Endogenous Federal Grants and Crowd-out of State Government Spending: Theory and Evidence from the Federal Highway Aid Program

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Contrary to simple theoretical predictions, existing evidence suggests that federal grants do not crowd out state government spending. A legislative bargaining model with endogenous grants documents a positive correlation between grant receipts and preferences for public goods; this correlation has likely biased existing work against measuring crowd-out. To correct for such endogeneity, the model motivates instruments based on the political power of state congressional delegations. Exploiting this exogenous variation in grants, the instrumental variables estimator reports crowd-out that is statistically and economically significant. This endogeneity may explain the flypaper effect, a nonequivalence between grant receipts and private income. (*JEL* D70, H40, H77)

> "Angels in heaven don't decide where highways will be built. This is a political process."
>
> —U.S. House Transportation Committee Chair Bud Shuster, defending the earmarking of federal transportation aid for special highway projects.[1]

When measuring the incidence of a policy, analysts often cite cross-state variation in policies and the relevant economic outcomes. However, policies are not determined in a vacuum. As noted in Timothy Besley and Anne Case (2000), political representatives, whose actions may reflect unobserved constituent preferences and other state characteristics, determine policies.[2] Thus, reliance on cross-state variation in policies may lead to incorrect conclusions. Statistical correlations between policies and economic outcomes may reflect the role of these unobserved characteristics, rather than the effect of policies themselves.

This paper studies such policy endogeneity in the context of the incidence of intergovernmental grants, which are fiscal transfers from higher-level to lower-level governments in a federal system.[3] In a simple political economy model, David F. Bradford and Wallace E. Oates (1971a, b) predict that grants crowd out state government spending, leading to little or no increase in combined public spending. However, existing empirical work has found only weak support for this crowd-out hypothesis and several studies have even found that federal grants increase, or crowd in, state government spending.

This literature, both theoretical and empirical, has assumed that state policy makers face

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[1] *Washington Post,* April 1, 1998.

[2] Besley and Case study policy endogeneity in the context of the incidence of workers' compensation benefits. Since states set these benefits through a political process, the authors argue that cross-state variation may reflect economic and political conditions within the state. Therefore, difference-in-difference estimation may provide biased economic incidence estimates.

[3] According to the Census Bureau's Survey of Governments and the Economic Report of the President, grants received by state and local governments in the United States during fiscal year 1996 totaled $478 billion, representing 6 percent of GDP and 17 percent of total public spending.

an exogenous distribution of federal grants. This paper recognizes that both federal grants and state government spending are determined through a political process and that grant receipts, the outcome of a bargaining game at the federal level, may reflect underlying constituent preferences through their elected representatives. More specifically, a legislative bargaining model developed in this paper predicts that, when forming majority coalitions, committee chairs prefer to include those states with relatively strong preferences for public goods since their vote is cheaper to secure.

This link between preferences and grant receipts may explain the weak evidence of crowd-out in the existing literature. As an illustration of this grant endogeneity, consider Figure 1, which depicts highway finances in Massachusetts. Between 1983 and 1997, there is a positive correlation (0.58) between state spending and federal grants, suggesting federal grant crowd-in, and this relationship appears to be strongest after 1991, when both grants and state spending were rapidly increasing. However, this increase in federal grants was not exogenous. A third factor, the state's desire to complete a highway project in Boston, known as the Big Dig, simultaneously increased both federal grants and state spending. In 1983, Governor Dukakis's administration conceived the project and Speaker of the House Thomas (Tip) O'Neill (D, MA) secured federal funding in 1985. During the 1991–1998 period, $6 billion in combined spending was allocated to this project.[4] With this variation in federal grants and state spending alone, one cannot distinguish between the endogenous grants hypothesis, the conjecture that preferences influence both grants and spending, and the crowd-in hypothesis, the idea that grants increased state spending.

Similarly to Besley and Case, the legislative bargaining model, which incorporates policy determination, provides a framework for selecting instruments to correct for such endogeneity. In the model, the committee chair uses his political, or proposal, power to increase grant receipts for his home state. Thus, measures based on the political power of congressional delegations, such as committee representation, partisan affiliation, and tenure, serve as instruments for grant receipts. While traditional regression methods find no evidence of crowd-out, the endogeneity-corrected estimates, which exploit exogenous variation in delegation political power, demonstrate that grants do crowd out state spending in an economically and statistically significant manner.

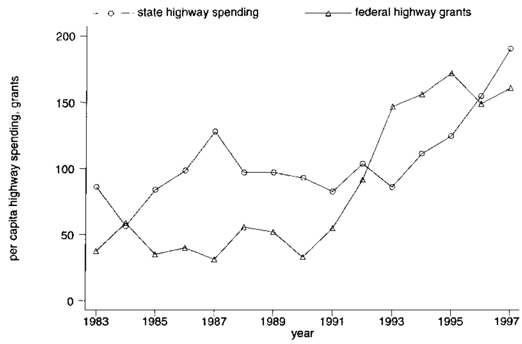

FIGURE 1. MASSACHUSETTS HIGHWAY FINANCE

I. Theoretical Model

A. *Federal Grant Crowd-out*

Consider a simple model, similar to Bradford and Oates, of a single state government allocating resources, private income and federal grants, between consumption of private and public goods. Consistent with the empirical literature, which typically assumes an exogenous distribution of grants, this section treats these grants and the associated federal taxes as predetermined. The next section relaxes this assumption by constructing a model in which federal and state officials simultaneously determine both federal grants and state public spending according to a political bargaining process.

A single state has N residents, each of whom has convex preferences over a public good (G) and a numeraire private good (z_i). These preferences are represented by the utility function $U(G, z_i; \mu_i)$, where the parameter $\mu_i \in \{\mu_L, \mu_H\}$ represents public good preferences, which can be either low or high. For all public goods levels, high-preference constituents are willing to pay more for public goods, as reflected in the marginal rate of substitution:

[4] *Boston Herald,* October 13, 1998.

$$(1) \quad U_G(G, z_i; \mu_H)/U_z(G, z_i; \mu_H) > U_G(G, z_i; \mu_L)/U_z(G, z_i; \mu_L).$$

The public good is financed through a combination of state government spending (g) and federal aid (A), which is given exogenously and financed through predetermined nondistortionary federal taxes τ_i. State spending is also financed through nondistortionary taxes, with individual tax shares given by s_i. Thus, each individual faces a private budget constraint:

$$(2) \quad z_i = m_i - \tau_i - s_i g$$

where m_i is individual pretax income.[5] This budget can be alternatively represented by inserting the public sector budget $PG = g + A$, where P is the relative price of public goods:

$$(3) \quad s_i PG + z_i = m_i - \tau_i + s_i A.$$

This budget constraint demonstrates that federal aid is a fungible resource that can be used for either public or private purposes. Given this resource constraint and preferences above, each resident has a preferred level of combined public spending given by:

$$(4) \quad PG_i(s_i P, R_i; \mu_i) = A + g_i(s_i P, R_i; \mu_i)$$

where $g_i(s_i P, R_i; \mu_i)$ is preferred state spending, $s_i P$ is the price of public goods faced by constituent i, and $R_i = m_i - \tau_i + s_i A$ represents total resources available to constituent i.

Assuming a majority voting process for determining public good (G) provision, the outcome of this process will reflect the demand of the median voter (G_m).[6] To examine the effect of federal aid on state government spending, differentiate equation (4) with respect to grants (A) and note that $\partial G_m/\partial A = s_m \partial G_m/\partial m_m$:

$$(5) \quad \partial g_m/\partial A = s_m P \partial G_m/\partial m_m - 1.$$

This expression demonstrates that, after accounting for income effects [$s_m P \partial G_m/\partial m_m$], federal grants crowd out state government spending dollar for dollar.[7]

Since measured income effects for public goods are typically small, federal grants should crowd out state government public spending approximately dollar for dollar. However, the empirical literature has tended to find only partial crowd-out of state spending by federal grants and several have even found evidence of crowd-in.[8] In attempting to explain this empirical puzzle, several authors have challenged the theoretical assumptions in Bradford and Oates. Rather than critique these theoretical assumptions, this paper incorporates the political determination of federal grants, thereby providing both a theoretical critique of the empirical assumption of exogenous grants and a theoretical framework for selecting instruments to correct for grant endogeneity.[9]

B. *A Model with Endogenous Grants*

The simple theoretical model of the previous section, as well as the empirical estimates of

[5] This budget constraint abstracts from deductibility of state taxes against federal income taxes. Deductibility introduces implicit matching grants and associated price effects for state spending. While property and income taxes are deductible from federal income taxes, state gasoline taxes, the empirical application in this paper, are not.

