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Vertical Grants and Local Public Efficiency: The Inference-disturbing Effect of Fiscal Equalization

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Abstract

The existing empirical literature on the impact of vertical grants on local public-sector efficiency yields mixed results. Given the fact that vertical financial equalization systems often reduce differences in fiscal capacity, we argue that empirical studies based on cross-sectional data may yield a positive relationship between grants and efficiency of public service production even when the underlying causal effect is not. We provide a simple illustrative theoretical model to show the logic of our argument and illustrate its relevance by an empirical case study for the German state of Saxony-Anhalt. We show that our main argument of an inference-disturbing

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effect applies to those existing studies that are more optimistic about the impact of vertical grants. Finally, we argue that it may disturb the inference drawn from studies in a number of other countries where vertical grants—intended or not—concentrate in fiscally weak municipalities.

Keywords
vertical grants, local public finance, efficiency, DEA, bureaucracy

Vertical grants are an integral part of fiscal relations in federalist countries (e.g., Boadway and Shah 2009). Following Silkman and Young (1982), a number of studies analyzed their impact on the efficiency of local public service production. Kalb (2010) finds negative effects on cost efficiency caused by the German local government fiscal equalization grants (for the German state of Baden-Württemberg). Balaguer-Coll, Prior, and Tortosa-Ausina (2007) and Balguer-Coll and Prior (2009) report a significantly negative effect of current grants from higher levels of government on the technical efficiency of Spanish (Valencian) municipalities. The same holds for De Borger and Kerstens (1996) and the cost efficiency effect of general-purpose grants on Belgian municipalities. Loikkanen and Susiluoto (2005) find (at least for some years) a negative impact of state block grants on technical efficiency in Finland. In contrast, according to Worthington (2000), the general-purpose grants to the Australian local governments have no effect. Grossman, Panagiotis, and Wassmer (1999) analyze US central cities and find no effect of state grants and a positive effect of federal grants on the technical (output-)efficiency. Finally, Geys and Moesen (2009) report a significantly positive impact on cost efficiency for Flemish municipalities.

In this article, we argue that this mixed evidence may result from the fact that the studies differ in the degree to which they control for an important inference-disturbing factor. The starting point of our argument is the fact that vertical grants in many countries are designed to reduce the differences in fiscal capacity between municipalities. If a grant scheme discriminates in favor of municipalities with below-average fiscal capacity but preserves the initial ordering in fiscal capacities among municipalities, high per capita grants coincide with low fiscal capacity even after fiscal equalization and thus less leeway for slack and inefficiency. Thus, municipalities that receive high per capita grants face—on average—stricter fiscal constraints and thus are (forced to be) technically more efficient. This does not imply any causal

relationship between high vertical grants and high levels of efficiency. Instead, a third variable—the municipality's fiscal capacity before grants—drives both the amount of per capita grants and the fiscal capacity after grants and thereby the degree of efficiency.

In this article, we show that this effect is highly relevant. In the second section, we present a simple model to illustrate the role of grants and income for public-sector efficiency. Based on our model, we show how fiscal equalization systems that reduce fiscal stress influence the correlation between vertical grants and efficiency and how cross-sectional studies that do not control for the inference-disturbing effect of the vertical grants system may lead to the wrong conclusions regarding the causal impact of vertical grants on efficiency. A closer look at the existing empirical studies in the third section shows that all studies controlling for the inference-disturbing effect find a negative relationship between grants and efficiency, whereas some studies that do not include such controls find a neutral or positive effect. In the fourth section, we present a case study of the German state of Saxony-Anhalt using an input-oriented nonparametric efficiency analysis (Data Envelope Analysis [DEA]) and the two-stage bootstrap approach suggested by Simar and Wilson (2007). The case study shows that including or omitting a variable to control for the inference-disturbing effect of fiscal equalization fundamentally changes the outcome of the regression model. Without this control, the regression results point at a positive relationship between vertical grants and efficiency. Once an appropriate control variable is included, however, a positive relationship is no longer supported. The fifth section shows that the main argument of this article is likely to be relevant in a number of different countries throughout the world. The sixth section concludes.

Vertical Grants, Efficiency, and Fiscal Equalization—Theoretical Considerations

A Simple Model of Local Service Production, Vertical Grants, and Efficiency

We build on the standard theory of bureaucracy (e.g., Wintrobe 1997) and present a very simple model to depict the relationship between vertical grants and local public-sector efficiency to show how fiscal equalization shapes this relationship (see also Kalb 2010). Consider a certain municipality M with N inhabitants situated in a federalist country with two layers of government—a federal and a municipal level. We assume that the federal

level does not produce any services but merely collects taxes and provides municipalities with vertical grants. We also assume that the overall amount of federal revenues is fixed, but the government decides how to distribute these funds among municipalities. The citizens in municipality M derive utility from the amount of private goods (x) they consume and the amount Q of nonrival public services provided locally.

Public services are produced by the local authorities. The bureaucrat heading the local public authorities sets the price p_Q at which his bureau provides local public services. Local authorities are controlled by the so-called sponsor who represents the local population's interest and negotiates the budget and the amount of public services with the bureau head. The bureaucrat knows the sponsor's preferences and the minimum costs, while the sponsor does not know the latter (e.g., Wintrobe 1997; Kalb 2010). We assume that the sponsor is equivalent to the median voter in municipality M. Given the prize p_Q and the tax schedule that determines the share of p_Q that he has to bear, the local median voter chooses the amount of local public services Q that maximizes his utility. Before local bureaucrats and sponsors make their choices, the federal government decides about the grant-distribution scheme. This specifies the amount of grants G that municipality M receives. The local bureaucrat and the local median voter take the federal government's decisions as given. Hereafter, we drop the specification "local" when referring to the local median voter and bureaucrat and their activities. Given his informational advantage, the bureaucrat can solve the game by backward induction. He anticipates the median voter's reaction to the price p_Q and chooses the price that maximizes his own utility.

