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Vertical Grants and Local Public Efficiency

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Vertical Grants and Local Public Efficiency

Abstract

This paper analyses the impact of vertical grants on local public sector efficiency. First, we develop a theoretical model in which the bureaucrat sets the tax price while voters choose the quantity of public services. In this model, grants reduce efficiency if voters do not misinterpret the amount of vertical grants the local bureaucrats receive. If voters suffer from fiscal illusion, i.e. overestimate the amount of grants, our model yields an ambiguous effect of grants on efficiency. Second, we use the model to launch a note of caution concerning the inference that can be drawn from the existing cross-sectional studies in this field: Taking into account vertical financial equalization systems that reduce differences in fiscal capacity, empirical studies based on cross-sectional data may yield a positive relationship between grants and efficiency even when the underlying causal effect is negative. Third, we perform an empirical analysis for the German state of Saxony-Anhalt, which has implemented such a fiscal equalization system. We find a positive relationship between grants and efficiency. Our analysis shows that a careful reassessment of existing empirical evidence with regard to this issue seems necessary.

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

JEL Classification: H11, H72

Vertikale Zuweisungen und kommunale Effizienz

Zusammenfassung

Dieser Beitrag untersucht den Einfluss vertikaler Zuweisungen (d.h. Zuweisungen einer übergeordneten Gebietskörperschaft an eine nachgeordnete Gebietskörperschaft) auf die Effizienz des kommunalen Sektors. Erstens wird ein theoretisches Modell entwickelt, in dem die Bürokraten den Steuerpreis festsetzen, während die Wähler über die gewünschte Menge der öffentlichen Leistungen entscheiden. In diesem Modellrahmen bewirken Zuweisungen eine Effizienzverringern, solange die Wähler die Höhe der vertikalen Zuweisungen, die die Bürokraten erhalten haben, nicht falsch einschätzen. Falls die Wähler unter Fiskalillusion leiden sollten, d.h. die Höhe der erhaltenen Zuweisungen überschätzen, liefert das Modell keine eindeutigen Ergebnisse bezüglich der Effizienzwirkungen von Zuweisungen mehr. Zweitens werden die Modellergebnisse herangezogen, um zur Vorsicht bei Rückschlüssen aus den vorliegenden Querschnittsanalysen zu diesem Bereich zu mahnen: Bei vertikalen Finanzausgleichssystemen zum Ausgleich von Finanzkraftunterschieden können empirische Untersuchungen auf der Basis von Querschnittsdaten einen positiven Zusammenhang zwischen Effizienz und Zuweisungen nahelegen, selbst wenn der zugrundeliegende Kausalzusammenhang negativ ist. Drittens wird eine empirische Analyse für das Bundesland Sachsen-Anhalt durchgeführt, das ein entsprechendes System des kommunalen Finanzausgleichs praktiziert. Die Ergebnisse deuten auf einen positiven Zusammenhang zwischen Zuweisungen und kommunaler Effizienz hin. Die Analyse zeigt daher, dass eine vorsichtige Neubewertung der vorliegenden empirischen Ergebnisse zu diesem Thema notwendig scheint.

Schlagwörter: vertikale Zuweisungen, Kommunalfinzen, Effizienz, DEA, Bürokratie

JEL-Klassifikation: H11, H72

1. Introduction

Since the beginning of the economic analysis of federalism, the effects of vertical grants have been a main subject (e. g. Oates 1972, LeGrand 1975, Bradbury et al. 1984). The early literature focussed on their effect on the amount of public goods and services and found the well-known “flypaper effect” (e. g. Hines and Thaler 1995 for an overview). Following Silkman and Young (1982), a number of studies have emphasized the impact of vertical grants on the efficiency of local public service production. Most papers are empirical contributions that do not provide theoretical models to derive their central hypothesis. Kalb (2010) is an exception in this respect. He adapts the model on fiscal illusion and bureaucratic power by Moesen and van Cauwenberge (2000) and shows that vertical grants reduce local efficiency.

The existing empirical studies on global local government efficiency find only limited support for this hypothesis. Kalb (2010) finds negative effects on cost efficiency caused by the German local government fiscal equalization grants in Germany (Baden-Württemberg). Balaguer-Coll et al. (2007) and Balaguer-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 goes for Vanden Eeckaut et. al. (1993) and De Borger and Kerstens (1996) and the cost efficiency effect of general purpose grants on Belgian municipalities. Loikkanen and Susiluoto (2005) find 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 on efficiency. Grossmann et al. (1999) analyse U.S. central cities and find no effect of state grants or federal grants on the technical efficiency. Finally, Geys and Moesen (2009) report a significantly positive impact for Flemish municipalities. While the results are inconclusive at first sight, there seems to be an interesting regularity: Studies using per capita grants as explanatory variables find a negative impact of grants on efficiency, whereas studies that use grant dependence – i.e. the ratio of grants to overall revenues – find that grants are either insignificant or even efficiency-enhancing.

