The Effect of Federal Intergovernmental Grants on State Taxes: New Evidence of Budget Persistence

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May 30, 2013

Abstract

I examine whether federal intergovernmental grants have a persistent long-term effect on state fiscal policy. A simple theoretical framework is developed based on the median voter model and is structurally estimated based on a 30-year panel of U.S. federal grants and state tax revenues. In both OLS and IV estimates I find evidence that temporary federal aid has a persistent effect on state finances. Each $1 of federal grants predicts eventual state tax increases of between $0.04 and $0.17. These effects are most evident on state personal income and corporate income taxes. There is some evidence that state tax and expenditure limitations (TELs) and supermajority voting rules mitigate these effects. To address possible endogeneity of federal grants I employ an instrumental variables strategy which yields similar results. Consistent with previous literature I find state budgets respond asymmetrically with respect to increases and decreases in federal grants, with temporary grant-funded expenditures persisting over time in state budgets.

Keywords: Fiscal federalism; intergovernmental grants; budget asymmetry.

JEL Classification Numbers: H77; H20; H71.

[†]I would like to thank Richard Carson, Julie Cullen, Mark Jacobsen, Michelle White and Michael Wither for helpful comments. Support from the Institute for Humane Studies is gratefully acknowledged. All remaining errors are my own. Email: adchamberlain@ucsd.edu

1 Introduction

In the wake of the 2009 "American Recovery and Reinvestment Act" there has been a renewed interest in the effects of federal intergovernmental grants on state budgets. A key question is whether states respond symmetrically with respect to expansions and contractions in federal aid—that is, does temporary state spending induced by federal grants disappear from state budgets when grant provisions expire? Or do federal grants have a lasting effect on state budgets, with temporary aid giving rise to permanent state expenditure programs that ultimately require increased local revenue?

There is a large literature examining whether state expenditures respond asymmetrically to federal grants, with mixed empirical results. I contribute to this literature by presenting new evidence of the long-term budget persistence of federal intergovernmental grants to states. We develop a simple theoretical extension of the median voter model that allows for the identification of asymmetric responses of state taxes to federal grants over time. We then structurally estimate the model using a large 30-year panel of U.S. federal intergovernmental grants and state tax data, both via OLS (using a first-differences panel estimator) and via instrumental variables (using a 2SLS estimator).

Our basic results suggest significant state budget persistence of federal grants. Each $1 in federal aid temporarily stimulates U.S. state spending by roughly $0.76 with only about $0.65 of it ultimately disappearing from state budgets in future years. The remaining $0.11 ultimately becomes persistent state expenditures financed by state tax revenue—an indication of positive budget asymmetry. Put differently, each $1 of federal grants predicts eventual state own-source revenue increases of between $0.04 and $0.17. These effects are most evident for state personal income taxes and corporate income taxes. While I find some evidence that state tax and expenditure limitations (TELs) and supermajority voting rules on taxes help mitigate these budget asymmetries, they are present in nearly every subsample examined. My basic finding of budget persistence of federal intergovernmental

grants is evident in both OLS first-differences and IV estimates. The results suggest that temporary federal grants to states may indeed have lasting, and perhaps unintentional, future budgetary consequences.

I organize the remainder of this paper as follows. Section II surveys the related literature. Section III develops a simple theoretical model allowing for the identification of budgetary persistence of federal grants. Section IV presents our data and identification strategy. Finally, Section V presents the empirical results from OLS and IV estimations and briefly concludes.

2 Related Literature

The most closely related literature is one examining whether state budgets are asymmetric with respect to increases and decreases in federal grants. The classic median voter model predicts symmetry in the response of state taxes and spending to federal grants, and thus no long-term budget persistence from temporary intergovernmental grants. Much of the early "flypaper effect" literature examining the relationship between federal grants and state fiscal policy implicitly assumes this symmetry in their empirical specifications. This large early literature is surveyed in Gramlich and Galper (1973); Wyckoff (1991); Hines and Thaler (1995); Bailey and Connolly (1998); and Inman (2008).

By the 1970s researchers began questioning whether state and local budgets would respond symmetrically to increases and decreases in federal intergovernmental grants. One of the earliest discussions of this possibility appears in a 1973 commentary from Stephen Goldfeld who writes, "I am not sure how it would be done, but it would be desirable to incorporate the fact that, once a program is started, it is not easy to turn off." In the same commentary [Goldfel and Brainard (1973)], William Brainard adds that "some types of spending work on a ratchet—for example, it is particularly difficult to cut educational expenditures... The asymmetry of increases and decreases in the expenditure process may be fairly unimportant for growing communities, but critical to those that are stagnant or contracting."

The first empirical evidence for state budget asymmetry did not emerge for another decade, beginning with studies of the elimination of the federal General Revenue Sharing (GRS) program. Betwen 1972 and 1986 the GRS program provided unconditional federal intergovernmental grants to state and local governments as part of a revenue sharing arrangement. Gramlich (1987) was the first to examine the impact of the GRS repeal, concluding that withdrawal of federal aid coincided with an increase in state own-source revenue—an indication that grant-financed expenditures persisted in state budgets after GRS repeal. More recently Volden (1999), Lalvani (2002) and Owens (2010) each have provided empir-

ical evidence of state budget asymmetry. However, the literature on grant-related budget asymmetry remains mixed, with Stine (1994), Gamkhar and Oates (1996), Gamkhar (2000), Gamkhar (2001), and Gordon (2004) finding no evidence of asymmetry. These and other related works in the "grant asymmetry" literature are reviewed extensively in Alderete (2004).

The most similar recent work is Sobel and Crowley (forthcoming). In it, the authors argue that federal grants may lead to upward "ratcheting" of state taxes over time based on a variety of formal and informal arguments from the public choice and political science literatures. Using a reduced form empirical strategy and U.S. data from 1995 to 2008, they find federal intergovernmental grants have a significant positive effect on local state revenue. While carefully executed, their empirical work has the drawback of not being framed by a formal theoretical model and makes use of a fixed-effects panel estimator in levels which may yield unreliable results in the case of nonstationary federal grants and state tax revenue over time.