The median voter takes the price p_Q as given and votes for the amount of local public services that maximize his utility subject to his budget restriction:

$$y + \sigma^{\text{med}} G = p_x x + \sigma^{\text{med}} p_Q Q. \tag{1}$$

Here, y stands for the median voter's income (net of federal taxes) and σ^{med} denotes the share of the total supply price that the median voter has to bear either through higher taxes or foregone transfers. For reasons of simplicity, we assume σ^{med} to be invariant in p_Q or G.

We assume a very simple linear function for the median voter's demand for public services:

$$Q_{\text{med}} = \frac{a(y + \sigma^{\text{med}} \cdot G) - \sigma^{\text{med}} p_Q}{b}. \tag{2}$$

An increase in available funds—be it from vertical grants or by income—increases the median voter's willingness to pay for public services (i.e., $\partial a/\partial y > 0$ and $\partial a/\partial G > 0$).

Like Migué and Bélanger (1974) and Kalb (2010), we assume that the minimal costs of producing a certain amount of Q are given by:

$$C(Q) = cQ + dQ^2, \qquad c > 0, d \geq 0 \tag{3}$$

The fiscal residual (FR) is the difference between the budget claimed by the bureaucrat in exchange for a certain amount of Q and the minimum costs required to produce this amount:

$$\mathrm{FR} = p_Q Q - C(Q). \tag{4}$$

We follow Migué and Bélanger (1974) and Kalb (2010) and assume that the bureaucrat is interested in both FR and the budget size. His utility function is given by:

$$U^B = Q^{\alpha} FR^{1-\alpha}, \qquad 0 < \alpha < 1 \tag{5}$$

Anticipating the median voter's reaction[1] to the supply price p_Q, the bureaucrat chooses the supply price p_Q that maximizes his utility. In equilibrium, the amount of public services reads:

$$Q^* = \begin{cases} \dfrac{\dfrac{a(y + \sigma^{\mathrm{med}} \cdot G)}{\sigma^{\mathrm{med}}} - c}{(2-\alpha)\left(\dfrac{b}{\sigma^{\mathrm{med}}} + d\right)} & \text{if } \dfrac{a(y + \sigma^{\mathrm{med}} \cdot G)}{\sigma^{\mathrm{med}}} > c \\ 0 & \text{else} \end{cases}. \tag{6}$$

If municipal expenditures in equilibrium are lower than the grant municipality M received (i.e., $p_Q Q < G; p_Q Q < G$), every voter receives a transfer from the local government. For the median voter, this amounts to $\sigma^{\mathrm{med}}(G - p_Q Q)$. If $p_Q Q > G$, every voter has to pay local taxes. The median voter has to pay local taxes amounting to a total of $\sigma^{\mathrm{med}}(p_Q Q - G)$.

The Impact of Vertical Grants on the Efficiency of Local Public Service Production

Now, we return to the main question of this article: how do vertical grants influence the efficiency of local public service production? We use the ratio

of FR and quantity of public services in equilibrium (FR*/Q*) as a measure of relative inefficiency. The higher FR*/Q*, the more resources are wasted per unit output. We ask whether vertical grants raise or reduce this ratio. In all cases where $Q^* > 0$, differentiating this ratio with respect to G yields

$$\frac{\partial(\mathrm{FR}^*/Q^*)}{\partial G} = \left[\frac{\partial a}{\partial G} + \frac{\partial a}{\partial y}\frac{\partial y}{\partial G}\right]\frac{1}{\sigma^{\mathrm{med}}}\left[1 - \frac{1}{2-\alpha}\right]. \tag{7}$$

The first bracket captures the net effect of a change in resources controlled by the median voter. If the government raises the grants to municipality M at the expense of the grants given to other municipalities, $\partial y/\partial G = 0$, and thus equations (7) becomes positive. Reducing the federal tax burden for municipality M without reducing G has the same impact and so does an exogenous increase in income y. In other words, the relative efficiency depends on the amount of resources commanded by the median voter. Relative efficiency decreases as the median voter's budget constraint is relaxed. As the median voter's budget constraint is relaxed, the bureaucrat increases the FR, while the increase in output Q^* is only moderate. As a result, the ratio FR*/Q* increases in G. The effect is stronger the lower the share σ^{med} the median voter contributes to local taxes and receives from transfers and the smaller α, that is, the more emphasis the bureaucrat places on the FR.[2] If we ignore discretionary decisions in favor of municipality M, the net effect of grants on relative efficiency depends on the change in income y accompanying the change in grants G. In a world with identical municipalities and nondiscriminating federal governments, $\partial y/\partial G = -1$ and vertical grants have no impact on relative efficiency.

Vertical Grants as Part of a Fiscal Equalization System

In reality, municipalities differ in fiscal capacity or average income of their citizens. To reduce these differences, many upper-tier governments use vertical grants that discriminate between municipalities (e.g., Boadway and Shah 2009). This produces an important regularity: the higher the amount of vertical grants per capita $g_i = G_i/N_i$ municipality i receives, the lower the private and public means per capita in this municipality. In real-life situations, the means comprise the private income (net of national or other local taxes) as well as the tax base of local business taxes, land taxes, and so on. Hereafter, we will refer to the sum of these means as own resources. In our simple model, these own resources are captured by the median voter's income y. Using the broader concept of own resources (hereafter y'), the regularity produced by fiscal equalization systems can be phrased as

follows: there is a negative correlation between the grants per capita g_i municipality i receives and the own resources per capita (y_i') available to the representative (median) voter before grants in this municipality (i.e.,$\rho(g_i, y_i') < 0$). Hence, we expect that for most pairs i, j the following relationship holds:

$$g_i > g_j \quad \text{if} \quad y_i' < y_j'. \tag{8}$$

This regularity—if combined with the essential result of our analysis—has important implications for cross-sectional studies analyzing the impact of vertical grants on efficiency: if the correlation is negative (i.e. $\rho(g_i, y_i' + g_i) < 0$),[3] municipalities that receive high per capita grants are still—on average—financially weaker than municipalities receiving lower per capita grants. If the degree of inefficiency as expressed in (FR_i/Q_i) increases in the funds under the command of the median voter, we continue to observe $\rho(g_i, FR_i/Q_i) < 0$ even though the additional funds the median voter gets to command are actually causing an increase in (FR_i/Q_i).