[6] While the median voter approach is most commonly used in local public finance, Bradford and Oates show that the federal grant crowd-out result is robust to alternative collective choice mechanisms, such as Lindahl pricing.

[7] Note that equations (4) and (5) only hold at an interior solution (i.e., the constraint $PG \geq A$ is nonbinding).

[8] Recent surveys of the literature on intergovernmental grants include James R. Hines and Richard H. Thaler (1995), Stephen J. Bailey and Stephen Connolly (1998), and Oates (1999). Early work included Robert P. Inman (1972), Edward M. Gramlich and Harvy Galper (1973), Martin S. Feldstein (1975), Gramlich (1977), and Paul N. Courant et al. (1979).

[9] Although endogeneity is not their main focus, two studies on intergovernmental grants employ instrumental variables techniques in some of their specifications. Elizabeth Becker (1996), in a study of functional form assumptions, uses state demographic instruments and finds slightly stronger evidence of crowd-out. Sharma Gamkhar and Oates (1996) study state responses to grant increases, relative to grant decreases, and use instruments based on national aggregate time-series variation in demographics but still find little evidence of crowd-out. Since federal grants are often distributed by formulas relating to state characteristics, these demographics are correlated with grant levels, the first requirement for an instrument to be valid. However, demographics may be invalid instruments if these measures represent state preferences for public services. In addition to demographics, Gamkhar and Oates use partisan control of the U.S. Congress as an instrument for grant levels. Unfortunately, this measure may also reflect time-series variation in preferences for public services through the choice of voters.

crowd-out, relies on the assumption that grants are exogenous to states' public spending decisions. However, grant receipts may reflect underlying constituent preferences since federal legislatures bargain over the distribution of grants. As a representation of this bargaining process, consider a federation of S states. Given a lack of individual-level data in the empirical section to follow, I now abstract from within-state heterogeneity in state tax shares ($s_{i,s} = 1/N$) and preferences ($\mu_{i,s} = \mu_s$). Further, in order to focus on variation in preferences, federal taxes and private income are assumed equal, both within and across states. That is, $\tau_{i,s} = B/SN$ where B is the federal budget size and $m_{i,s} = m$. The role of these assumptions will be discussed below.

The bargaining model consists of two stages, a federal budgetary stage and a state budgetary stage. The first stage follows a simple version of David P. Baron and John Ferejohn (1987, 1989). A federal legislature, with one representative from each state, determines the distribution of grants across states from the federal budget B, which is given exogenously. The second stage is essentially the single state model of the previous section, in which state governments, taking first-stage intergovernmental grant levels as given, allocate federal grants and private income between public and private consumption.

1. Federal budgetary stage:
   (a) The committee chair, or proposer (p), offers a distribution of grants (A_1, A_2, ... , A_S) from the total federal budget of size B.[10]
   (b) All representatives vote on the proposal. If a majority approves it, the proposed budget is implemented and financed with individual taxes of B/SN. Otherwise, no grants are provided ($A_s = 0$, all s) and taxes are zero ($\tau = 0$).
2. State budgetary stage: Each state government, given the resource constraint in equation (3), chooses public spending equal to or greater than federal grants ($PG_s \geq A_s$).

[10] No amendments are permitted to this proposal. Highway aid authorization bills are typically considered under a closed rule, which prohibits amendments to the committee's version of the bill (Diana Evans, 1994).

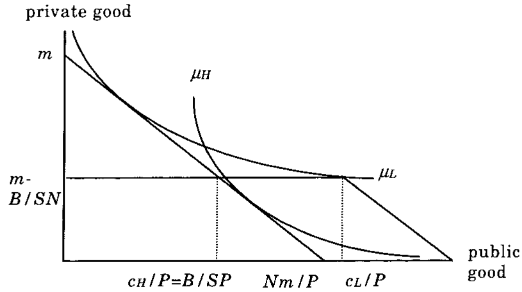

FIGURE 2. COST OF SECURING A VOTE (c_L, c_H): CASE WHERE HIGH TYPE SUPPLEMENTS

Since the chair requires only a majority of votes to pass his proposed federal budget, he provides grants to a minimum winning coalition of $(S + 1)/2$ states, including his home state, and provides no grants to the remaining states. To maximize the grant for his home state, the chair includes in this coalition those states whose votes can be secured with the least possible outlay. In this model, the votes of high-spending states are cheaper to secure, assuming that the federal budget size (B) is sufficiently large. For this to occur, the budget must be large enough that low-spending states do not supplement, with state taxes, a grant equal to their federal tax contribution.[11,12]

Figures 2 and 3 demonstrate the differential costs (c) of securing votes from low- and high-spending states. Note that these figures depict the minimum grant levels required to secure the respective vote and thus depict hypothetical, rather than equilibrium, grant payments. Consider first the case, depicted in Figure 2, in

[11] If the federal budget size were not sufficiently large, the committee chair could secure the vote of both high- and low-spending states with a grant equal to their federal tax contribution.

[12] The budget size B must be sufficiently large that $B/S \geq PG_s(P/N, m; \mu_L)$. For completeness, one must also assume a maximum budget size such that the chair receives a positive grant, net of taxes. Otherwise, the chair would prefer to revert federal tax dollars back to the states. This maximum condition on the budget size is given by the expression $B - c(B)*(S - 1)/2 \geq B/S$, where $c(B)$ is the average cost of securing a vote across the coalition and is increasing in B. This constraint does not bind at the minimum budget size $[B_{\min} = S*PG_s(P/N, m; \mu_L)]$ since the cost of securing both preference type votes equals the tax contribution in this case $[c(B) = B/S]$. Thus, there exists a range of budget sizes over which the equilibrium of interest occurs.

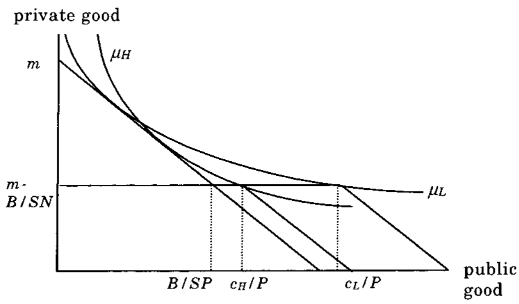

FIGURE 3. COST OF SECURING A VOTE (c_L, c_H): CASE WHERE HIGH TYPE DOES NOT SUPPLEMENT

which the federal budget is small enough that high-spending states will choose to supplement, with state tax revenue, a federal grant equal to their federal tax contribution.[13] The resource constraint connecting m and Nm/P depicts the situation in which a majority votes against the federal budget and no federal grants are provided. The second resource constraint, starting at $m - (B/SN)$ and with a kink at $c_H/P = B/SP$ for high types and c_L/P for low types, corresponds to an approved federal budget with positive federal grants and taxes. The high-demand representative will be indifferent between a federal budget with a grant equal to their federal tax contribution (B/S) and a zero federal budget. Thus, to secure the vote of high-spending states, the chair can offer them a grant equal to their federal tax contribution ($c_H = B/S$). In order to secure the vote of low-spending representatives, the chair would need to offer a grant higher than the federal tax contribution ($c_L > B/S$). Thus, in forming majority coalitions, the chair prefers to include states with strong preferences for public goods. Consider next the differential costs, depicted in Figure 3, for the case in which the federal budget size is large enough that high-spending states will not supplement, with state revenue, a federal grant equal to their federal tax contribution.[14] As in Figure 2, the vote of high-spending states is cheaper than that of the low-spending state ($c_H < c_L$).[15]

In both figures, the committee chair must offer a higher grant level to low-spending states as compensation for returning their federal tax contribution as a grant earmarked for public services, a good for which they have a weak preference. Thus, in equilibrium, the chair prefers to include high-spending states in the coalition because securing their vote is less costly. Due to this preference, the correlation between preferences for the public good and grant receipts is positive ($\rho_{\mu,A} > 0$). This correlation is derived in the published Appendix, under the assumption that representatives from low- and high-spending states are equally likely to be assigned to the committee chair.[16]

C. *Extensions*

It is worth noting which assumptions are for convenience and which are crucial in the model. First, the specific form of legislative bargaining is not crucial. Models with alternative legislative processes, such as the universalism and Coasian bargaining models, also predict a positive correlation between grant receipts and state preferences for public goods. The universalism model of Barry R. Weingast et al. (1981) characterizes legislators as independently choosing project sizes for their districts and therefore internalizing only their state's share ($1/S$) of the total tax cost. In this model, which has an endogenous federal budget size, the distribution of grants can be characterized as follows:

$$(6) \quad NU_G(A_s, z_{i,s};\ \mu_s)/U_z(A_s, z_{i,s};\ \mu_s) = P/S.$$

Given that the marginal rate of substitution is increasing in preference type, high-preference states will receive larger grants than low-preference states. Donald Wittman (1989) argues that legislative institutions create property rights and thus encourage Coasian bargaining. In this setting, legislators internalize tax burdens of their own, as well as other states, and

[13] $PG_s(P/N,\ m;\ \mu_H) > B/S$.