This paper contributes to the existing literature in three ways. First, I develop a simple theoretical model of the impact of federal grants on state taxes over time under the assumption of budget-persistent federal grants. Next, I structurally estimate the model based on a 30-year panel of federal grants and state taxes for the U.S. Finally, I use an estimation strategy that avoids a potential problem in some previous literature: the potential for spurious regressions due to nonstationary state tax and grant data. My findings provide new evidence of state budget asymmetry with respect to federal intergovernmental grants—a potentially important result for state lawmakers considering whether to increase budgetary reliance on federal intergovernmental aid.

3 Theory

3.1 Basic Model

We develop a simple model that allows for the identification of persistent effects of federal intergovernmental grants on state taxes. The model is a straightforward extension of the median voter model, modified to allow intergovernmental-grant-funded state spending at time t to persist beyond time $t+k$ when federal grants expire. State lawmakers choose the level of government spending G and private consumption goods C to maximize the utility of the median voting block, subject to an annual balanced-budget constraint. Suppose for simplicity that intergovernmental grants T_t are unconditional or non-matching grants.[1] At time t state lawmakers face the decision problem,

$$\max_{C_t, G_t} U(C_t, G_t) \text{ subject to } P_C C_t + P_G G_t \leq Y_t + T_t \tag{1}$$

where $U(C_t, G_t)$ captures the single-peaked preferences of the median voter over private consumption goods C and government services G, P_C is the average price of private consumption goods, P_G is the average price of government services, Y is state private income and T is federal intergovernmental grants. We make the usual assumptions on utility of U_C, $U_G > 0$ and U_{CC}, $U_{GG} < 0$. Further, we assume private consumption and government services are complements in the Edgeworth-Pareto sense (Samuelson, 1974) such that the marginal utility of government services increases with private consumption and vice versa, or U_{CG}, $U_{GC} \geq 0$. The state's first-order conditions are then given by,

[1] This simplification is without loss of generality. All of the results below can be similarly derived for the case of conditional or matching intergovernmental grants.

$$U_C(C_t, G_t) + \lambda_t P_C = 0 \tag{2}$$

$$U_G(C_t, G_t) + \lambda_t P_G = 0 \tag{3}$$

$$Y_t + T_t - P_C C_t - P_G G_t = 0 \tag{4}$$

where U_C and U_G are the median voter's marginal utilities for C and G, respectively and λ is the usual multiplier from the associated Lagrangian. At time t, state lawmakers follow a simple rule: continue spending on government services until the marginal utility of G relative to the price of government services P_G is just equal to the marginal utility of private consumption goods C relative to their price P_C, subject to the balanced-budget constraint from equation (4). Denote these optimal solutions $C_t^*(P_C, P_G, Y_t, T_t)$ and $G_t^*(P_C, P_G, Y_t, T_t)$.

The effects of an additional federal intergovernmental grant ΔT_t on state tax revenue R_t can be seen via the usual comparative statics. Totally differentiating equations (2) - (4) with respect to federal intergovernmental grants T_t we have the following linear system,

$$\begin{bmatrix} U_{CC} & U_{CG} & P_C \\ U_{GC} & U_{GG} & P_G \\ P_C & P_G & 0 \end{bmatrix} \begin{bmatrix} \frac{\mathrm{d}C_t}{\mathrm{d}T_t} \\ \frac{\mathrm{d}G_t}{\mathrm{d}T_t} \\ \frac{\mathrm{d}\lambda_t}{\mathrm{d}T_t} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \tag{5}$$

To simplify notation, let the average price of government services be the numeraire good so that $P_G = 1$, and label the 3 x 3 bordered Hessian on the left as $\mathbf{D_t}$. Solving for the marginal effect of federal grants on state government spending dG_t/dT_t via Cramers rule we have,

$$\frac{\mathrm{d}G_t}{\mathrm{d}T_t} = \frac{\begin{vmatrix} U_{CC} & 0 & P_C \\ U_{GC} & 0 & P_G \\ P_C & 1 & 0 \end{vmatrix}}{|\mathbf{D_t}|} = \frac{U_{GC}P_C - U_{CC}}{U_{GC}P_C + U_{CG}P_C - U_{CC} - U_{GG}P_C^2} \tag{6}$$

Dividing numerator and denominator by $U_{GC}P_C - U_{CC}$ we have,

$$\frac{\mathrm{d}G_t}{\mathrm{d}T_t} = \frac{1}{1 + \frac{U_{GC}P_C - U_{CC}P_C^2}{U_{GC}P_C - U_{CC}}} < 1 \tag{7}$$

Equation (7) yields a key testable implication of the model. In the denominator, $U_{GC} \geq 0$ by complementarity of private consumption and government services and $U_{CC} < 0$ by concavity of the utility function. Thus, we have $0 < dG_t/dT_t < 1$ so that the marginal effect of federal grants on state spending is bounded by zero and unity. Thus, we expect states receiving federal grants to use some fraction for increased spending G and refund the remaining $1 - dG_t/dT_t$ back to households in the form of tax reductions. Under the static median voter model, we thus should observe a negative same-period correlation between federal intergovernmental grants T_t and state tax revenue R_t. Previous estimates of dG_t/dT_t from the flypaper effect literature range from 0.40 to 0.90[2], implying an effect of current federal grants on state taxes dR_t/dT_t of roughly -0.10 to -0.60.

3.2 Incorporating Budget Persistence

We now extend the above framework to allow for the possibility that temporary federal grants at time t may become "persistent," having a lasting effect on state budgets at time $t + k$. Consider N states indexed by the letter $i = 1, ..., N$. Suppose state S_i initially receives no federal aid and has government spending of G_{i0} and tax revenue $R_{i0} = G_{i0}$[3]. In period $t = 1$, suppose S_i receives a federal grant T_{i1}. As noted above, state lawmakers spend a fraction of the grant $dG_t/dT_t < 1$ and refund the remaining $(1 - dG_t/dT_t)$ back to

[2]See Hines and Thaler (1995), Table 1 for a summary of previous estimates of dG_t/dT_t.