The Effect of Fiscal Equalization Systems in the Present Context

As—according to our model—both income and vertical grants have a negative effect on efficiency, financially weak municipalities are more efficient than financially strong municipalities. Thus, the direct correlations between the degree of inefficiency (FR^*/Q^*) and the amount of grants received per capita observed in cross-sectional studies will be negative and point at an efficiency-enhancing effect of vertical grants. In other words, the fiscal equalization system may have an inference-disturbing effect for studies that test for the impact of vertical grants on efficiency using cross-sectional data only. This argument holds even if panel data from more than one time period are used. When the strength of the inference-disturbing effect of the fiscal equalization system increases, the correlation $\rho(g_i, y_i' + g_i)$ becomes stronger in absolute terms.

The inference-disturbing effect continues to exist in cases where minimum standards regarding the quantity of public services ($Q_{\min}$) are in place. To see why, consider two municipalities a and b for which $Q^* > Q_{\min}$. If $y_a > y_b$ and $g_a < g_b$, while the initial order in income is not disturbed (i.e. $y_a + g_a > y_b + g_b$), the median voter's willingness to pay for $Q_{\min}$ is higher in municipality a. Thus, we observe a negative relationship between the degree of inefficiency ($FR_i/Q_{\min}$) and the amount of vertical grants even though the underlying causal effect is positive.

Reassessment of Existing Empirical Studies

According to our model, the correct way to control for the inference-disturbing effect in empirical studies is to control for the amount of own resources commanded by the median voter. In particular, it is necessary to control for the local tax base that can be taxed to fund public expenditures. Table 1 provides a systematic overview of the existing studies on the relationship between vertical grants and efficiency. The table also reports some background characteristics and the methods used. The studies are mostly using cross-sectional data from a certain region or state. They cover different regions with different schemes of vertical grant allocation. While it is difficult to provide precise estimates regarding the correlation between grants and own resources, we can roughly differentiate between countries where equalizing grants play an important role (e.g., Germany) and those countries where they are of minor importance (e.g., Spain, United States). Table 1 clearly shows that not all studies contain control variables that capture the own resources commanded by the median voter (y_i'). In particular, only few studies control for difference in the tax base that the median voter can rely on when funding public services. Balaguer-Coll, Prior, and Tortosa-Ausina (2007), Balaguer-Coll and Prior (2009), and Grossman, Panagiotis, and Wassmer (1999) do control for the tax revenues. As the tax rate is often set endogenously, controlling for the tax base is an imperfect measure when it comes to our main argument. This is why we put them in parentheses. While those studies with proper controls for own resources always arrive at a negative impact of vertical grants on efficiency, this is not the case for studies with imperfect controls. This raises the concern that the results from the former studies are biased by the inference-disturbing effect described above.

A Case Study of Saxony-Anhalt

In this section, we report on an empirical study to learn more about the inference-disturbing effect. We use data from the German state Saxony-Anhalt. In Saxony-Anhalt, formula-based vertical grants account for a substantial share of the municipal budget. The vast majority of municipalities heavily rely on these formula-based grants. The intrastate distribution of these unconditional block grants is intended to reduce fiscal shortage in municipalities with limited own revenues. At the same time, it largely preserves the initial ordering in fiscal capacity. The amount of grants an individual municipality receives is exogenous to the grant-receiving

Table 1. Previous Literature on the Impact of Vertical Grants on Public Service Efficiency.

	Effect of grants on efficiency	Effect of own resources on efficiency	Period covered	Nobs	Country	Fiscal equalization system	Proxy for own resources included	Grants measured	First-stage method	Second-stage method
Worthington (2000)	No		1993	177	Australia	No	no	(Grants/total revenue)	DEA/SFA	Tobit regression
Grossman, Panagiotis and Wassmer (1999)	Contradictory	(Negative)	1967 to 1982	169	United States	Yes, less effective	(Tax revenues)	Grants/total expenditures	SFA	—
Kalb (2010)	Negative	Negative	1990 to 2004	3,675	Germany	Yes	Abundant municipality dummy	Grants/ population	SFA	—
Balaguer-Coll, Prior, and Tortosa-Ausina (2007)	Negative	(Negative)	1995	414	Spain	Yes, less effective	(Tax revenue and own revenue)	Grants/ population	DEA/FDH	Nonparametric smoothing
Balaguer-Coll and Prior (2009)	Negative	(Negative)	1992 to 1995	1,032	Spain	Yes, less effective	(Tax revenue)	Grants/ population	DEA	Tobit
De Borger and Kerstens (1996)	Negative	(Negative)			Belgium	Yes	Income	Grants absolute value	DEA/SFA	Tobit/OLS
Loikkanen and Susiluoto (2005)	Negative		1994 to 2002	353	Finland	Yes	No		DEA	OLS
Geys and Moesen (2009)	Positive		2000	300	Belgium	Yes	No	Grants/total revenue	SFA	—

Source: Authors' compilation.

Note: Sorted chronologically depending on the effect of grants on technical/cost efficiency—Grossman is not assessable because different country settings are involved. DEA = Data Envelope Analysis; SFA = Stochastic Frontier Analysis; FDH = Free Disposable Hull.

municipality. Technically, the correlation between own resources per capita and grants per capita $\rho(g_i, y_i')$ is strongly negative and the correlation between grants and available means including grants $\rho(g_i, y_i' + g_i)$ is also strictly negative (Haug 2013). Thus, Saxony-Anhalt is a highly suitable laboratory for our purposes.