[14] $PG_s(P/N,\ m;\ \mu_H) \leq B/S$.

[15] In a more general model, with an endogenous budget size B, the case depicted in Figure 3 would always result. With a small budget, as depicted in Figure 2, the agenda-setter has an incentive to expand the budget. Increasing the budget by one dollar, the chair must pay $1/S$ to each member of the winning coalition, which is of size $(S - 1)/2$, excluding the chair, and thus keeps $(S + 1)/2S$ for his home state, a gain of $(S - 1)/2S$ net of taxes.

[16] With large legislatures, the role of the single committee chair becomes small in computing the correlation $\rho_{\mu A}$. Thus, this positive correlation is essentially independent of the preference of the agenda-setter.

grant levels can be best characterized by a Samuelson rule:

$$(7) \quad NU_G(A_s, z_{i,s}; \mu_s)/U_z(A_s, z_{i,s}; \mu_s) = P.$$

Again, high-preference states will secure larger grants.[17] In both of these alternative legislative models, high-preference states secure larger grants.

Second, given a lack of individual-level data and a desire to focus on heterogeneity across states, the model with endogenous grants assumes that individuals are identical within states. This assumption abstracts from tax shifting, in which federal and state governments have access to different tax bases and resident tax burdens vary across these two bases. Ronald C. Fisher (1979, 1982) argues that, if the median voter has a relatively low federal tax burden, then the estimated effects of federal grants could include the positive income effect due to the shift from state to federal taxes.[18] However, such shifting is less relevant for highway spending, the empirical application in this paper, given that federal and state governments finance such spending with a common tax base, gasoline tax revenue.[19] The assumption of identical residents also abstracts from elections to legislatures. V. V. Chari et al. (1997) and Besley and Stephen Coate (1999) study interactions between elections and legislative bargaining and document incentives to strategically delegate to high-spending representatives. However, in addition to transportation services, the empirical application in this paper, federal legislatures provide many other public goods. This multidimensionality of policies may make it difficult for states to delegate in such a manner. For example, federal provision of both national and local public goods will diminish incentives to strategically delegate since high-spending representatives also increase national public goods.[20]

Third, the assumption of equal income and federal tax shares across states can be relaxed, so long as this variation is both independent of preferences and less salient than preferences in determining the cost of securing votes. For example, suppose that states vary in income $[m_s \in \{m_L, m_H\}]$. For normal public goods, high-income states would place more value on federal grants, making their vote cheaper. In this case, the saliency of preferences requires that votes of low-preference, high-income states are more expensive than votes of high-preference, low-income states. That is, $c(\mu_L, m_H) > c(\mu_H, m_L)$, where c is the cost of, or the minimum grant required to secure, a vote. If states vary in federal tax shares $[f_s \in \{f_L, f_H\}]$, the votes of low-burden states will tend to be cheaper. In this case, saliency of preferences requires $c(\mu_L, f_L) > c(\mu_H, f_H)$. These conditions for the saliency of preferences guarantee the inclusion of high-preference states in the winning coalition.

Fourth, the assumption of nondistortionary taxes is crucial for the crowd-out result in equation (5). Jonathan H. Hamilton (1986) demonstrates that, if state taxes entail more distortions than federal taxes, perhaps due to avoidance behavior, federal grants will not fully crowd out state spending on public goods. Similarly, Thomas J. Nechyba (1997) presents a model in which state income taxes are less distortionary than local income taxes, due to Tiebout migration. In this setting, state grants, which are funded by state income taxes, may increase combined spending on public goods. Such distortions can be introduced to the model, in a reduced-form manner, with a cost of state funds parameter (θ). Only $(1 - \theta)$ proportion of collected revenues are spent on public goods and equation (4) becomes $PG = A + (1 - \theta)g$. In this case, equation (5) is altered such that

[17] Technically, the social planner would be indifferent between federal funding and state funding of these public goods, given the assumption of nondistortionary taxation. However, if state taxes entail more distortions due to tax avoidance behavior, for example, the planner would have a preference for federal funding.

[18] See Bogart et al. (1992), Bogart and Peter M. VanDoren (1993), and Timothy Goodspeed (1998) for analyses of recent changes in local property taxes, education aid in New Jersey, and state income taxes.

[19] Federal highway grants are funded from a trust fund, into which gasoline tax receipts are deposited. According to Table SF-1 of Highway Statistics 1997, 52 percent of state highway spending is financed through gasoline taxes. Further, the two other largest revenue sources, vehicle taxes (26 percent) and tolls (8 percent), have an incidence distribution similar to that for gasoline taxes since all three sources tax highway users.

[20] While Chari et al. (1997) argue that national policies do not alter states' incentives to elect high-spending representatives, their result rests on the assumption of a large number of districts and a powerful executive branch.

$\partial g_m/\partial A = (1 - \theta)^{-1} s_m P \partial G_m/\partial m_m - 1$. As distortions ($\theta$) increase, federal grant crowd-out increases, away from -1. Although such distortions may be important empirically, note that distortionary state taxes would only serve to bias the empirical analysis against measuring crowd-out.

Fifth, the assumption of complete information is critical. Radu Filimon et al. (1982) introduce incomplete voter information and budget-maximizing state officials and predict zero federal grant crowd-out.[21] Further, nonzero crowd-out is crucial to the result of a positive correlation between grants and preferences, as the chair must provide a higher grant to low-spending states in order to compensate them for returning their federal tax dollars with strings attached. Unfortunately, the assumption of complete information cannot be directly tested. However, similarly to distortionary taxation, incomplete information would only serve to bias the empirical results in this paper against measuring crowd-out.

II. Empirical Implications

For empirical purposes, consider a Stone-Geary utility specification:

$$(8)\quad U(G_s, z_{i,s}; \mu_{i,s}) = \beta \ln[G_s - (\mu_{i,s}/P)] + (1 - \beta)\ln[z_{i,s}]$$

where μ represents minimum spending on public goods. This utility function exhibits the single-crossing property in preferences (μ) as expressed in equation (1). Given a lack of individual-level data, I again abstract from within-state variation.[22] In this case, assuming state government spending is positive, it is given by:

$$(9)\quad g_s = \beta M_s + (\beta - 1)A_s + (1 - \beta)\mu_s$$

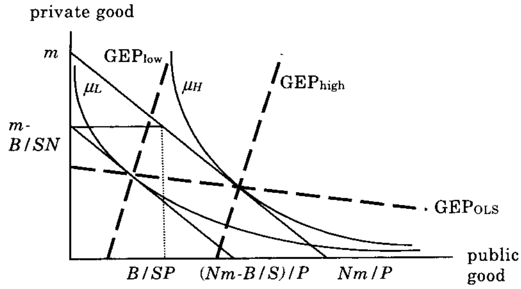

FIGURE 4. GRANT EXPANSION PATHS (GEP)

where $M_s = N(m_s - \tau_s)$ is state income, after federal taxes.

Interpreting the remainder term $[(1 - \beta)\mu_s]$ as unobserved heterogeneity, one can regress state spending (g_s) on private income (M_s) and federal grants (A_s) and treat the grants coefficient as a measure of crowd-out. Consider the probability limit of the grants coefficient from such a regression:

$$(10)\quad \text{plim}(b_A) = (\beta - 1) + (1 - \beta)(\sigma_\mu/\sigma_A)\rho_{A,\mu}.$$

In this expression, the grants coefficient converges to the true crowd-out measure $(\beta - 1)$ plus an asymptotic bias term $(1 - \beta)\rho_{A,\mu}(\sigma_\mu/\sigma_A)$, which is positive due to the positive correlation between preferences and federal grants.[23] If the correlation between preferences and grants is sufficiently large $[\rho_{\mu,A} > \sigma_A/\sigma_\mu]$, the estimates support crowd-in $[\text{plim}(b_A) > 0]$, even in the context of this model, which predicts significant crowd-out.