[3]For simplicity, we assume states maintain balanced budgets. Of the 50 states, 45 are constitutionally required to do so, and four others are required to do so by statute. Only Vermont has neither a constitutional nor statutory balanced budget requirement.

households. Define $\alpha = dG_t/dT_t$. We label α the "stimulative" parameter in the model. In period one, state spending rises to $G_{i0} + \alpha T_{i1}$ and state taxes fall to $G_{i0} + (\alpha - 1)T_{i1}$.

Now consider time $t = 2$, in which the state receives an additional federal grant T_{i2}. As before, state S_i spends part of the grant α and refunds the remaining $(1 - \alpha)$ back to households. Suppose the grant-funded spending αT_{i1} from the previous period does not fully disappear from state budgets, and instead some fraction of it becomes permanent state spending financed by local tax revenue. Define β as the fraction of the previous period's grant-induced spending that persists into the current period. We label β the "persistence" parameter in the model. In period $t = 2$ state spending thus rises to $G_{i0} + \alpha\beta T_{i1} + \alpha T_{i2}$, where the term $\alpha\beta T_{i1}$ is the increase in state spending at time $t = 2$ due to previous federal aid from time $t = 1$. Due to state balanced budget requirements, local taxes in period $t = 2$ rise to $G_{i0} + \alpha\beta T_{i1} + (\alpha - 1)T_{i2}$.

We can continue tracing the "stimulative" and "persistence" effects of federal intergovernmental grants on state taxes and spending in future periods $t = 3$, ..., $t = T$ as well. Table 1 illustrates the evolution of state government spending G_{it} and tax revenue R_{it} over time in the model. The bottom row provides general expressions for state spending and tax levels in period t as a function of initial state spending G_{i0}, a history of federal intergovernmental grants $H_i = \{T_{i1}, T_{i2}, ..., T_{it}\}$, and the parameters α and β capturing the stimulative and persistence effects of federal aid.

Our relationship of interest is the effect of past intergovernmental grants on state tax revenue at time t. This is given in the bottom row of Table 1 as,

$$R_{it} = G_{i0} + (\alpha - 1)T_{it} + \alpha\beta \sum_{j=1}^{t-1} T_{ij} \tag{8}$$

Equation 8 specifies that state tax revenue in state i at time t should equal a state-specific constant G_{i0}, plus $(\alpha - 1)$ times current federal grants, plus $\alpha\beta$ times the sum of past federal

Table 1: Expressions for State Government Spending G_{it} and Tax Revenue R_{it} Over Time

Time	State Government Spending (G_{it})	State Tax Revenue (R_{it})	Federal Grants (T_{it})
0	G_{i0}	$R_{i0} = G_{i0}$	0
1	$G_{i0} + \alpha T_{i1}$	$G_{i0} + (\alpha - 1)T_{i1}$	T_{i1}
2	$G_{i0} + \alpha T_{i2} + \alpha\beta T_{i1}$	$G_{i0} + (\alpha - 1)T_{i2} + \alpha\beta T_{i1}$	T_{i2}
3	$G_{i0} + \alpha T_{i3} + \alpha\beta(T_{i1} + T_{i2})$	$G_{i0}+(\alpha-1)T_{i3}+\alpha\beta(T_{i1}+T_{i2})$	T_{i3}
$\vdots$	$\vdots$	$\vdots$	$\vdots$
t	$G_{i0} + \alpha T_{it} + \alpha\beta \sum_{j=1}^{t-1} T_{ij}$	$G_{i0}+(\alpha-1)T_{it}+\alpha\beta \sum_{j=1}^{t-1} T_{ij}$	T_{it}

Source: Author's calculations.

grants. While state tax revenue R_{it} and federal grants T_{it} can be directly observed, the structural parameters α and β cannot. Thus, our goal is to make inferences about the symmetry of state budgets with respect to federal grants by econometrically estimating α and β from U.S. data.

4 Data and Identification Strategy

Our data consist of a 30-year panel of state tax revenue and federal grants for the U.S. states from 1981 through 2010. Data on federal intergovernmental grants are from the U.S. Census Bureau's annual "Federal Aid to States for Fiscal Years" and "Federal Expenditures by State for Fiscal Years" reports. Information on state tax and own-source revenues are from the Census Bureau's annual "State Government Finances" reports. All figures are inflation-adjusted into real dollars using the "Consumer Price Index—CPI-U" from the U.S. Bureau of Labor Statistics. Table 2 presents summary statistics.

Table 2: Summary Statistics for the Panel Data Set

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Year	1500	n.a.	n.a.	1981	2010
State Population	1500	5,345,230	5,853,118	418,000	37,300,000
Real State Personal Income ($000)	1500	85,700,000	104,000,000	5,473,533	755,000,000
Real Own-Source Revenue ($000)	1500	7,043,333	8,304,256	467,833	67,300,000
Real Total Tax Revenue ($000)	1500	5,311,147	6,659,144	295,657	55,300,000
Real Income Tax Revenue ($000)	1500	1,742,820	2,930,967	0	25,900,000
Real Corporate Tax Revenue ($000)	1500	353,660	603,192	0	5,497,981
Real General Sales Tax Revenue ($000)	1500	1,725,809	2,209,663	0	16,000,000
Real Alcohol Tax Revenue ($000)	1500	50,405	66,656	0	397,946
Real Tobacco Tax Revenue ($000)	1500	102,541	124,787	2,817	725,652
Real Total Federal Grants Received ($000)	1500	2,975,975	3,730,408	239,480	30,500,000

Note: Revenue and federal grant figures are reported in thousands of inflation-adjusted 1982-84 dollars. The data set is a panel of the 50 U.S. states from 1981-2010. Due to the use of various lags of the data, only 1200 observations from 1987-2010 are utilized in our estimation procedure.