We provide a direct test for the presence of the inference-disturbing effect using a proxy variable for the own resources available. Our case study shows that introducing a suitable control variable changes the coefficient estimator for the impact of grants on efficiency fundamentally. Without a suitable control variable, the regressions point at a positive relationship between grants and efficiency. Once the control variable is introduced, however, the same data set and the same empirical approach suggests that the relationship is neutral or even negative.

Institutional Background

The East German state of Saxony-Anhalt (population = 2.25 million, area = 20.452 km^2) comprises independent cities (*kreisfreie Stadt*) and counties (*Landkreise*). Each *Landkreis* consists of a number of county-affiliated municipalities that could be either independent municipalities providing all municipal services on their own or cooperating municipalities that are members of municipal associations. The county-affiliated municipalities are responsible for a wide range of tasks. Next to overhead cost items such as central administration or auxiliary service units, the most important expenditure items are day care facilities for children (about 25 percent of current expenditures), administration of civil engineering, street cleaning and maintenance, public order and fire protection, primary schools (only buildings and nonteaching staff), water provision, and sewage disposal, but also public green, cemeteries, and sports or leisure facilities. Less than 20 percent of the current budget is spent on nonmandatory tasks (Haug 2013). Their main sources of revenues are taxes (property tax, local business tax, shares in the federal income tax, and VAT) and grants (mostly general-purpose formula-based current grants and investment grants). Nearly 40 percent of their current expenditures are covered by grants (Haug 2013).

The fiscal equalization system uses the largest share of its grants to reduce the fiscal gap. The fiscal gap in municipality i is defined to be the positive difference between municipality i's standardized fiscal need FN_i and its fiscal capacity FC_i. Municipalities with $FN_i - FC_i \leq 0$ ("abundant municipalities") do not receive formula-based grants (*Schlüsselzuweisungen*). These formula-based grants dominate the total amount of vertical grants

and made up for 36 percent of all municipal revenues in 2004 on average (for details, see Haug 2013).

The vast majority of municipalities in Saxony-Anhalt suffered from fiscal stress and 97 percent of them received unconditional formula-based grants. In 2004, the fiscal equalization system of Saxony-Anhalt used a fill-up rate of 70 percent. Thus, a certain degree of fiscal shortage remains even after key grants have been distributed. The fiscal need is calculated by multiplying a standardized base amount for all municipalities with the sum of the "weighted" inhabitants $W(i)$ (weights per capita increase with total population of the municipality):

$$\mathrm{FC}_i = \sum_{r=1}^{R} \mathrm{TB}_i^r \cdot \bar{t}^r \tag{9}$$

Here, TB_i^r represents the tax base of local tax r ($r = 1, 2, \ldots, R$) in municipality i. For every local tax r, this tax base is multiplied by the same tax rate for all municipalities $\bar{t}^r$. Summing across all R local taxes yields a standardized measure for the fiscal capacity for municipalities operating with different local tax rates. The tax bases TB_i^r and hence the fiscal capacity in municipality i are positively correlated with the average or median income in this municipality. Given that the fill-up rate is less than 100 percent, higher grants per capita coincide with lower overall funds before and after fiscal equalization on average, that is, $\rho(g_i, y_i) < 0$ and $\rho(g_i, y_i + g_i) < 0$. This holds for the relationship between abundant and nonabundant municipalities as well as for the relationship between municipalities within these categories (for details, see Haug 2013).

For 2004, the correlation between unconditional formula-based grants per capita (overall grants for current expenditures per capita) and total municipal tax revenues is -0.65 (-0.51).[4] This implies that the correlation between grants per capita and total means per capita $\rho(g_i, y_i' + g_i) < 0$ is negative even in case that municipal tax revenues and per capita household income on the municipal level should be uncorrelated.[5] Thus, Saxony-Anhalt is a highly suitable laboratory for our purposes.

Empirical Implementation

Our empirical analysis involves two steps. In step 1, we apply the concept of the input distance function (Shephard 1970). This function describes the ratio between the actual input quantity to the technically achievable minimum input quantity for a given output quantity. The fiscal residuum can be

easily interpreted in terms of relative efficiency: If we assume identical and exogenous factor prices as well as constant and identical factor intensities for all municipalities, then the cost embody a "composite input" valued in monetary units. Hence, the (minimum) cost function $C(Q)$ represents the (minimum) input requirement function for any given output quantity, and the fiscal residuum is the excess input quantity over the minimum input requirement. Assuming identical "portfolios" of public services in all municipalities, Q is a composite bundle of public outputs. The input distance function for the one-input–one-output case thus reads

$$\delta(C, Q^*) = \frac{C_{\text{act}}(Q^*)}{C_{\min}(Q^*)} = \frac{C_{\min}(Q^*) + \text{FR}(Q^*)}{C_{\min}(Q^*)} = 1 + \frac{\text{FR}(Q^*)/Q^*}{C_{\min}(Q^*)/Q^*} \geq 1 \tag{10}$$

with C_{act} as the actual spending and $C_{\min}$ as the minimum cost.

In the multi-input–multi-output case, we have to allow for varying input and output mixes. In this case, we have to analyze the radial distance at which decision-making units are located to the production frontier. The fiscal residuum of each municipality can be interpreted as the vector of the excess physical units of all actual input quantities $\mathbf{x}$ (for the input-oriented case) that could be saved without having to reduce output ($\mathbf{y}$) if the municipality was to produce efficiently. Thus, the FR can be described as follows:

$$\text{FR}(y) = \left(1 - \delta^{-1}(\mathbf{x}, \mathbf{y})\right)\mathbf{x} \text{ or } \mathbf{x} - \mathbf{x}^*(\mathbf{y}) = \left(1 - \delta^{-1}(\mathbf{x}, \mathbf{y})\right)\mathbf{x} \tag{11}$$