As a depiction of this grant endogeneity, Figure 4 reflects grant expansion paths for representative low-spending states, which receive grant levels of zero in equilibrium, and high-spending states, which receive B/S. Although not a general result, the estimated grant

[21] See also Fisher (1982), who develops a model of fiscal illusion in which residents confuse average and marginal costs of public goods.

[22] Within states, residents are assumed to have equal preferences ($\mu_{i,s} = \mu_s$), income ($m_{i,s} = m_s$), federal taxes ($\tau_{i,s} = \tau_s$), and state tax shares ($s_{i,s} = 1/N$).

[23] This expression is derived in an unpublished Appendix (available from the author) using equation (9) and an assumption of nonredistributive grants ($\rho_{A,M} = 0$). The empirical results below, which yield only a weak correlation between income and grants, support the nonredistributive grants assumption. Of course, other grant programs may significantly redistribute income.

expansion path (GEP_{OLS}), which relies on cross-state variation, suggests crowd-in, while the true grant expansion paths (GEP_{low} and GEP_{high}) reflects crowd-out. This crowd-in interpretation is flawed in its comparison of government spending between states with unobserved preferences that are positively correlated with grant levels.

To correct for this endogeneity, the bargaining model motivates instruments for grants based upon committee membership. In the model, the proposer (p) uses his agenda-setting power to secure a grant for his home state in excess of its tax contribution (B/S), implying a positive correlation between committee representation and grants ($\rho_{p,A} > 0$).[24] More broadly, committee membership can be interpreted as a measure of the political power of state delegations. Partisan affiliation and tenure serve as two additional measures of this political power and will be included in the set of instruments.

III. Federal Highway Aid Program

As a case study of grant endogeneity, this paper examines the Federal Highway Aid Program. The federal government levies a tax on gasoline sales and the proceeds are deposited into the Federal Highway Trust Fund, which finances grants for state highway construction and maintenance.[25] This program consists of closed-end matching grants; the role of this matching rate and associated price effects will be discussed below.

Although highway grants are distributed primarily according to formula, individual legislators, especially those with political power, have available several means for altering the distribution of grants for the benefit of their home state. In reference to highway grants, Senator Patrick Moynihan (D, NY) stated "You don't have a formula here, you have 50 negotiated numbers."[26] The first tool available to legislators is earmarked projects, which are typically identified by House and Senate transportation committees. The most recent reauthorization included 1,467 projects with a total cost of $9 billion.[27] Second, legislators can simply create new grant programs. During the 1992–1997 authorization negotiations, the Senate created a new formula for distributing a trust fund surplus. The new formula, proposed by Senator Robert Byrd (D, WV), primarily provided benefits to those states, such as West Virginia, with high state gasoline tax rates and low per capita income.[28] Third, legislators can change the Interstate Cost Estimate, a list of projects eligible for federal funds. In 1985, Thomas (Tip) O'Neill (D, MA) used his power as Speaker of the House to add the Big Dig project to this list, thereby increasing grant receipts for Massachusetts.[29]

A. *Data Sources*

The Census Bureau's Annual Survey of Governments (U.S. Department of Commerce) and Federal Highway Administration's (FHA) Highway Statistics Series provide two independently collected sources of data on highway spending and grants and are summarized in an unpublished Appendix. The correlation between these two sources is 0.94 for per capita highway spending and 0.90 for per capita highway grants. Table 1 provides summary statistics. Spanning the last three authorizations, corresponding to state fiscal years 1983–1997 and excluding Hawaii, Alaska, and Nebraska, the sample size is 705.[30] Figure 5 depicts 1997

[24] This result rests upon the assumption of a maximum budget size B. See footnote 12 for further details.

[25] States may use authorized funds for construction and improvement of roads that are designated federal-aid highways. Among state-controlled roads, the federal-aid highway system supports 72 percent of total lane mileage and 85 percent of the total road miles traveled in the United States in 1997 (U.S. Department of Transportation, Federal Highway Administration, 1995).

[26] *Washington Post*, May 23, 1998.

[27] For example, this reauthorization provided $97 million over six years to "reconstruct and widen I-40 Crosstown Bridge and Realignment in downtown Oklahoma City."

[28] *Washington Post*, June 19, 1991.

[29] *Washington Post*, February 28, 1985.

[30] Nebraska is excluded because it has a nonpartisan legislature and the empirical model below controls for legislative party composition. Alaska and Hawaii are considered fiscal outliers. The enactment of the Surface Transportation Assistance Act of 1982, which authorized federal highway grants for fiscal years 1983–1986, marked a shift from interstate construction to interstate maintenance since the interstate system was 95 percent complete (Robert Jay Dilger, 1989). Thus, excluding years prior to 1983 makes highway spending and grants from these two sources more comparable over time.

TABLE 1—SUMMARY STATISTICS FOR KEY VARIABLES

Variable	Definition	Sample Average (Standard Deviation)	Source
Census combined spending	Per capita federal and state combined spending on construction, maintenance, and operation of highways, streets, and related structures, including grants to local governments, fiscal year	264.88 (98.75)	Census Bureau Survey of Governments
Census grants	Per capita federal aid to state governments for highway spending, fiscal year	92.43 (44.73)	Census Bureau Survey of Governments
FHA combined spending	Per capita federal and state combined spending on construction, maintenance, administration, and law enforcement/safety, including grants to local governments, fiscal year	292.95 (100.84)	FHA Highway Statistics Series
FHA grants	Per capita federal aid to state governments for highway spending, fiscal year	98.41 (60.06)	FHA Highway Statistics Series
Federal gasoline tax liabilities	Per capita federal gasoline taxes required to fund highway grants (Census definition)	80.54 (20.89)	FHA Highway Statistics Series
U.S. House transportation	Percentage of state representatives to U.S. House on transportation authorization committee	0.10 (0.13)	Almanac of American Politics
U.S. House majority party	Percentage of state representatives to U.S. House in majority party (in year grants authorized)	0.58 (0.25)	United States Congressional Officeholders
U.S. House tenure	Average tenure of state representatives in U.S. House (in year grants authorized)	7.87 (3.72)	United States Congressional Officeholders
U.S. Senate transportation	Percentage of state representatives to U.S. Senate on transportation authorization committee	0.17 (0.24)	Almanac of American Politics
U.S. Senate majority party	Percentage of state representatives to U.S. Senate in majority party (in year grants authorized)	0.55 (0.36)	United States Congressional Officeholders
U.S. Senate tenure	Average tenure of state representatives in U.S. Senate (in year grants authorized)	9.48 (5.60)	United States Congressional Officeholders

Notes: Forty-seven states, fiscal years 1983–1997. Seven hundred and five observations (703 for FHA data). All monetary values are in 1997 dollars.
Sources: Almanac of American Politics (Michael Barone, various years); United States Congressional Officeholders (Inter-university Consortium for Political and Social Research and Carroll McKibbin, 1997).

cross-sectional variation, demonstrating a positive correlation between federal grants and state highway spending and suggesting federal grant crowd-in. However, using this evidence alone, one cannot distinguish between the effect of federal grants on state spending and the correlation between federal grants and unobserved preferences.

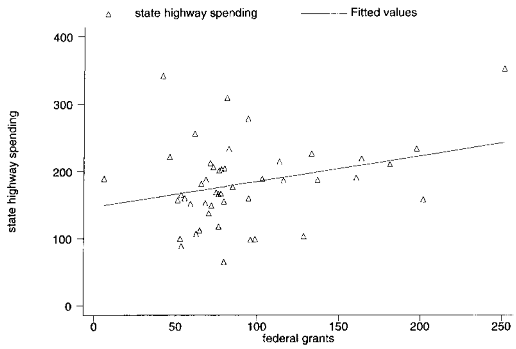

FIGURE 5. CROSS-SECTIONAL VARIATION, 1997

B. *Data Considerations*

Although the crowd-out prediction of Bradford and Oates applies to lump-sum grants, federal highway aid consists of matching grants.[31] The federal government provides matching funds up to a state-specific cap, at which point the state must begin to provide full funding.[32] Thus, for states spending more than their cap, the closed-end matching grants are effectively lump-sum grants. Between 1983 and 1997, virtually all states appear to have spent more on eligible highways than the amount required to exhaust their federal funds and thus face only income effects (an unpublished Appendix provides further details). Furthermore, even if some states are facing price effects, these observations will bias the estimators against measuring crowd-out since these matching grants and associated price effects will stimulate more spending than do lump-sum grants.