Sources: Federal grants from 1995-2010 are from the U.S. Census Bureau's "Federal Aid to States for Fiscal Years" reports; grants from 1981-1994 are from the U.S. Census Bureau's "Federal Expenditures by State for Fiscal Years" report; all tax revenue data are from the U.S. Census Bureau's "State Government Finance" series; State Personal Income is from the U.S. Bureau of Economic Analysis. I thank George Crowley and Russell Sobel for providing observations of federal intergovernmental grants from 1995-2008.

Our goal is to estimate the structural parameters α and β from equation (8) above. To do so, consider the following fixed-effects panel model,

$$R_{it} = \alpha_i + \phi_1 T_{it} + \phi_2 \sum_{j=t-k}^{t-1} T_{ij} + \delta_i t + \xi_t + X_{it}\beta + \epsilon_{it} \tag{9}$$

where R_{it} is state tax revenue in state i at time t, α_i is a state-specific fixed-effect, T_{it} is federal grants-in-aid, δ_{it} is a state-specific linear time trend to control for upward trends in federal aid over time, ξ_t is a year-specific fixed-effect, X_{it} is a vector of state covariates affecting state tax revenue consisting of state population and real state personal income, and ϵ_{it} is a mean-zero error term. For the sum of previous federal aid, I choose the most recent five years ($k = 5$) in my basic model. Multi-year federal grants typically require states to spend the obligated funds within four fiscal years.[4] Thus, any associated "persistence" of federal aid on state taxes should be apparent within one to five years following the initial grant.[5],[6]

One drawback of the empirical model in equation (9) is that both federal grants T_{it} and state tax revenues R_{it} are nonstationary series. Both state taxes and federal grants are strongly trending upward in real terms throughout the sample period from 1981 to 2010. Thus, the fixed-effects estimator in levels from equation (9) runs the risk of so-called "spurious regression" and potentially misleadingly high R-squared values.[7] One solution is to transform the series via first differencing and proceed to estimate a first-differences model with the resulting stationary series. The corresponding first-differences estimator is given

[4]For a discussion of the multi-year structure of federal grants-in-aid, see Gamkhar (2003).

[5]As a robustness check, I also examined models with up to ten lags of federal aid. However, no lags beyond five years had coefficients that were statistically significant.

[6]Due to timing differences between state and federal fiscal years, I lag all federal grants in the panel by one year. This is done to assure that all information about the complete year of federal aid at time t is available to states prior to the start of their state's fiscal year.

[7]For a discussion of "spurious regression" and related issues that arise with non-stationary time-series see Hamilton (1994).

by,

$$\Delta R_{it} = \phi_1 \Delta T_{it} + \phi_2 \Delta \sum_{j=t-k}^{t-1} T_{ij} + \delta_i + \gamma_t + \Delta X_{it}\Gamma + \eta_{it} \tag{10}$$

Equation (10) is our basic estimating equation, which I estimate below via OLS and 2SLS approaches. The coefficient of interest is ϕ_2, the effect of changes in past federal intergovernmental grants on current state tax levels. Note that ϕ_1 and ϕ_2 correspond directly to the structural parameters α and β from the above model. Specifically, $\phi_1 = (\alpha - 1)$, and $\phi_2 = \alpha\beta$. Thus, by econometrically estimating equation (10) we are able to recover the "stimulative" and "persistence" coefficients from our theoretical model as,

$$\alpha = \phi_1 + 1 \tag{11}$$

$$\beta = \phi_2/(\phi_1 + 1) \tag{12}$$

The estimate of $dG_t/dT_t = \alpha$ is the fraction of federal intergovernmental grants at time t that result in new state spending at time t. The estimate of β is the fraction of grant-funded spending in year t that results in permanent locally financed state spending in at time $t+1$, ..., $t+k$. The combined effect $\alpha\beta$ is the amount by which local tax revenues must ultimately rise for each \$1 of federal intergovernmental aid received.

Based on estimates from previous literature we expect a coefficient on current grants ϕ_1 of between -0.1 and -0.6, implying a stimulative parameter α of between 0.4 and 0.9. If federal grants have no persistent effect on state taxes, $\beta = 0$ and we should expect to find a coefficient on the sum of past grants of $\alpha\beta = \phi_2 = 0$. If temporary federal grants induce permanent state spending obligations that result in higher state own-source revenue, $\beta > 0$ and we should expect a coefficient on past grants ϕ_2 of between 0 and 0.9.

5 Results

5.1 Basic Results

Table 3 presents our basic OLS results. It shows the regression of state own-source revenue for the 50 U.S. states on current and lagged federal grants-in-aid, state and year fixed effects, and controls for population and real personal income as specified by our estimating equation (10). Our basic model is presented in column (6). As an exhibit, in columns (1) though (5) we show the individual components of the overall sum of past federal grants. For example, in column (1) we regress own-source revenue on current grants and last year's grants; in column (2) we regress revenue on current grants and the last two years of grants; and so on. Standard errors are reported in parentheses, which are heteroskedasticity-robust and clustered at the state level to allow for arbitrary autocorrelation in state-level observations over time.

Table 3: Regression of State Own-Source Revenue on Current and Past Federal Grants (OLS First-Differences Panel Estimator)

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Δ Federal Grants at Time t ($\phi_1 = \alpha - 1$)	-0.287***	-0.270***	-0.274***	-0.289***	-0.273***	-0.241***
	(0.078)	(0.083)	(0.089)	(0.102)	(0.094)	(0.066)
Δ Federal Grants at Time $t-1$	0.087	0.074	0.071	0.058	0.080	
	(0.165)	(0.149)	(0.135)	(0.122)	(0.118)	
Δ Federal Grants at Time $t-2$		0.252***	0.253***	0.240***	0.272***	
		(0.070)	(0.068)	(0.079)	(0.071)	
Δ Federal Grants at Time $t-3$			-0.028	-0.029	-0.006	
			(0.168)	(0.165)	(0.149)	
Δ Federal Grants at Time $t-4$				-0.098	-0.113	
				(0.128)	(0.141)	
Δ Federal Grants at Time $t-5$					0.241**	
					(0.112)	
Δ Sum of Past Federal Grants ($\phi_2 = \alpha\beta$)						0.106***
						(0.035)
Δ State Personal Income	0.100***	0.097***	0.098***	0.099***	0.098***	0.094***
	(0.021)	(0.021)	(0.024)	(0.025)	(0.024)	(0.022)
Δ State Population	-1.211***	-1.213***	-1.229***	-1.254***	-1.198***	-1.107***
	(0.290)	(0.279)	(0.251)	(0.270)	(0.224)	(0.242)
n	1150	1150	1150	1150	1150	1150
Adjusted R-squared	0.494	0.503	0.503	0.504	0.511	0.499

*, **, and *** denote statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Note: All specifications include state and year fixed effects. Heteroskedasticity-robust standard errors are reported in parentheses, which have been clustered by state.