Here, $\mathbf{x}^*$ represents the vector of minimum input requirement given the production technology and the output $\mathbf{y}$. For each input x_i, the input distance function can be written as:

$$\delta = \frac{x_i}{x_i^*(\mathbf{x}_{j \neq i}, \mathbf{y})} \tag{12}$$

To estimate the unknown municipal production frontier empirically and measure relative efficiency δ_i for each municipality, we chose a nonparametric approach, the DEA model suggested by Banker, Charnes, and Cooper (1984) for step 1. Given these DEA measures, we proceed with step 2 and analyze the impact of vertical grants on relative efficiency. We use the two-stage approach suggested by Simar and Wilson (2007) especially because of its similarity to standard regression analysis. Essentially, it consists of a truncated regression of the input distance measures with a vector of environmental variables $\mathbf{z}$. The method involves a bootstrap procedure that takes sampling variability into account and remedies the severe

problems of unmodified two-stage approaches (e.g., serial correlation of the dependent variables, general upward bias of nonparametric efficiency measures; Bogetoft and Otto [2011, 156–57]).[6]

One important assumption of two-stage nonparametric approaches is that neither grants nor the other chosen environmental variables alter the production technology. In other words, the environmental variables are neither a substitute for regular inputs nor undesired outputs that need additional inputs. They merely change the incentives of the bureaucrats because of the induced changes in their power to skim the fiscal residuum. Consequently, the expected overall effect of grants on the DEA measure δ depends on the effect of an increase in grants allocated to the median voter on Q^* and its effect on the relation of average fiscal residuum to average cost.

From equations (6) and (7), we can see that Q^* as well as $FR(Q^*)/Q^*$ rise with increasing grants. The total effect in equations (10) then depends on the production technology: for constant or increasing returns to scale, relative inefficiency δ increases and only in case of decreasing returns to scale a decrease in δ is possible if and only if the grant-induced increase in $FR(Q^*)/Q^*$ is lower than the increase in average cost $C(Q^*)/Q^*$. Hence, for most cases we expect that δ is higher the higher the (per capita) grants the municipality receives.

Data on Inputs, Outputs, and Environmental Variables

Using the method described above, we assess the efficiency of municipal associations and independent municipalities that provide the whole bundle of public goods and services on their own. Below, we use the generic term municipal units when referring to independent municipalities and/or municipal associations. We use data for the year 2004—the last year before a fundamental local government reform in Saxony-Anhalt. Earlier years cannot be analyzed due to limits in the availability of essential variables. This leaves us with 203 observations for 2004: 46 independent municipalities and 157 municipal associations (see Haug 2013).

Information on the physical inputs employed by the municipalities is not available (e.g., Kalb 2010; Kalb, Geys, and Heinemann 2012), and we use costs to approximate physical inputs. We construct three categories of input costs: labor costs, capital costs, and costs for resources and intermediate inputs. Labor costs comprise of the expenditures for staff. We use the aggregate real investment since 1995 as a proxy for the capital stock and

hence as a proxy for the unobservable total capital costs.[7] Resources and intermediate inputs consist of all other current expenditures.[8]

The chosen output proxies correspond to the municipalities' tasks and are very similar to those used in other studies (e.g., Geys and Moesen 2009; Kalb 2010). As the day care facilities for children are the most important expenditure block in Saxony-Anhalt, we use the number of approved places in childcare centers as output measure.[9] Similarly, the students in elementary school are used as a proxy for municipal tasks related to schools. Other important municipal tasks include maintenance and cleaning of public green, cemeteries, sport and recreation facilities, and municipal streets. Their (potential) outputs are approximated by the municipality's recreational and traffic area. The output for some services like public safety, economic development, or business-related infrastructure cannot be measured properly or adequate data have not been published. Here, we follow the literature (e.g., De Borger and Kerstens 1996; Geys, Heinemann, and Kalb 2010) and assume that these outputs are correlated with the size of the population (public consumption goods) and the number of employees subject to social security contribution (public inputs). Finally, a number of service categories like sewage disposal and water or energy supply are excluded entirely because these services are frequently outsourced to municipal enterprises outside the core budget and thus corresponding output as well as input measures are not available.

Regarding the central variable—vertical grants—the existing studies use two different measures to capture the impact of grants: grant dependency, measured as percentage of formula-based grants of the municipality's total adjusted current revenue, and (formula-based) grants per capita. In the context of our article, grant dependency is less suitable because it combines the effect of grants (in the numerator) with the effect of own resources (part of the denominator)—two effects that must be separated. Therefore, grants per capita is our main indicator.

The inference-disturbing effect is evoked by the fact that the formula-based grants a municipality receives are higher the lower its fiscal capacity (see The Impact of Vertical Grants on the Efficiency of Local Public Service Production and Institution Background subsections). To eliminate the inference disturbing effect and isolate the effect of vertical grants on efficiency, we need to control for the fiscal capacity. The fiscal capacity variable we use is calculated according to equation (9) including the standardized (net) revenues of the local business tax (trade tax) and the property tax as well as the municipality's shares in the national income tax and the national value added tax (normalized by population size). We use

standardized rather than actual revenues from local taxes for two reasons. First, they correspond directly to the own resources as defined in the second section because these own resources represent the potential that can be used to fund public service provision. Second, they avoid a possible endogeneity problem resulting from the fact that expenditures and local tax rates are likely to be determined simultaneously.

Furthermore, we introduce a number of control variables commonly used in previous studies (see Table 2 for descriptive statistics). First, we include a proxy for the average income per capita (y_i). It is defined as the per capita difference between the aggregate gross income and the income tax paid in 2004 according to the German wage tax and income tax statistic. Higher-income (which usually correlates with higher education) households might demand more efficient public service production (Knack 2002) but could also abuse their knowledge for distributive purposes and hence enhance inefficient spending. Debt per capita is used to capture municipalities' fiscal stress that forces a municipality to produce more efficiently. At the same time, it accounts for the inefficiencies of the past resulting from fiscal illusion (Oates 1988). Additionally, we introduce some demographic characteristics: population density and its square as explanatory variables because densely populated municipalities might benefit from "economies of density." On the other hand, higher population density might increase "wear and tear" of public infrastructure and hence induce additional expenditures, for example, on municipal road cleaning and maintenance. We also account for the impact of overall population decline using the relative population change between 1995 and 2004 because municipalities confronted with severe population decline might suffer from cost hysteresis in public service production. The share of senior citizens older than sixty-five is used to account for the impact of the age composition on democratic control and composition of public services. A higher share of old people might, on the one hand, save costs for certain youth-specific services (childcare facilities, schools). On the other hand, it might also indicate the increasing inability of the inhabitants to control the bureaucrats effectively. The unemployment rate is used as an indicator for the demand for welfare and social services. Finally, we introduce a dummy variable for municipal associations and include the number of member municipalities. The need to negotiate and compromise between multiple partners might reduce bureaucrats' rents. However, according to the theory of dispersed ownership (e.g., Sørensen 2007), incentives for free riding on monitoring and control activities might also increase in municipal associations.