A second data consideration relates to the institutional reliance on formulas. The majority of Federal Highway Aid funds are distributed by a formula relating to state characteristics.[33] Given this reliance on a formula, it may be difficult for powerful legislators to alter the distribution of grants and, in this case, the fixed-effects model will not be identified since it relies on within-state, time-series variation in grant levels and political power. An unpublished Appendix performs a variance decomposition for the grants variable and reports that a transitory, within-state component accounts for a substantial (18 percent) amount of the total variance.[34] This within-state variation may reflect the numerous means available to politically powerful legislators for altering grant levels, as outlined above in the anecdotal evidence on political bargaining in the Federal Highway Aid Program.

C. *Redistribution Across States*

To focus on variation in preferences, the legislative model assumed equal federal tax shares, implying that all redistribution across states can be attributed to grant receipts. The summary statistics in Table 1 provide some support for this view, as the variation in grant receipts exceeds the variation in federal gasoline tax liabilities, as reflected in the standard deviations. However, there remains significant variation across states in federal tax burdens. Table 2 provides state-specific breakdowns of per capita tax payments into and grants receipts from the trust fund between 1983 and 1997. Donor states, those with negative rates of return, are concentrated in the Midwest and South, while donee states are concentrated in the Northeast and sparsely populated West. The success of these northeastern states may reflect the clout of their delegations in Congress prior to the Republican victories in 1994. The next section returns to the issue of measuring crowd-out in a model with endogenous grants, the main focus of this paper.

IV. Empirical Model and Results

A. *Ordinary Least-Squares (OLS) Estimation*

As demonstrated in the theoretical analysis, the correlation between grant levels and preferences for public services biases OLS estimators

[31] Bradford and Oates also consider matching grants.

[32] The federal and state government shares for interstate projects are currently 90 percent and 10 percent, respectively; other projects on federal-aid highways typically have shares of 80 percent and 20 percent.

[33] While the formula has changed over time, it has traditionally included interstate lane miles, vehicle miles traveled on the interstate system, the state's share of the cost to complete the interstate system, urbanized population, total population, and total lane miles.

[34] This evidence is consistent with R. Michael Alvarez and Jason L. Saving (1997), who find that House members on powerful committees are more successful at steering formula grants, relative to project grants, to their home district.

TABLE 2—REDISTRIBUTION ACROSS STATES IN THE FEDERAL HIGHWAY AID PROGRAM, 1983–1997

State	Highway Grant Receipts	Associated Gasoline Taxes	Rate of Return (Percent)
Alabama	$ 87.47	$ 89.08	−1.81
Alaska	$370.24	$ 76.80	382.08
Arizona	$ 68.43	$ 77.49	−11.69
Arkansas	$ 85.71	$103.35	−17.07
California	$ 58.66	$ 64.70	−9.34
Colorado	$ 82.63	$ 67.59	22.25
Connecticut	$120.01	$ 63.00	90.49
Delaware	$112.71	$ 80.47	40.06
Florida	$ 51.93	$ 68.71	−24.42
Georgia	$ 84.15	$ 97.97	−14.11
Hawaii	$121.69	$ 42.19	188.43
Idaho	$118.52	$ 82.84	43.07
Illinois	$ 63.69	$ 59.29	7.42
Indiana	$ 69.85	$ 84.97	−17.79
Iowa	$ 90.64	$ 77.69	16.67
Kansas	$ 89.27	$ 86.90	2.73
Kentucky	$ 74.53	$ 84.05	−11.33
Louisiana	$ 55.05	$ 77.07	−28.57
Maine	$ 80.25	$ 83.02	−3.34
Maryland	$ 94.40	$ 68.03	38.76
Massachusetts	$ 84.81	$ 58.43	45.15
Michigan	$ 56.46	$ 64.19	−12.04
Minnesota	$ 75.65	$ 67.38	12.27
Mississippi	$ 80.75	$ 90.05	−10.33
Missouri	$ 75.90	$ 90.72	−16.34
Montana	$190.87	$103.45	84.50
Nebraska	$ 98.64	$ 84.96	16.10
Nevada	$ 92.25	$ 86.05	7.21
New Hampshire	$ 77.29	$ 65.40	18.18
New Jersey	$ 74.35	$ 66.87	11.19
New Mexico	$105.82	$ 96.65	9.49
New York	$ 46.42	$ 46.76	−0.73
North Carolina	$ 79.88	$ 81.53	−2.02
North Dakota	$183.62	$100.20	83.25
Ohio	$ 57.21	$ 68.33	−16.27
Oklahoma	$ 71.13	$ 97.50	−27.05
Oregon	$ 76.14	$ 82.59	−7.81
Pennsylvania	$ 73.65	$ 66.10	11.42
Rhode Island	$126.56	$ 54.77	131.08
South Carolina	$ 63.25	$ 86.08	−26.52
South Dakota	$173.80	$ 94.50	83.92
Tennessee	$ 73.26	$ 88.98	−17.67
Texas	$ 68.02	$ 83.48	−18.52
Utah	$104.39	$ 75.72	37.86
Vermont	$139.88	$ 81.52	71.59
Virginia	$ 64.83	$ 78.26	−17.16
Washington	$ 94.11	$ 69.41	35.59
West Virginia	$145.72	$ 77.33	88.44
Wisconsin	$ 59.50	$ 72.71	−18.17
Wyoming	$240.80	$174.21	38.22

Notes: All variables are measured in per capita terms. Grant receipts reflect Census data.

against measuring federal grant crowd-out. As an empirical demonstration of this bias, suppose that preferences for public spending, as captured in the Stone-Geary parameter μ, consist of a constant (α) plus an unobserved component (v), which varies both across states (s) and time (t):

$$\mu_{s,t} = \alpha + \sigma v_{s,t} \tag{11}$$

where σ represents the standard deviation of $v_{s,t}$.

Substituting equation (11) into equation (9) yields the following regression equation:

$$g_{s,t} = \underline{\alpha} + \beta_1 A_{s,t} + \beta_2 M_{s,t} + \underline{\sigma} v_{s,t} \tag{12}$$

where $\underline{\alpha} = (1 - \beta)\alpha$, $\underline{\sigma} = (1 - \beta)\sigma$, $\beta_1 = \beta - 1$ captures federal grant crowd-out, and $\beta_2 = \beta$ captures income effects.

Assuming that preferences are mean independent of grant receipts and income $[E(v_{s,t}|A_{s,t}, M_{s,t}) = 0]$, one can consistently estimate the parameters of equation (12) using OLS. Column (1) of Table 3 presents the results from such a regression using Census data. For comparability across states, all variables have been converted into per capita measures.[35] The results of this regression suggest that federal grants increase, or crowd in, state highway spending, and this effect is both statistically and economically significant.

B. *Controlling for State Preferences*

The source of the endogeneity of grants is omitted variable bias, a failure to control for preferences that may influence both grant receipts and state highway spending. Consider a parameterization for preferences that includes both observed ($\mathbf{X}$) and unobserved (v) components, as well as state fixed effects:

$$\mu_{s,t} = \alpha_s + \boldsymbol{\gamma}'\mathbf{X}_{\mathbf{s,t}} + \sigma v_{s,t}. \tag{13}$$

[35] To convert equation (12) into a per capita expression, simply divide both sides by state population. This per capita specification is consistent with the intergovernmental grants literature (e.g., Robert A. Moffitt, 1984).