As expected, the coefficients on federal grants at time t are all negative, between zero and one in absolute value, and are statistically significant as predicted by the median voter model. A coefficient of -0.241 in column (6) implies a "stimulative" parameter of $\alpha = 0.759$, which implies states spend an average of \$0.76 of each federal dollar on new government spending and refund the remaining \$0.24 back to households in the form of tax reductions. This estimate is within the range found in previous literature.[8]

The key finding from Table 3 is the positive coefficient on the sum of past federal grants in column (6). A coefficient of $\alpha\beta = 0.106$ implies each dollar of federal aid results in higher state own-source revenue of about \$0.11 in the long run. This implies a "persistence" parameter of $\beta = (0.106/0.759) = 0.140$, suggesting that roughly 14 percent of all temporary grant-funded spending ultimately becomes a permanent tax-financed state program.[9] Put differently, of the roughly \$0.76 of each grant dollar spent by states, about \$0.11 or 14 percent ultimately becomes permanently higher state spending financed through own-source revenue. These results suggest federal intergovernmental aid indeed may indeed have lasting effects on state government finances, and provide evidence of state budget asymmetry with respect to federal grants.

Table 4 presents similar results for the effect of federal intergovernmental grants on state tax revenue, which excludes all non-tax revenue sources such as fees, charges and lotteries that are included in own-source revenue above. As before, the estimated coefficients for our basic model in column (6) all have the expected sign and magnitude and are highly statistically significant. I find one dollar of federal grants lowers state tax levels by an average of \$0.16 in the current year ($\alpha = 0.838$) but ultimately results in higher state tax

[8] In the "flypaper effect" literature, studies typically estimate the impact of non-matching federal grants only, whereas we estimate the combined effect of both matching and non-matching grants. Because matching grants generally have a more stimulative effect on state spending, we should expect our estimate of α to be somewhat higher than if only non-matching grants were analyzed. As expected, our estimate of $\alpha = 0.759$ falls near the high end of previous estimates, which range from roughly 0.4 to 0.9 [see Hines and Thaler (1995)].

[9] I bootstrap the standard error for our estimate of $\beta = (\phi_2/(\phi_1+1))$ with $n = 1,000$ replications, yielding a standard error of .0665. Thus, β is statistically different from zero at the 5 percent level ($p = 0.036$).

levels of roughly \$0.09 in the future ($\alpha\beta = 0.094$, and $\beta = 0.112$).

One interesting finding is that the budget "persistence" of federal aid appears to be somewhat larger for state own-source revenue ($\beta = 0.140$) than for state tax revenue ($\beta = 0.112$). Although the difference between the two estimates does not reach statistical significance, it is suggestive that states may have incentives to rely more heavily on non-tax revenue from fees, charges and lotteries when responding to expiring federal aid than direct tax increases.[10] This may be the result of legal constraints that make direct taxes more difficult to increase than non-tax sources, or may simply reflect that non-tax revenues are generally less visible or "salient" to taxpayers and can thus be raised at lower political cost to lawmakers.

[10]This pattern of effects is also noted in Sobel and Crowley (forthcoming).

Table 4: Regression of State Tax Revenue on Current and Past Federal Grants (OLS First-Differences Panel Estimator)

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Δ Federal Grants at Time t ($\phi_1 = \alpha - 1$)	-0.203***	-0.193***	-0.203***	-0.215***	-0.197***	-0.162***
	(0.050)	(0.052)	(0.062)	(0.068)	(0.061)	(0.043)
Δ Federal Grants at Time $t-1$	0.124	0.116	0.110	0.099	0.123	
	(0.147)	(0.137)	(0.123)	(0.115)	(0.109)	
Δ Federal Grants at Time $t-2$		0.151**	0.154**	0.143*	0.177**	
		(0.074)	(0.075)	(0.082)	(0.074)	
Δ Federal Grants at Time $t-3$			-0.059	-0.060	-0.035	
			(0.162)	(0.159)	(0.143)	
Δ Federal Grants at Time $t-4$				-0.083	-0.099	
				(0.086)	(0.093)	
Δ Federal Grants at Time $t-5$					0.263***	
					(0.093)	
Δ Sum of Past Federal Grants ($\phi_2 = \alpha\beta$)						0.094***
						(0.015)
Δ State Personal Income	0.093***	0.092***	0.093***	0.094***	0.093***	0.089***
	(0.022)	(0.022)	(0.025)	(0.026)	(0.025)	(0.022)
Δ State Population	-1.274***	-1.275***	-1.308***	-1.330***	-1.269***	-1.191***
	(0.345)	(0.300)	(0.347)	(0.377)	(0.281)	(0.288)
n	1150	1150	1150	1150	1150	1150
Adjusted R-squared	0.492	0.496	0.496	0.497	0.509	0.495

*, **, and *** denote statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Note: All specifications include state and year fixed effects. Heteroskedasticity-robust standard errors are reported in parentheses, which have been clustered by state.

5.2 Effect in Subsamples

One potentially interesting question is whether the effect of past federal grants on state taxes varies within subsamples featuring different political and legal restrictions on state taxing authority. Specifically, I examine whether the above effects are influenced by the presence of a supermajority-voting rule for tax increases or a state tax and expenditure limitation (TEL).[11] Tables 5 and 6 present our results for own-source revenue and state tax revenue. For simplicity, I report estimates for our main econometric model only from column (6) of the above tables. In column (1) I repeat the overall national results for comparison. In columns (2) and (3) I examine states with and without statutory TELs. In columns (4) and (5) I show results for states with and without supermajority voting rules on tax changes.