Table 2. Descriptive Statistics Saxony-Anhalt 2004.

Variable	Mean	Standard deviation	Minimum	Maximum
Inputs				
Labor (in €)	2,894,448	2,894,205	460,538	17,700,000
Capital (in €): interest and rent expenditures	428,926	502,415	48	3,222,858
Capital (in 1,000 €): aggregated real investment expenditures 1995 to 2004	34,370	24720.86	4,185	147,400
Resources and intermediate inputs (in €)	2,212,260	2,430,012	347,249	17,800,000
Outputs				
Population	9,615.13	7,833.50	2,229.00	45,737.00
Approved childcare places	443.08	340.29	102.00	2,046.00
Children in elementary school	235.81	194.76	0	1,179.00
Traffic and recreational area (hectare)	465.15	219.86	67.00	1,191.00
Employees subject to social security contribution (at place of work)	2,508.83	3,169.39	213.00	17,918.00
Environmental variables				
Grants as share of total adjusted current income	0.31	0.09	0	0.48
Grants per capita (in €)	246.7	53.98	0	315.8
Fiscal capacity per capita (in €)	369.1	473.5	162.6	5,145.0
Net private income per capita (in €)	7,233	983.0011	5,188	11,760
Debt per capita (in €)	942.90	657.11	24.14	4,041.48
Municipal association	0.7734	0.4197	0	1
Number of member municipalities in municipal associations	5.49	4.00	1.00	22.00
Population density	141.90	169.63	21.16	1,216.41
Share of senior citizens	0.20	0.02	0.13	0.27
Relative population change 1995 to 2004	−0.04516	0.1029	−0.3527	0.5530
Unemployment rate (unemployed divided by population between fifteen and sixty-four)	0.10	0.02	0.01	0.15

Source: Authors' calculations.
Note: $N = 203$.

Results

In step 1 of our analysis,[10] we calculate the bias-corrected relative (global) input efficiency measures. They correspond to the estimated value for the relative efficiency δ_i of each municipality (see equations (12)). The median value for our baseline model (model grant per capita [GPC]-1, see Table 3) is given by 1.11 (mean = 1.16). This means that the median municipal unit could reduce its inputs by 11.1 percent while keeping output constant. The vast majority of municipalities operate at a nearly scale-efficient level (median value of relative scale efficiency = 1.02). Only some larger municipalities (over 20,000 inhabitants) operate under decreasing returns to scale.

In step 2, we use the bias-corrected technical efficiency scores to evaluate the impact of environmental variables on municipal efficiency (see Table 3) by a truncated regression analysis. In the baseline model (table 3, model GPC-1), we include all control variables described above together with grants per capita but we do not control for fiscal capacity. As predicted, we observe a significantly negative coefficient for grants per capita. The same result emerges if we redo the analysis but restrict our sample to municipalities with less than 20,000 inhabitants (model GPC-2) to reduce heterogeneity in municipal tasks and returns to scale. In sum, these results clearly suggest that grants have a positively significant effect on efficiency. However, the picture changes substantially if we control for the municipalities' fiscal capacity (GPC)-1A and GPC-2A. The coefficients for the grant variable lose their significance and become positive in all models while fiscal capacity produces the expected positive sign.

The results remain stable if we introduce the interaction between grants per capita and fiscal capacity to account for a possible moderating effect of the two (model GPC-1B and GPC-2B). It is significantly negative (only for the restricted sample) but negligible in size. Comparing the log-likelihood values shows that models including fiscal capacity should be preferred. In the last three columns of table 3, we reestimate the baseline model using grant dependency instead of grants per capita (model grant dependency [GD]-1), introduce fiscal capacity (GD-1A), and the interaction between grant dependency and fiscal capacity (GD-1B). Grant dependency alone yields a negatively significant coefficient in model GD but seizes to be significant in model GD-1B, though not in model GD-1A.

This pattern clearly supports our main argument: a positive empirical relationship between grants and efficiency cannot be taken as empirical evidence for a positive causal effect of vertical grants on efficiency if the regressions do not account for the inference-disturbing effect of the fiscal

Table 3. Results of the Second-stage Truncated Regression.