TABLE 3—FEDERAL GRANT CROWD-OUT, CENSUS DATA

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	Fixed Effects	2SLS First Stage	2SLS Second Stage	LIML First Stage	LIML Second Stage
Dependent variable	State spending	State spending	Grant receipts	State spending	Grant receipts	State spending
Panel A: Primary Coefficients						
Grant receipts	0.6888 (0.3378)**	−0.0327 (0.0559)		−0.8786 (0.4199)**		−1.1159 (0.4915)**
Income	−0.0008 (0.0016)	0.0094 (0.0011)**	0.0004 (0.0008)	0.0100 (0.0013)**	0.0004 (0.0007)	0.0101 (0.0013)**
Population		1.1206 (2.9469)	−1.5983 (2.0640)	−0.6449 (3.5341)	−1.7213 (1.9726)	−1.1402 (3.6958)
Drivers per capita		−49.6204 (47.5347)	−93.2635 (33.7362)**	−116.6749 (64.3122)*	−87.2797 (32.1495)**	−135.4853 (69.0985)**
Vehicles per capita		−46.1828 (28.5600)	32.4672 (20.2753)	−26.2207 (34.6197)	34.3160 (19.2992)*	−20.6212 (36.3033)
Governor Democrat		7.9187 (2.9358)**	−1.6301 (2.0636)	6.1768 (3.5188)*	−1.7717 (1.9694)	5.6882 (3.6792)
State House Democrats		44.6344 (23.3247)*	−24.9912 (16.7629)	24.2678 (28.9005)	−25.0012 (15.8485)	18.5548 (30.4697)
State Senate Democrats		8.8056 (18.9367)	25.0203 (13.9682)*	28.9344 (24.1295)	27.8671 (13.0828)**	34.5809 (25.6045)
Panel B: U.S. House Instruments						
Transportation committee			−3.9545 (9.3307)		−4.6333 (7.0913)	
Majority party			−7.8995 (6.4774)		−11.6433 (4.9893)**	
Tenure			−0.9621 (0.4265)**		−0.6934 (0.3751)*	
Panel C: U.S. Senate Instruments						
Transportation committee			9.1975 (6.2833)		11.7674 (4.9188)**	
Majority party			1.1518 (2.9091)		1.6293 (2.2079)	
Tenure			0.9268 (0.2954)**		0.7673 (0.2823)**	
Panel D: Statistical Tests						
R^2	0.2002	0.8187	0.7849			
Overidentification test p-value			0.582		0.623	
Instrument F-test (p-value)			2.64 (0.016)		2.65 (0.014)	
Observations	705	705	705	705	705	705
State fixed effects	no	yes	yes	yes	yes	yes

** Denotes 5-percent significance.
* Denotes 10-percent significance.

Inserting equation (13) into equation (9) yields the regression equation:

$$(14) \quad g_{st} = \underline{\alpha}_s + \underline{\boldsymbol{\gamma}}'\mathbf{X_{s,t}} + \beta_1 A_{s,t} + \beta_2 M_{s,t} + \underline{\sigma} v_{s,t}$$

where $\underline{\boldsymbol{\gamma}}' = (1 - \beta)\boldsymbol{\gamma}'$. The vector **X** includes population, drivers per capita, vehicles per capita, and state legislative composition (percent Democrats) and an indicator for Democrat governor. The population variable measures heterogeneity in preferences due to state size. The next two variables, vehicles and drivers per capita, capture transportation demand. The political variables measure differences in preferences across political parties. Finally, state fixed effects control for time-invariant, state-specific preferences for highway spending, such as geography.

Column (2) of Table 3 presents the results from this fixed-effects regression. The coefficient on grants receipts is now close to zero and statistically insignificant, suggesting neither crowd-in nor crowd-out. This finding is consistent with the zero crowd-out prediction of Filimon et al. (1982). The other coefficients in column (2) are insignificant with the exception of the income variable and Governor and State House Democrats variables, which are both positive, suggesting that Democrats have a stronger preference for highway spending than do Republicans.

These control variables may not completely capture a state's preference for highway spending. Some aspects of preferences, such as attitudes towards public transportation, are unobservable. Similarly, a fixed effect may not correct this endogeneity problem if preferences for public services within a state vary over time. For example, California significantly increased state highway spending after 1989, reflecting a 10-year project, with a cost estimated up to $5 billion, to repair and bolster 2,000 bridges following the October 1989 San Francisco Bay area earthquake.[36] In this case, preferences for highway construction varied significantly within the sample period, and a fixed effect may mitigate, but will not eliminate, this endogeneity problem.

[36] *San Francisco Chronicle,* October 16, 1999.

C. *Instrumental Variables Estimation*

As demonstrated in the theoretical section, grant receipts and preferences for public goods may be positively correlated and, in this case, the mean independence assumption $[E(v_{s,t}|A_{s,t}, M_{s,t}) = 0]$ is suspect. An alternative assumption $[E(v_{s,t}|p_{s,t}, M_{s,t}) = 0]$ allows for a dependence between preferences and grant receipts, instead relying on the independence of committee membership, or proposal power (p), which is omitted from equation (9). In this case, equation (14) parameters can be consistently estimated with two-stage least squares (2SLS).

As noted in the theoretical section, in addition to committee membership, two additional measures of political power will be employed as instruments: party representation and tenure. In addition, three alternative sets of instruments will serve as a robustness check. These instruments are measured in the year of authorization.[37]

The first measure of political power of state delegations, the proportion serving on the transportation authorization committee, serves as an empirical analog to the committee chair in the bargaining model.[38] These committees typically propose the distribution of highway funds and then present this proposal to the full legislature with limited amendment opportunities. This agenda-setting power allows committee members to increase spending for their home state.[39] The House Committee on Transportation and

[37] Thus, while the unit of observation is the state fiscal year, there is somewhat limited time-series variation in the set of instruments because these funds were authorized only three times between 1983 and 1997. I also estimated the empirical model measuring the instruments in the year of appropriation, rather than authorization. However, I found that the authorization measures had more explanatory power in the first-stage regressions. This may reflect the fact that authorization committees typically generate the formula used to distribute highway funds. Further, as noted in Section III, the authorization committee tends to fund earmarked projects.

[38] Results using the number of committee members, not presented here, are very similar to the baseline results.

[39] For example, South Dakota, but not North Dakota, was represented on the House Transportation Committee in 1998, and this committee recently earmarked six times more in highway projects for South Dakota than for its neighbor. In terms of receiving earmarked grants for his home state, "being on the committee was very important" said Representative John Thune (R, SD) (*Associated Press,* March 26, 1998).

Infrastructure and the Senate Environment and Public Works Committee have jurisdiction over transportation authorizations.[40] The second measure, the proportion of a state's representatives in the majority party, captures the importance of party politics. By including members of their own party in the winning coalition, party leaders improve the reelection opportunities of their fellow party members and therefore increase the likelihood of retaining majority control.[41] During all three authorizations, the Democrats controlled the House of Representatives. In the Senate, the Republicans had control during the first authorization, corresponding to fiscal years 1983–1986, and the Democrats controlled the last two. The third measure, the average tenure of the state representatives, is motivated by the importance of tenure in the committee system. The committee chair and minority-ranking member are typically the longest-serving members within the respective party.

The 2SLS results are displayed in columns (3) and (4) of Table 3. Focusing on the first-stage results, there is no correlation between per capita income and grants. States with more drivers receive less in grants, perhaps reflecting a correlation between the drivers and vehicles variables. States with more vehicles per capita receive larger grants, reflecting the impact of vehicle miles traveled in the aid formula, although this coefficient is statistically insignificant. The state government political party variables have mixed signs. Note that both the first and second stage of 2SLS also include state fixed effects.[42]

The next six rows of column (3) present the coefficients on the instruments for grants. While four of the six instruments are statistically insignificant, they are jointly significant with an F-statistic of 2.64. In addition, an overidentification specification test supports the instrument exogeneity assumption ($\rho_{p,\mu} = 0$).[43] The coefficients on the three House instruments have a counterintuitive negative sign while the Senate variables have the expected positive sign. There are two possible explanations for this divergence. First, the Democratic Party controlled the House, but not the Senate, for the entire sample period, providing little time-series variation in these House instruments, especially the majority party variable. Second, the area represented by Senators (the state) but not the area represented by House representatives (the congressional district) matches the unit of observation in the empirical model. If politically powerful House members increase earmarked projects for their own district at the expense of other districts within their state, this political power may not translate into increased grants for the state as a whole.[44] Alternatively, politically powerful House members may expend their limited resources lobbying for grants with more concentrated, district-specific benefits, such as Housing and Urban Development (HUD) grants to cities and urban counties.

In the second stage, presented in column (4), the grants coefficient is -0.88, suggesting significant crowd-out. Further, although the standard error is large, the coefficient is statistically different from zero, the coefficient associated with the prediction of Filimon et al. (1982). However, I cannot reject varying degrees of partial crowd-out, as well as overcrowding, given that the grants coefficient has a 95-percent confidence interval of $[-0.06, -2.42]$. This large confidence interval reflects the loss in power from using only the variation in grant receipts attributable to political power and ignoring the endogenous variation, that attribut-

[40] Shepsle (1978) and Weingast and William J. Marshall (1988) study the assignment of congressional representatives to committees. In over 80 percent of cases, freshmen are assigned to one of their top three choices. Further, Weingast and Marshall (1988) find that legislators request to serve on committees relevant to constituent interests.

[41] For example, Massachusetts, which has a delegation dominated by Democrats, was the only state to experience a decrease in federal highway aid during the most recent authorization, the first since the Republicans took control of Congress in 1994 (*Boston Globe,* March 25, 1998).