Overall, I find suggestive evidence that the presence of statutory TELs and supermajority voting rules is associated with lower degrees of budget asymmetry with respect to federal grants. In the case of state own-source revenue (Table 5), the estimated coefficients on past federal grants $\alpha\beta$ are statistically significantly smaller in states with both TELs and supermajority voting rules on taxes than in states with no statutory taxing limitations.[12] While this evidence is suggestive, it should be interpreted cautiously. State enactment of TELs and voting rules is clearly endogenous, and likely reflects other unobserved characteristics of states not accounted for by the simple estimation procedure used to generate the estimates in Tables 5 and 6. Thus, these estimates should not necessarily be interpreted as the causal effect of TELs or supermajority voting rules on the presence of state budget asymmetry with respect to federal grants.

[11] Information on U.S. states with active TELs and supermajority voting rules for tax purposes is from the National Conference of State Legislatures (see www.ncsl.org/issues-research/budget/state-tax-and-expenditure-limits-2008.aspx).

[12] The pair-wise test statistic for the two estimates is given by $t_{A,B} = \frac{E^A - E^B}{\sqrt{(s^A)^2 + (s^B)^2}}$, with t = 2.69 for TELs and t = 1.97 for supermajority voting rules on taxes.

Table 5: Effect of Federal Intergovernmental Grants on State Own-Source Revenue in Various Subsamples

Variable	(1) Full Sample (All U.S. States)	(2) States with Tax-Expenditure Limitations	(3) No Tax-Expenditure Limitation	(4) States with Supermajority Voting Rules on Taxes	(5) No Supermajority Voting Rule on Taxes
Δ Federal Grants at Time t ($\phi_1 = \alpha - 1$)	-0.241***	-0.208**	-0.291***	-0.294***	-0.177*
	(0.066)	(0.092)	(0.086)	(0.059)	(0.104)
Δ Sum of Past Federal Grants ($\phi_2 = \alpha\beta$)	0.106***	0.065*	0.193***	0.056	0.179***
	(0.035)	(0.034)	(0.036)	(0.048)	(0.040)
Δ State Personal Income	0.094***	0.106***	0.048***	0.126***	0.048***
	(0.022)	(0.020)	(0.011)	(0.008)	(0.006)
Δ State Population	-1.107***	-1.094***	-0.917	-0.964**	-1.376**
	(0.242)	(0.191)	(1.196)	(0.366)	(0.578)
n	1150	690	460	368	782
Adjusted R-squared	0.499	0.511	0.507	0.578	0.443

*, **, and *** denote statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Note: All specifications include state and year fixed effects. Heteroskedasticity-robust standard errors are reported in parentheses, which have been clustered by state.

Table 6: Effect of Federal Intergovernmental Grants on State Tax Revenue in Various Subsamples

Variable	(1) Full Sample (All U.S. States)	(2) States with Tax-Expenditure Limitations	(3) No Tax-Expenditure Limitation	(4) States with Supermajority Voting Rules on Taxes	(5) No Supermajority Voting Rule on Taxes
Δ Federal Grants at Time t ($\phi_1 = \alpha - 1$)	-0.162***	-0.141**	-0.201***	-0.146***	-0.161**
	(0.043)	(0.053)	(0.065)	(0.031)	(0.070)
Δ Sum of Past Federal Grants ($\phi_2 = \alpha\beta$)	0.094***	0.077***	0.135***	0.082**	0.126***
	(0.015)	(0.026)	(0.016)	(0.036)	(0.023)
Δ State Personal Income	0.089***	0.099***	0.046***	0.120***	0.042***
	(0.022)	(0.022)	(0.006)	(0.011)	(0.006)
Δ State Population	-1.191***	-1.174***	-0.696	-0.990***	-1.128**
	(0.288)	(0.194)	(1.101)	(0.168)	(0.521)
n	1150	690	460	368	782
Adjusted R-squared	0.495	0.508	0.497	0.556	0.473

*, **, and *** denote statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Note: All specifications include state and year fixed effects. Heteroskedasticity-robust standard errors are reported in parentheses, which have been clustered by state.

5.3 Effect on Specific State Taxes

We next examine which state taxes appear to be most heavily affected by past federal grants. Among the major state taxes, I examine which ones lawmakers appear to rely on most heavily when filling in budgetary holes left behind by expiring or shifting federal grants. Table 7 presents results for five major taxes: state personal income taxes, corporate income taxes, general sales taxes, and alcohol and tobacco excise taxes.

Of the taxes examined, federal grants appear to have a significant upward effect on two: state personal income taxes and corporate income taxes. I find each dollar of federal aid predicts eventual increases in personal income tax levels of roughly 5.1 cents, corporate income tax levels of 3.6 cents. I do not find any statistically significant effect of federal grants on state general sales taxes, or on alcohol or tobacco excise taxes. As noted above, these estimates likely represent only a partial view of the fiscal response of states to expiring federal grants, as much of the response appears to occur through non-tax fees, charges, lottery and other non-tax revenue sources.

Table 7: Effect of Federal Grants on Various State Tax Levels

Variable	(1) Total State Tax Revenue	(2) Personal Income Tax Revenue	(3) Corporate Income Tax Revenue	(4) General Sales Tax Revenue	(5) Alcohol Tax Revenue	(6) Tobacco Tax Revenue
Δ Federal Grants at Time t ($\phi_1 = \alpha - 1$)	-0.162***	-0.196***	-0.021	0.016	0.002***	-0.002
	(0.043)	(0.068)	(0.028)	(0.028)	(0.001)	(0.005)
Δ Sum of Past Federal Grants ($\phi_2 = \alpha\beta$)	0.094***	0.051**	0.036***	0.005	-0.000	-0.003
	(0.015)	(0.025)	(0.008)	(0.009)	(0.001)	(0.003)
Δ State Personal Income	0.089***	0.043**	0.007***	0.020***	0.000	0.000
	(0.022)	(0.020)	(0.002)	(0.005)	(0.000)	(0.001)
Δ State Population	-1.191***	-0.160	-0.163**	-0.058	0.010	0.093***
	(0.288)	(0.260)	(0.065)	(0.266)	(0.006)	(0.031)
n	1150	1150	1150	1150	1150	1150
Adjusted R-squared	0.495	0.265	0.229	0.309	0.011	0.026

*, **, and *** denote statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Note: All specifications include state and year fixed effects. Heteroskedasticity-robust standard errors are reported in parentheses, which have been clustered by state.