	Coefficients								
Variable	GPC-1	GPC-1A	GPC-1B	GPC-2	GPC-2A	GPC-2B	GD-1	GD-1A	GD-1B
Grant dependency	–	–	–	–	–		−0.8228***	−0.42961**	−0.18847
Grants per capita	−0.00075**	0.00018	0.00035	−0.00091***	0.00035	0.00075*	–	–	–
Fiscal capacity p.c.	–	0.00023***	0.00027***	–	0.00029***	0.00039***	–	0.00015***	0.00017***
Grant dep.*fiscal cap. p.c.	–	–	–	–	–	–	–	–	−0.00201***
Grants p.c.*fiscal cap. p.c.	–	–	0.00000	–	–	0.00000***	–	–	–
net private income p.c.	0.00003	0.00004	0.00004	0.00003	0.00004	0.00005	0.00003	0.00003	0.00004
Dummy municipal association	−0.0596	0.00418	0.00656	−0.08511	−0.02191	−0.01724	−0.03877	−0.00315	0.00663
Number of municipalities	0.0025	−0.00113	−0.00122	0.00146	−0.00189	−0.00176	0.00216	0.00063	0.00125
Population density	−0.00159***	−0.00173***	−0.00168***	−0.00206***	−0.00073	−0.00022	−0.00165***	−0.00173***	−0.00149***
Population density squared	0.00000***	0.00000***	0.00000***	0.00000	−0.00001**	−0.00001***	0.00000***	0.00000***	0.00000***
Share of senior citizens	2.73577***	1.20397	1.06613	2.97976**	1.54804	1.21075	3.08281***	1.93213*	1.67261
Debt per capita	0.00008***	0.00009***	0.00009***	0.00009***	0.00009***	0.00009***	0.00006***	0.00008***	0.00007***
Unemployment rate	2.41074	2.5076**	2.40487	2.49477*	2.9176**	2.555*	2.79836**	2.68774**	2.24136**
Relative pop. change	0.39437	−0.2528	−0.31328	0.53364**	−0.04262	−0.17962	0.38311*	−0.03521	−0.18593
Constant	0.38127	0.26772	0.25687	0.44493	0.07197	0.05374	0.33142	0.36013	0.47421
Observ.	202	202	202	180	180	180	202	202	202
LogL	206.036	215.613	216.112	175.389	195.046	196.667	214.062	217.692	222.205
Descriptive statistics bias-corrected efficiency score									
Mean	1.16	1.159	1.159	1.167	1.159	1.159	1.158	1.158	1.157
Median	1.112	1.113	1.113	1.116	1.113	1.112	1.11	1.111	1.109
IQR	0.145	0.149	0.147	0.155	0.161	0.157	0.148	0.15	0.148
Min	1.037	1.033	1.033	1.038	1.011	1.008	1.032	1.031	1.033
Max	1.787	1.786	1.786	1.787	1.783	1.783	1.786	1.785	1.785

Source: Authors' calculations.

Note: The reported significance levels are based on the percentile confidence intervals. The capital proxy used in the first stage for all models are the aggregated real investments. A negative sign of the coefficient indicates a reduction of the relative distance to the estimated production frontier, that is, an efficiency improvement.

GD = Grant dependency; GPC = Grant per capita; IQR = Interquantile range; OLS = Ordinary least squares.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

equalization system. Without this control, the coefficient estimator for the grant variable is likely to be driven by the fact that both depend on the own resources that the median voter commands (i.e., his own income, means from local business taxes, land taxes, etc.). Once we introduce the fiscal capacity to account for the inference-disturbing effect, the negatively significant coefficients disappear.

Relevance for Other Countries

The findings above are far from unique. A second case study on the West German state of Lower Saxony (7.93 million inhabitants, 47,614 km^2) yields qualitatively identical results. Given the limited space, we do not report the results here. Together with the results of Kalb (2010), the results for Saxony-Anhalt and Lower Saxony suggest that our main argument applies to the empirical studies on vertical grants and efficiency in Germany.

Similarly, it is likely to apply to a number of countries, particularly, to those countries whose fiscal transfer systems between national or subnational governments and local governments show the following characteristics: first, there must be either a system of general-purpose grants that explicitly aims at income equalization or at least the grant system must result in a negative correlation between the sum of all current (noninvestment)—general purpose or earmarked—grants received on the one hand and the tax revenues at the municipal level on the other (equalization condition). Second, the fiscal equalization system must only reduce the dispersion of municipal income while preserving—at least on average—the fiscal ranking, that is, overcompensation of "poor" municipalities must be avoided (rank-preserving condition).

The Equalization Condition

There are a number of countries in which vertical grants are explicitly designed to favor fiscally weak municipalities. These include Austria (e.g., Bröthaler, Bauer, and Schönbäck 2006), Poland (e.g., Uryszek and Ponterlitschek 2008), Israel (e.g., Brender 2003), Belgium (e.g., Geys and Revelli 2009), and the unitary Nordic states (e.g., Moisio 2002; Ministry of Finance and Swedish Association of Local Authorities and Regions 2008; Borge 2013). These countries fulfill the equalization condition unless the degree to which other grants concentrate in fiscally strong municipalities neutralizes the redistribution in favor of fiscally weak municipalities. While

this is not entirely impossible, the fact that equalizing grants play a prominent role in these countries suggests that these countries fulfill the equalization condition.

This is less obvious for countries like Spain (e.g., Solé-Ollé 2010) or Croatia (e.g., Glaurdic and Vukovic 2017) where grants that explicitly favor fiscally weak municipalities only play a minor role. It is also less clear for Australia. On the one hand, the Australian municipal grant system (e.g., New South Wales [NSW] Local Government Grants Commission, several years) with their expenditure allowance and revenue allowance seem to be similar to the Scandinavian systems. The latter are calculated by multiplying the number of properties in a municipality with the average NSW property tax rate and with the difference between the average NSW property value and the municipality's average property value. Consequently, municipalities with low property values that are usually correlated with low household incomes and low tax revenues are "brought up to the average," whereas municipalities with above-average property values with usually higher household incomes and tax revenues receive negative allowances (NSW Local Government Grants Commission, several years). On the other hand, the link between grants and fiscal capacity is less direct.

The Rank-preserving Condition

In the unitary Nordic states, the vertical grant systems are suspected to have a distinct tendency to overcompensation (especially in Finland). While a systematic reversal in ranking seems unlikely, the rank-preserving condition is likely to be violated at least in parts. The same may apply to Spain where the allocation formula of the most important municipal general-purpose grant (*Participación en los Tributos del Estado*) is dominated by population weights (75 percent) that rise much more progressively than in the German system. Hence, the grants are most likely concentrated in urban areas with high tax capacities (Solé-Ollé 2010).

In sum, there are a number of countries where our main argument is likely to apply. In these countries, studies on the impact of vertical grants on local sector efficiency can only deliver meaningful results if they account for the essential characteristics of the vertical grant system. The same holds for studies on the impact of transnational programs like the European Union (EU) cohesion policy on public-sector efficiency because it concentrates EU funds in poor and fiscally weak regions.