[42] Christopher Cornwell et al. (1992) demonstrate that, as in the case of OLS, linear simultaneous equations model estimators, such as 2SLS, with fixed effects are consistent even without a transformation to sweep out the fixed effects (i.e., a dummy variable specification).

[43] This test studies the statistic NR^2, where N is the sample size and R^2 is the goodness of fit from a regression of the second-stage residuals on the instruments and other predetermined variables (Jerry A. Hausman, 1983).

[44] For example, the district of Jim Oberstar (D, MN), ranking minority member of the House Transportation Committee, recently received 57 percent of the total dollars earmarked for special projects in Minnesota, even though his district represents only 33 percent of Minnesota's total square miles and 12 percent of the total population (*Associated Press,* March 26, 1998).

able to preferences. In an attempt to increase the power of these estimates, alternative sets of instruments will be used later in the analysis. Given this caveat, the 2SLS results report crowd-out that is both statistically and economically significant. Further, this result is in stark contrast to the OLS and fixed-effects estimates, which report no evidence of crowd-out.

D. *Robustness Checks*

While consistent, the 2SLS estimator is biased towards the OLS estimator in finite samples and this bias is especially pronounced if the instruments are only weakly correlated with the endogenous variable.[45] If the OLS grants coefficient is biased upwards, due to a positive correlation between grant levels and preferences for public spending, then the 2SLS estimator will also be biased against measuring crowd-out since the OLS and 2SLS biases operate in the same direction. While limited information maximum likelihood (LIML) and 2SLS are asymptotically equivalent, Staiger and Stock (1997) report that LIML has a smaller finite sample bias and suggest its use as an alternative to 2SLS. An unpublished Appendix provides the likelihood function for the LIML estimator.

Columns (5) and (6) present the LIML results. In the first stage, the pattern of signs matches the 2SLS results and four out of six are statistically significant. Similarly to the 2SLS results, the instruments are jointly significant and the overidentification test supports the exclusion restriction assumptions. While the second-stage grants coefficient in column (6) is -1.12, suggesting overcrowding, it is not statistically different from the full crowd-out coefficient of -1 and is again statistically different from zero.

As an additional robustness check, Table 4 presents the results using the FHA data. The pattern of coefficients is qualitatively similar to that of Table 3 as the grants coefficient falls in the endogeneity-corrected estimates. In the first stage of 2SLS and LIML, the instruments have the same sign as those in the Census data results. The LIML estimator again reports a second-stage grants coefficient that suggests overcrowding, although one cannot reject full dollar-for-dollar crowd-out. Both the 2SLS and LIML coefficients on grant receipts are statistically significant and thus reject zero crowd-out.

Given the negative signs on the House instruments and large standard errors on the second-stage grants coefficient, Table 5 presents 2SLS results using three alternative sets of instruments.[46] Columns (1) and (2) include interactions of the three measures of political power and suggest an important interaction between tenure and majority party affiliation, an effect that is statistically significant for both the House and Senate and for both data sources.[47] Given that majority party affiliation and tenure are perhaps the two most important factors in securing committee chairs, this positive interaction may reflect logrolling, an agreement between two committee chairs to propose budgets favorable to each other's states. While the 2SLS grants coefficient is similar to that in the baseline Table 4 estimates, the standard error falls due to the power gained from additional instruments. The 95-percent confidence interval suggests a crowd-out range of $[-0.56, -1.85]$ for the Census data and $[-0.45, -1.42]$ for the FHA data.

Second, columns (3) and (4) drop the House variables from the set of instruments given their counterintuitive sign in the baseline specification. In the Census data, the first-stage coefficient on the Senate transportation committee instrument is now statistically significant at the 10-percent level, supporting the theoretical prediction that committee members use their agenda-setting power to increase grants for their home state. The Census data suggest statistically significant crowd-out, while the results using FHA data are statistically insignificant, reflecting a grants coefficient that is smaller in absolute value as well as a loss in power from dropping three instruments.

The third alternative set of instruments excludes the Senate transportation committee instrument as well as all House instruments, given

[45] See John Bound et al. (1995) and Douglas Staiger and James H. Stock (1997).

[46] LIML results for these alternative instrument sets are available in an unpublished Appendix.

[47] Similarly to the baseline instruments, these interaction-based measures of political power are created at the legislator level and then averaged across the delegation.

TABLE 4—FEDERAL GRANT CROWD-OUT, FHA DATA

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	Fixed Effects	2SLS First Stage	2SLS Second Stage	LIML First Stage	LIML Second Stage
Dependent variable	State spending	State spending	Grant receipts	State spending	Grant receipts	State spending
Panel A: Primary Coefficients						
Grant receipts	0.4241 (0.0558)**	0.1361 (0.0573)**		−0.9099 (0.4023)**		−1.3345 (0.5260)**
Income	0.0010 (0.0018)	0.0087 (0.0011)**	−0.0003 (0.0008)	0.0086 (0.0013)**	−0.00002 (0.0007)	0.0086 (0.0014)**
Population		−0.5509 (2.8970)	−1.9286 (1.9755)	−3.1895 (3.7018)	−2.1994 (1.8888)	−4.2605 (4.1612)
Drivers per capita		33.0875 (46.8796)	−118.4557 (32.3068)**	−70.6886 (69.7902)	−110.1349 (30.7673)**	−112.8123 (82.1398)
Vehicles per capita		−57.1690 (28.1143)**	34.9378 (19.4286)*	−27.8329 (36.3311)	38.0458 (18.4623)**	−15.9252 (41.0056)
Governor Democrat		7.0678 (2.8852)**	−0.4558 (1.9762)	6.2311 (3.5640)*	−0.8686 (1.8842)	5.8915 (3.9547)
State House Democrats		−0.4057 (22.9280)	−18.6414 (16.0474)	−19.7675 (29.1474)	−19.6011 (15.1178)	−27.6266 (32.7028)
State Senate Democrats		21.8738 (18.6531)	12.2934 (13.4114)	34.7587 (23.4635)	15.9085 (12.4722)	39.9888 (26.2210)
Panel B: U.S. House Instruments						
Transportation committee			−3.7611 (8.9289)		−4.9829 (5.9855)	
Majority party			−7.5157 (6.2002)		−15.6831 (4.3832)**	
Tenure			−1.2125 (0.4101)**		−0.9492 (0.3481)**	
Panel C: U.S. Senate Instruments						
Transportation committee			1.4053 (6.0137)		0.5268 (4.0118)	
Majority party			3.8492 (2.7851)		2.6649 (1.9761)	
Tenure			1.0868 (0.2828)**		0.8776 (0.2702)**	
Panel D: Statistical Tests						
R^2	0.1748	0.7585	0.8908			
Overidentification test p-value			0.227		0.306	
Instrument F-test (p-value)			3.40 (0.003)		3.16 (0.004)	
Observations	703	703	703	703	703	703
State fixed effects	no	yes	yes	yes	yes	yes

** Denotes 5-percent significance.
* Denotes 10-percent significance.

TABLE 5—ALTERNATIVE INSTRUMENT SETS, SELECTED 2SLS COEFFICIENTS

	(1) Census Data	(2) FHA Data	(3) Census Data	(4) FHA Data	(5) Census Data	(6) FHA Data
Panel A: U.S. House Instruments						
Transportation committee	14.3772 (50.2900)	48.8750 (47.4959)				
Majority party	−17.4005 (9.8397)*	−19.2711 (9.3588)**				
Tenure	−2.5452 (0.7860)**	−3.1850 (0.7638)**				
Committee × majority	−50.1094 (94.5698)	−106.5556 (89.3047)				
Committee × tenure	10.0284 (8.4469)	10.0740 (7.9956)				
Majority × tenure	3.2098 (1.4348)**	4.0550 (1.3862)**				
Committee × majority × tenure	−10.1220 (13.3206)	−12.3415 (12.6105)				
Panel B: U.S. Senate Instruments						
Transportation committee	3.4935 (20.8807)	−0.0568 (19.7131)	10.6665 (6.0977)*	3.4061 (5.8514)		
Majority party	−11.9714 (7.6615)	−18.3071 (7.2309)**	0.9202 (2.8521)	3.3868 (2.7387)	1.0795 (2.8552)	3.4376 (2.7359)
Tenure	−0.1153 (0.5424)	−0.2388 (0.5121)	0.6914 (0.2807)**	0.8066 (0.2695)**	0.6981 (0.2811)**	0.8087 (0.2693)**
Committee × majority	12.9644 (28.7379)	23.6171 (27.1185)				
Committee × tenure	1.9163 (2.0870)	1.2515 (1.9706)				
Majority × tenure	1.6252 (0.7933)**	2.5508 (0.7485)**				
Committee × majority × tenure	−2.9490 (3.1909)	−3.9338 (3.0107)				
Panel C: Second-Stage Coefficient						
Per capita grant receipts	−1.2068 (0.3278)**	−0.9319 (0.2484)**	−0.9308 (0.5572)*	−0.5750 (0.5134)	−0.5639 (0.6151)	−0.5910 (0.5245)
Panel D: Statistical Tests						
Overidentification test p-value	0.112	0.001	0.495	0.932	0.401	0.791
Instrument F-test (p-value)	2.34 (0.004)	4.04 (0.000)	3.08 (0.027)	3.37 (0.018)	3.09 (0.046)	4.90 (0.008)

