 (0.00705)	0.00697 (0.00676)	-0.00102 (0.00151)	0.000611 (0.00302)	0.00193 (0.00375)	0.00105 (0.00208)
Income per capita	0.00431 (0.00307)	0.00765*** (0.00264)	0.00292** (0.00121)	0.00456*** (0.00174)	0.00829*** (0.00258)	0.00360*** (0.000810)
State and local fuel and vehicle tax revenue receipts per capita	0.302** (0.143)	0.352** (0.142)	0.0455 (0.0487)	0.326* (0.192)	0.258 (0.227)	-0.0200 (0.134)
Oil and gas industry share of state GDP	1.100*** (0.333)	1.139*** (0.390)	0.0759 (0.200)	-0.134 (0.313)	0.0712 (0.365)	0.209*** (0.0715)
Nonhighway federal grants effective matching rate	0.147 (0.231)	-0.0256 (0.176)	-0.170 (0.167)	-0.169 (0.105)	-0.221* (0.121)	-0.0500 (0.0485)
Nonhighway federal grants per capita	0.000569 (0.0301)	0.0178 (0.0236)	0.0167 (0.0253)	0.100*** (0.0357)	0.125** (0.0508)	0.0213 (0.0320)
Other Variables						
Vehicle registrations per capita	0.0458 (0.0353)	0.0866*** (0.0304)	0.0341** (0.0162)	0.00438 (0.0158)	0.00564 (0.0247)	0.00389 (0.0114)
Public lane miles per capita	-0.350 (1.878)	-1.256 (1.602)	-0.769 (0.587)	-1.347 (0.838)	-2.426* (1.453)	-1.109* (0.641)
Utah Olympics dummy	0.0968*** (0.00776)	0.0883*** (0.00774)	-0.00864*** (0.00228)	0.0119*** (0.00343)	0.00550 (0.00358)	-0.00498*** (0.00129)

Georgia Olympics dummy	0.0308*** (0.00557)	0.0292*** (0.00515)	-0.00110 (0.00203)	0.000263 (0.00237)	0.00430* (0.00259)	0.00310*** (0.00102)
Number of Observations (states × state fiscal years)	1,100	1,100	1,100	1,100	1,100	1,100

Source: Congressional Budget Office. For data sources, see Table 2.

Standard errors are shown in parentheses.

ARRA = American Recovery and Reinvestment Act; GDP = gross domestic product.

* $p < .10$; ** $p < .05$; *** $p < .01$.

References

- Cameron, A. Colin, and Douglas L. Miller. 2015. "A Practitioner's Guide to Cluster-Robust Inference," *The Journal of Human Resources*, vol. 50, no. 2 (Spring), pp. 317–372, <http://dx.doi.org/10.3368/jhr.50.2.317>.
- Campbell, Sheila. 2018. "Fiscal Substitution of Investment for Highway Infrastructure," Congressional Budget Office Working Paper 2018-08 (August), <https://www.cbo.gov/publication/54371>.
- Carlson, E. Dean. 1993. "INFORMATION: Interstate Maintenance Program," Federal Highway Administration Memorandum to Regional Federal Highway Administrators, Division Administrators, and Federal Lands Highway Program Administrator (June 14), www.fhwa.dot.gov/preservation/061493.cfm.
- Congressional Budget Office. 2016. *The Macroeconomic and Budgetary Effects of Federal Investment* (June), www.cbo.gov/publication/51628.
- . 2018. *Federal Support for Financing State and Local Transportation and Water Infrastructure* (October), www.cbo.gov/publication/54549.
- . 2020. Letter to the Honorable John Yarmuth providing answers to questions related to federal funding for state and local governments (May 13), www.cbo.gov/publication/56360.
- . 2021. *Effects of Physical Infrastructure Spending on the Economy and the Budget Under Two Illustrative Scenarios* (August), www.cbo.gov/publication/57327.
- Dupor, Bill. 2017. "So, Why Didn't the 2009 Recovery Act Improve the Nation's Highways and Bridges?" Federal Reserve Bank of St. Louis *Review*, vol. 99, no. 2 (Second Quarter), pp. 169–182, [http://doi.org/10.20955/r.2017.169–182](http://doi.org/10.20955/r.2017.169-182).
- Federal Highway Administration. 2009. "American Recovery and Reinvestment Act of 2009: Implementing Guidance" (updated April 1, 2009), www.fhwa.dot.gov/economicrecovery/guidance.htm.
- . 2019. *Highway Statistics 2018*, Table HM-48 (accessed December 11, 2020), www.fhwa.dot.gov/policyinformation/statistics/2018/.
- Feigenbaum, Baruch, and Joe Hillman. 2020. *Revealing State Gas Tax Diversions* (June), Reason Foundation, <https://reason.org/policy-brief/how-much-gas-tax-money-states-divert-away-from-roads/>.
- Gamkhar, Shama. 2003. "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 & Finance*, vol. 23, no. 1 (March), pp. 1–21, <http://doi.org/10.1111/1540-5850.2301001>.

- Government Accountability Office. 2004. *Federal-Aid Highways: Trends, Effect on State Spending, and Options for Future Program Design*, GAO-04-802 (August), www.gao.gov/products/GAO-04-802.
- Knight, Brian. 2002. “Endogenous Federal Grants and Crowd-Out of State Government Spending: Theory and Evidence From the Federal Highway Aid Program,” *American Economic Review*, vol. 92, no. 1 (March), pp. 71–92, <http://doi.org/10.1257/000282802760015612>.
- Leduc, Sylvain, and Daniel Wilson. 2017. “Are State Governments Roadblocks to Federal Stimulus? Evidence on the Flypaper Effect of Highway Grants in the 2009 Recovery Act,” *American Economic Journal: Economic Policy*, vol. 9, no. 2 (May), pp. 253–292, <http://doi.org/10.1257/pol.20140371>.
- Meyers, Harry G. 1987. “Displacement Effects of Federal Highway Grants,” *National Tax Journal*, vol. 40, no. 2 (June), pp. 221–235, www.jstor.org/stable/41788659.
- Nesbit, Todd M., and Steven F. Krefl. 2009. “Federal Grants, Earmarked Revenues, and Budget Crowd-Out: State Highway Funding,” *Public Budgeting and Finance*, vol. 29, no. 2 (Summer), pp. 94–110, <http://doi.org/10.1111/j.1540-5850.2009.00930.x>.
- Ramey, Valerie A. 2020. “The Macroeconomic Consequences of Infrastructure Investment,” National Bureau of Economic Research Working Paper 27625 (July), www.nber.org/papers/w27625.
- Sigritz, Brian. 2020. *2020 State Expenditure Report: Fiscal Years 2018–2020* (November). National Association of State Budget Officers, www.nasbo.org/reports-data/state-expenditure-report.
- Waidelich, Walter C., Jr. 2016. “Guidance on Highway Preservation and Maintenance,” Federal Highway Administration Memorandum (February 25), www.fhwa.dot.gov/preservation/memos/160225.cfm.