5.4 Effect by Granting Federal Agency

Finally, I examine whether federal grants from some federal agencies are more likely to place upward pressure on state taxes than others. In Table 8 I present regressions of state tax and own-source revenue on current and lagged federal grants from a variety of federal departments including Agriculture, Education, Health and Human Services, Housing and Urban Development, Transportation, and all others combined.[13] Because of limited data availability for federal grants from individual federal agencies, these estimates in Table 8 are based on a considerably smaller sample size of $n = 450$ (compared to $n = 1{,}150$ above). As a result, the model is much less precisely estimated for grants from individual agencies.

Of the federal agencies examined, only two had a statistically significant effect on state taxes and own-source revenue. The Department of Health and Human Services, which administers a large fraction of all federal aid through state Medicaid grants, and the Department of Transportation both had a large and significant impact on taxes and own-source revenue. Grants from Health and Human Services raised state own-source and tax revenue by \$0.386 and \$0.439 per dollar of grants, respectively. Transportation grants resulted in the largest effect, raising state tax revenue by \$0.539 per dollar of grants, respectively. I do not find a statistically significant effect from any of the other federal agencies examined.

[13] Due to limited data availability for individual federal departments prior to 1995, I restrict our sample in Table 8 to the ten-year period from 2001-2010 ($n = 500$).

Table 8: Effect of Federal Intergovernmental Grants from Specific Granting Agencies

Variable	(1) State Own-Source Revenue	(2) State Total Tax Revenue
Δ Federal Grants at Time t ($\phi_1 = \alpha - 1$)	-0.185*	-0.110
	(0.094)	(0.089)
Δ Sum of Past Department of Agriculture Grants ($\phi_2 = \alpha\beta$)	-2.685	-3.577
	(2.872)	(3.680)
Δ Sum of Past Department of Education Grants ($\phi_2 = \alpha\beta$)	-0.192	-0.256
	(0.856)	(0.801)
Δ Sum of Past Department of Health and Human Services Grants ($\phi_2 = \alpha\beta$)	0.386**	0.439***
	(0.154)	(0.144)
Δ Sum of Past Department of Housing and Urban Development Grants ($\phi_2 = \alpha\beta$)	0.169	0.067
	(0.216)	(0.178)
Δ Sum of Past Department of Transportation Grants ($\phi_2 = \alpha\beta$)	0.532	0.539*
	(0.351)	(0.318)
Δ Sum of Past All Other Departments Grants ($\phi_2 = \alpha\beta$)	0.307	0.072
	(0.344)	(0.270)
Δ State Personal Income	0.099***	0.093***
	(0.024)	(0.028)
Δ State Population	-3.201*	-3.156
	(1.853)	(2.107)
n	450	450
Adjusted R-squared	0.558	0.563

*, **, and *** denote statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Note: All specifications include state and year fixed effects. Heteroskedasticity-robust standard errors are reported in parentheses, which have been clustered by state.

5.5 Addressing Grant Endogeneity (IV Estimates)

One concern with the above estimates is that they may suffer from endogeneity bias. As with most federal policy, federal grants to states are endogenously determined by administrators within granting agencies and lawmakers in the U.S. Congress. For example, federal macroeconomic stimulus policy (such as the recent 2009 "American Recovery and Reinvestment Act") may lead to increased grants to states during economic recessions when state tax revenues typically decline. Similarly, state governments may exert additional grant-seeking effort when realizations of state own-source revenues fall below those projected for budgetary purposes. In each of these cases, federal grants at time t are likely to be correlated with unobserved factors ϵ_{it} that determine state tax revenue at time t.

To address this possibility I use an instrumental variables (IV) approach, instrumenting for current and past federal grants to state i using two well-known predictors of federal expenditures to states: (1) the average seniority (in years) of a state's members in the U.S. House of Representatives at time t, and (2) the number of state appointees on the powerful U.S. House Appropriations Committee at time t. A variety of previous studies have found congressional political power to be a strong predictor of federal expenditures to states [see for example Gruber and Hungerman (2005), Anderson and Tollison (1991), and Couch and Shughart (1998).] Data for both instruments is from 1993 to 2010, and is drawn from an online archive compiled by MIT Political Science professor Charles Stewart.[14]

I instrument for the two potentially endogenous regressors in our basic model from equation (6): ΔT_{it} and $\Delta \sum_{j=t-1}^{t-5} T_{ij}$. To account for the presence of five lags of federal intergovernmental grants in our endogenous regressors, I instrument using current and five lagged values for each of our chosen instruments, for a total of 12 excluded instruments for two endogenous regressors. After accounting for the various lags of data, our sample period for the IV estimation is the twelve-year period from 1999 through 2010 ($n = 600$).

[14]Data for both instruments is available at web.mit.edu/17.251/www/data_page.html.

For instrument relevance we require a significant correlation with current and past federal grants to state i. For validity, we require that these instruments be uncorrelated with unobservable determinants of state tax revenue (beyond state- and year-fixed effects, current and past federal grants, and state population and personal income), captured by ϵ_{it} in our estimating equation. While both instruments satisfy the usual criteria for relevance (as demonstrated below), there remain unresolved questions about validity. For example, we cannot rule out the possibility of reverse causality in which appointments to key congressional committees is determined by the level of federal aid received by states rather than the reverse. Similarly, it may be the case that states receiving large federal grants also happen to have more long-standing members of Congress for reasons unrelated to federal grant policy. While we are able to partially establish instrument validity via the usual over-identification tests (as shown below) we cannot conclusively establish the validity of our instruments. As a result, I suggest caution in interpreting my IV estimates as representing the pure causal effect of federal intergovernmental grants on state taxes.