** Denotes 5-percent significance.
* Denotes 10-percent significance.

their negative sign in the baseline estimates. Although the instruments pass the tests for exogeneity, Weingast and Marshall (1988) provide evidence that legislators choose to serve on committees relevant to their constituent interests; in this case, committee representation may be an invalid instrument. In the second stage, the grants coefficients in columns (5) and (6) are smaller in absolute value and no longer statistically significant, again reflecting the loss in power from dropping instruments. While closer to zero than the baseline 2SLS estimates, the point estimates are more supportive of crowd-out than the fixed-effect grants coefficients in Table 3. In summary, these robustness checks demonstrate that the measurement of crowd-out is robust to two instrumental variables estimators, two data sources, and four sets of instruments.

E. *Implications for Flypaper Effect Literature*

The flypaper effect, an empirical anomaly, suggests that grant receipts increase combined public spending more than do increases in private income, which are equivalent resources in theoretical models. The OLS and fixed-effects results, which suggest that federal grants increase combined spending dollar for dollar, are consistent with this puzzle. By contrast, the instrumental variables results provide a potential explanation since federal highway grants crowd out state highway spending and thus have little effect on combined spending. Thus, the endogeneity of grants may explain the flypaper effect.

Existing explanations for the flypaper effect include Moffitt (1984), who argues that previous research has ignored the importance of price effects inherent in matching grant programs. Accounting for price effects in the AFDC program, Moffitt finds that the flypaper effect disappears. However, this correction for matching grants does not explain the flypaper effect finding in grant programs without matching provisions.[48] In an alternative explanation focusing on econometric errors, Bruce W. Hamilton (1983) argues that the flypaper effect may be due to omitted variable bias if private income is negatively correlated with public good production costs, leading to a downward bias in the income coefficient. However, no attempt is made to correct empirically for this omitted variable bias.

V. Conclusion

This paper demonstrates that federal highway grants crowd out state highway spending, leading to little or no increase in net spending. If the federal government desires to increase highway spending, perhaps due to cross-state spillovers that are not internalized by state governments, the federal highway program needs to be altered. For example, by lowering the match rate from 80 percent and raising the limit on matching funds, known as the cap, more states would face price effects, thereby increasing highway spending at no additional cost to the federal government.

In summary, this paper develops a model that incorporates both the political determination of federal grants and the effects of such grants on state policies. Through incorporating the determination of grants, the model demonstrates a positive correlation between grant levels and unobserved preferences. This correlation, which has been previously ignored, biases estimators in the existing literature against measuring crowd-out. Consistent with this prediction, traditional regression methods in this paper provide little evidence of crowd-out. To correct for the correlation between federal grants and preferences for public services, the bargaining model motivates measures of the political power of state congressional delegations as instruments for grant levels. Exploiting this exogenous variation, the endogeneity-corrected estimates report federal grant crowd-out that is both economically and statistically significant. In the two-stage least-squares estimates with the most power, those that include interactions of baseline measures of political power, the 95-percent confidence intervals

[48] Related to this explanation is Howard A. Chernick (1979, 1981), who argues that federal agencies award project grants to those communities willing to commit more of their own revenues, and this targeting creates implicit matching grants. As empirical support for this argument, he finds a positive correlation between grants and proposed local contributions in the HUD water and sewer program. However, he does not attempt to incorporate this critique into a traditional flypaper effect specification.

suggest a crowd-out range of [−0.56, −1.85] for the Census data and [−0.45, −1.42] for the FHA data.

Appendix: Proof of Positive Correlation Between Public Spending and Preferences ($\rho_{A,\mu} > 0$) in the Model with Endogenous Grants

As mentioned in the text, assume throughout that representatives from low- and high-spending states are equally likely to be assigned to the committee chair:

$$\text{(A1)} \quad \Pr(\text{chair}|\mu_H) = \Pr(\text{chair}|\mu_L) = 1/S.$$

Since the covariance and correlation have identical signs, consider the covariance between public spending and preferences:

$$\text{(A2)} \quad \sigma_{A,\mu} = \mathrm{E}(\mu A) - \mathrm{E}(\mu)\mathrm{E}(A).$$

Apply the law of total probability to the first term of equation (A2):

$$\text{(A3)} \quad \sigma_{A,\mu} = \mu_L \Pr(\mu_L)\mathrm{E}(A|\mu_L) + \mu_H \Pr(\mu_H)\mathrm{E}(A|\mu_H) - [\mu_L \Pr(\mu_L) + \mu_H \Pr(\mu_H)](B/S).$$

Next, use the definitions $\Pr(\mu_L) = [S_L/S]$ and $\Pr(\mu_H) = [1 - (S_L/S)]$ where S_L is the number of low-preference states:

$$\text{(A4)} \quad \sigma_{A,\mu} = \mu_L(S_L/S)[\mathrm{E}(A|\mu_L) - (B/S)] + \mu_H[1 - (S_L/S)][\mathrm{E}(A|\mu_H) - (B/S)].$$

Next, note the following accounting identity:

$$\text{(A5)} \quad B = (S_L)\mathrm{E}(A|\mu_L) + (S - S_L)\mathrm{E}(A|\mu_H).$$

Solve (A5) for $\mathrm{E}(A|\mu_H)$:

$$\text{(A6)} \quad \mathrm{E}(A|\mu_H) = [B/(S - S_L)] - [S_L/(S - S_L)]\mathrm{E}(A|\mu_L).$$

Finally, plug (A6) into (A4) and rearrange:

$$\text{(A7)} \quad \sigma_{A,\mu} = (S_L/S)(\mu_L - \mu_H)[\mathrm{E}(A|\mu_L) - (B/S)].$$

Thus, $\sigma_{A,\mu} > 0$ if and only if $\mathrm{E}(A|\mu_L) < (B/S)$.

Since the distinction between low and high types is arbitrary, equation (A7) can be written as follows:

$$\text{(A8)} \quad \sigma_{A,\mu} = [1 - (S_L/S)](\mu_H - \mu_L) \times [\mathrm{E}(A|\mu_H) - (B/S)].$$

Thus, $\sigma_{A,\mu} > 0$ if and only if $\mathrm{E}(A|\mu_H) > (B/S)$.

Finally, to show that the correlation is positive, consider two cases:

Case 1: Every high type in winning coalition $[S_H \le (S - 1)/2]$

$$\text{(A9)} \quad \mathrm{E}(A|\mu_H) = \mathrm{E}(A|\text{not chair}, \mu_H)\Pr(\text{not chair}) + \mathrm{E}(A|\text{chair}, \mu_H)\Pr(\text{chair}).$$

Note that every high type is in the winning coalition and the chair secures more than his tax contribution of B/S according to the maximum budget size assumption in footnote 11:

$$\text{(A10)} \quad \mathrm{E}(A|\mu_H) > B/S \Pr(\text{not chair}) + B/S \Pr(\text{chair}) = B/S.$$

Thus, according to equation (A8), $\sigma_{A,\mu} > 0$.

Case 2: No low types in winning coalition $[S_H > (S - 1)/2]$

$$\text{(A11)} \quad \mathrm{E}(A|\mu_L) = \mathrm{E}(A|\text{chair}, \mu_L)\Pr(\text{chair}).$$

Note that the chair must pay at least (B/S) to $(S - 1)/2$ coalition members:

$$\text{(A12)} \quad E(A|\mu_L) \leq \{B - [(S-1)/2](B/S)\}(1/S) = [(S+1)/2S](B/S).$$

Finally, since the number of states (S) exceeds 1:

$$\text{(A13)} \quad E(A|\mu_L) < (B/S).$$

Thus, by equation (A7), $\sigma_{A,\mu} > 0$.

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