Conclusion

Our article contributes to the literature on vertical grants and their impact on public-sector efficiency. Its main argument is the following: cross-sectional studies on this issue are in danger of reaching false conclusions if they do not account for the inference-disturbing effect caused by the fact that vertical grants are often part of a fiscal equalization scheme that favors fiscally weak municipalities. Specifically, they may find a seemingly efficiency-increasing effect of vertical grants even though the underlying causal effect is negative or neutral.

We illustrate the main argument using a stylized theoretical model before we show its empirical relevance. First, we show that all existing studies that contain adequate controls for the impact of own resources and fiscal equalization arrive at a negative effect, while some of those that do not contain adequate controls reach a more positive conclusion. Second, we provide a case study for the German state of Saxony-Anhalt. Those regressions that do not account for these factors suggest that grants increase efficiency. Once we control for municipalities' fiscal capacity, however, our results hint at a neutral or even negative impact of vertical grants on efficiency. Thus, studies that use data from countries with grants that favor fiscally weak municipalities but do not control for own resources are in danger of arriving at false conclusions.

Our analysis has implications that go beyond the question of how to design studies on the relationship between vertical grants and public-sector efficiency. First, our results suggest that the optimistic view regarding the impact of vertical grants on local public-sector efficiency lacks empirical backing. Instead, the relationship is likely to be negative or at best neutral. It is important to note that this result is likely to apply to countries where vertical grants do not discriminate in favor of fiscally weak municipalities. Yet, empirical studies on these countries are less likely to arrive at wrong conclusions if they do not account for the characteristics of the vertical grant system. Second, one side result of our study is noteworthy. We find consistently negative coefficients of fiscal capacity in our case studies and so do the existing studies that include a proxy for own resources (see table 1). Kalb (2010) argues that this results from an increase in quality of services in economically strong municipalities. The stylized theoretical model we put forth suggests that increased inefficiencies in poor regions may result from the fact that vertical grants widen the public administration's leeway to extract rents.

Finally, our reassessment of the existing literature and our case study support the notion that there is an efficiency–equity trade-off of fiscal

equalization systems (e.g., Widmer and Zweifel 2012). This may aggravate the problems that fiscally weak municipalities face when trying to catch up with the more prosperous ones. On the other hand, Baskaran et al. (2016) show that tight monitoring by the grant-distributing government can restrict opportunistic government behavior at the local level. A disciplining effect is also found in Norway where the public media coverage of municipalities being under central governments' surveillance reduces the reelection probability of the incumbent (Hopland 2014). Thus, combining vertical grants with closer monitoring may be a way to resolve the efficiency–equity trade-off of fiscal equalization systems in federal states. Such considerations are of particular relevance for the EU and its regional policy where substantial amounts of grants are concentrated in poor European region and the information asymmetry is particularly large.

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Supplemental Material

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Notes

1. The amount $Q^{\text{opt}} = \left(a(y + \sigma^{\text{med}}G)/\sigma^{\text{med}} - c\right)/(b/\sigma^{\text{med}} + 2d)$ maximizes the median voter's utility.
2. The same result emerges if the bureaucrat can claim the full consumers' surplus from public service production.
3. Note that we can expect that $|\rho(g_i, y_i)| > |\rho(g_i, y_i + g_i)|$. Otherwise, the grants would fail to achieve their main goal: equalizing the municipal revenues to some extent while preserving the municipalities' relative position.

4. In contrast to the current grants hardly, any correlation can be found between the investment grants and the local tax revenues per capita (Spearman rank correlation [rsp] −0.07).
5. For 2004, we find a strong positive correlation (Spearman rsp +0.84) between the disposable household income per inhabitant and the total municipal tax revenues per capita at the level of the counties and independent cities in Germany (438 observations). As household income data are not available for municipalities, we use the net income (per capita) according to the income tax statistic 2004: aggregate income tax base minus aggregate income tax paid. The positive correlation between the municipal fiscal capacity per capita and this proxy is fairly weak for Saxony-Anhalt (Spearman rsp +0.1883742).
6. We carefully considered the application of other approaches, especially conditional robust frontier approaches (Cazals, Florens, and Simar 2002; Daraio and Simar 2005). Despite of their theoretical attractiveness (reduced outlier sensitivity, no implicit separability assumption), however, there are several severe practical problems involved with these methods (e.g., order m), especially for small- and medium-sized samples: Apart from the difficulties of integrating binary and categorical variables and the rather cumbersome interpretation of the effects of z, the conditional efficiency scores tend to indicate "efficiency by default" with increasing number of environmental variables. This approach is applicable only to univariate or at most bivariate z, which is—to our knowledge—standard practice in the efficiency literature. However, focusing on one or at most two variables at the time might causes severe omitted variable problems. And omitted variable problems are precisely what we are trying to avoid because the "wrong" sign of the transfer payment variables is supposed to result from omitting the tax variables in the second-stage regression. For further details, see the Online Supplementary Material provided.
7. The results for the models using interest/rent expenditures as capital proxy are qualitatively similar.
8. A few exceptions are made: expenditures for financial management and expenditures recorded for bookkeeping purposes like internal offsets are excluded. Finally, expenditures are corrected for double cost counting that mainly results from the aggregation of the budgets of the member municipalities and their municipal association (see Statistical Office of Saxony-Anhalt 2009).
9. These numbers are available at the municipal level only for 2006. The aggregated statistics at county level show that the number of available/approved places has increased somewhat over the period 2002 to 2006 and also afterward (Statistical Office Saxony-Anhalt 2010).
10. All steps of the estimation were programmed in R code (R version 3.1.2) including some components of the package Benchmarking by Peter Bogetoft

and Lars Otto, the package truncreg written by Yves Croissant, and the package truncnorm by Trautmann, H., Steuer, D., Mersmann, O., and Bornkamp, B. The R file is available on request from the authors.

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