I follow a standard 2SLS estimation procedure. Our first-stage results are presented in Table 9. Both measures of state political strength appear to be reasonably strong predictors of current and past federal intergovernmental grants to states. While not all of the instruments achieve statistical significance, the joint F-statistics for the two first-stage estimations are $F = 73.06$ for predicted current grants and $F = 95.45$ for the sum of past grants—well beyond the usual first-stage rule of thumb of $F > 10$. I conclude that weak instruments are unlikely to present a serious problem.

Our second stage IV estimates are presented in Table 10. After instrumenting for changes in current and past federal grants, I find somewhat larger effects when compared to OLS. Our coefficient of interest is $\phi_2 = \alpha\beta$ in the second row of the table, which captures the persistent effect of past grants on current state tax revenue. For own-source revenue I find $\alpha\beta = 0.804$ and for state tax revenue I find $\alpha\beta = 0.494$, both of which are statistically significant at the

Table 9: First-Stage IV: Regression of Endogenous Variables (Current and Past Federal Grants) on Included and Excluded Instruments, 1995-2010

Variable	Δ Federal Grants at Time t	Δ Sum of Past Federal Grants
U.S. House Seniority (t)	6,782*	9,223
	(3,808)	(11,780)
U.S. House Seniority (t-1)	(2,997)	(12,293)
	(5,651)	(8,383)
U.S. House Seniority (t-2)	(7,711)	10,523***
	(7,050)	(3,851)
U.S. House Seniority (t-3)	3,854	(9,231)
	(4,893)	(8,658)
U.S. House Seniority (t-4)	(2,430)	(1,336)
	(5,209)	(5,733)
U.S. House Seniority (t-5)	7,043	(2,737)
	(7,865)	(6,145)
House Appropriations Committee (t)	38,035	58,365
	(52,504)	(123,256)
House Appropriations Committee (t-1)	(139,058)	(1,647)
	(85,555)	(45,947)
House Appropriations Committee (t-2)	150,500**	17,491
	(70,269)	(76,204)
House Appropriations Committee (t-3)	(97,825)	(78,730)
	(84,500)	(81,874)
House Appropriations Committee (t-4)	172,856	120,475
	(125,720)	(101,122)
House Appropriations Committee (t-5)	(135,621)	769
	(77,872)	(68,365)
n	550	550
Adjusted R-squared	0.542	0.802
F-Statistic (First Stage)	73.06	95.45

*, **, and *** denote statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Note: All specifications include state and year fixed effects, as well as controls for state population and real Personal Income. Heteroskedasticity-robust standard errors are reported in parentheses, which have been clustered by state.

0.05 and 0.10 levels, respectively. As a test of instrument validity I perform the usual Sargan procedure as a test of over-identifying restrictions. The test fails to reject in our regression for state own-source revenue ($p = 0.399$) but rejects in the case of state tax revenue ($p = 0.008$), raising some question about the validity of our instruments in the case of state tax revenue. However, in the case of state own-source revenue in column (1) the instruments appear to be both relevant and valid.

Table 10: Second-Stage IV: Regression of State Tax and Own-Source Revenue on Federal Grant, Instrumenting for Current Grants and the Sum of Past Grants, 1995-2010

Variable	(1) State Own-Source Revenue	(2) State Total Tax Revenue
Δ Federal Grants at Time t ($\phi_1 = \alpha - 1$)	0.002	-0.006
	(0.519)	(0.312)
Δ Sum of Past Federal Grants ($\phi_2 = \alpha\beta$)	0.804**	0.494*
	(0.401)	(0.275)
Δ State Personal Income	0.060**	0.073***
	(0.024)	(0.018)
Δ State Population	-0.349	-0.515
	(1.412)	(0.762)
n	550	550
Adjusted R-squared	0.344	0.427
Sargan's Statistic (Instrument Validity)	12.595	26.785
Critical Value	21.03	21.03
P Value	0.399	0.008

*, **, and *** denote statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Note: All specifications include state and year fixed effects. Heteroskedasticity-robust standard errors are reported in parentheses, which have been clustered by state.

For comparison, Table 11 presents OLS estimates for the comparable sample period of 1999 through 2010. At least in the case of state own-source revenue, our IV results appear to reaffirm the basic findings from our OLS estimates: federal intergovernmental grants appear

to have persistent long-term effects on state tax revenues, even after accounting for the possible endogeneity of federal intergovernmental grants to states.

Table 11: OLS Results for Comparison with IV Estimates: Regression of State Tax and Own-Source Revenue on Federal Grants, 1995-2010

Variable	(1) State Own-Source Revenue	(2) State Total Tax Revenue
Δ Federal Grants at Time t ($\phi_1 = \alpha - 1$)	-0.339***	-0.228***
	(0.121)	(0.082)
Δ Sum of Past Federal Grants ($\phi_2 = \alpha\beta$)	0.246***	0.217*
	(0.090)	(0.121)
Δ State Personal Income	0.086***	0.085***
	(0.019)	(0.017)
Δ State Population	0.182	-0.204
	(0.759)	(0.604)
n	550	550
Adjusted R-squared	0.451	0.462

*, **, and *** denote statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Note: All specifications include state and year fixed effects. Heteroskedasticity-robust standard errors are reported in parentheses, which have been clustered by state.

6 Conclusion

Based on a simple extension of the median voter model and a 30-year panel of U.S. federal grants and state tax revenue, I find evidence that federal intergovernmental grants have a persistent effect on state budgets. Temporary grant-financed expenditures at the state level appear to persist in local budgets long after grants have expired, placing additional demands on local revenue sources to sustain them. I find empirical evidence of this phenomenon both in OLS and IV estimates. While these findings are suggestive, an important but unresolved question is the precise theoretical mechanism behind this apparent budgetary persistence of federal intergovernmental aid—an issue I reserve for future research.

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