Our paper contributes to the literature on vertical grants and local public sector efficiency in three ways. First, we provide an alternative model to analyse the interaction of voters and their local public administration and the impact of vertical grants on efficiency. Unlike Kalb (2010), our model suggests that grants reduce efficiency if fiscal illusion is not present. If, however, voters misperceive the amount of vertical grants, the effect will be undetermined. Depending on the parameter values, grants can be either efficiency-enhancing or efficiency-reducing.

Second, we use this model for a critical assessment of the empirical evidence on the impact of vertical grants on efficiency. We argue that it is necessary to account for the fact that vertical grants in many countries are designed to reduce the differences in fiscal ca-

capacity between municipalities. If a grant scheme discriminates in favor of financially weak municipalities 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. Consequently, we conclude that municipalities that receive high per capita grants face – on average – stricter fiscal constraints and thus are (forced to be) technically more efficient. This hypothesis 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. This hypothesis provides a possible explanation for the empirical regularity according to which efficiency correlates negatively with grants per capita while a neutral or even positive relationship is found for grant-dependency. On the other hand, it means that a positive relationship between vertical grants and efficiency cannot be interpreted as evidence in favour of an efficiency-enhancing effect of grants.

Our third contribution is an empirical test of the aforementioned hypothesis. For this purpose, we use municipal-level data from the German state Saxony-Anhalt in 2004. Saxony-Anhalt is excellent for our purpose because of the predominant role of formula-based vertical grants – so-called “Schlüsselzuweisungen”. These unconditional block grants are intended to reduce fiscal shortage in municipalities with limited own revenues. At the same time, they largely preserve the initial ordering in fiscal capacity. Their size is exogenous to the grant-receiving municipality. To estimate the effect of grants per capita and grant dependency on technical efficiency, we perform an input-oriented non-parametric efficiency analysis (DEA) and test for the impact of several environmental variables on efficiency scores using the bootstrap approach suggested by Simar and Wilson (2007). Unlike previous studies, we also include a dummy variable for the different forms of organizing public service provision on the local level. Our sample includes independent municipalities and municipal associations. We hypothesize that these institutional settings differ in the effectiveness with which citizens can control their local authorities. Our results show that global municipal efficiency rises in the degree of grant dependence and vertical grants per capita. We also find municipal associations to be more efficient than independent municipalities.

The paper proceeds as follows. In section 2, we develop our model and analyse the role of grants for public service production and efficiency. Section 3 uses the model to show how fiscal equalization systems that aim at reducing fiscal stress limit the possibility to use cross-sectional data to test for the impact of vertical grants on efficiency. The empirical part of our paper starts with section 4. This section describes the institutional background in Saxony-Anhalt, outlines the estimation method, and summarizes the data underlying our empirical analysis. The results are presented in section 5 and discussed in section 6. Section 7 concludes.

2. A model of local service production, vertical grants and efficiency

The seminal piece on the theory of bureaucracy of Niskanen (1971) provides the starting point for many papers that analyse local public service production. In this model, public services are provided by the local authorities headed by the chief bureaucrat. His utility is assumed to depend on the amount of the public services his bureau provides and the fiscal residual – i.e. the difference between his budget and the minimum costs necessary to produce the demanded amount of public services. The so-called sponsor represents the local population's interest and negotiates the budget and the amount of public services with the chief bureaucrat. The bureaucrat knows the sponsor's preferences and the minimum costs while the sponsor does not know the latter (for a review, see e. g. Moe 1997, Wintrobe 1997, Mueller 2004, chapter 16).

Kalb (2010) uses a model of bureaucracy to assess the impact of vertical grants on the efficiency of local public service production. He follows Niskanen (1971) in assuming an extremely strong position for the bureaucrat: He can make a “take it or leave it”-offer dictating both the budget and the quantity of public services. Kalb (2010) builds on an argument by Moesen and van Cauwenberge (2000), according to which a soft budget constraint promotes fiscal illusion, that is it makes voters underestimate the tax price of public services. Applying this argument to local public sector production, he argues that vertical grants lead voters to underestimate the tax price of public services and thus accept higher amounts of public services and larger budgets than they would without grants. He assumes that the degree of underestimation increases in the amount of grants and shows that the amount of public services produced and the fiscal residual the bureaucrat claims increase in the amount of grants. The latter result leads Kalb (2010) to conclude that vertical grants reduce efficiency in local public service production.

In this paper, we develop an alternative model to analyse the impact of vertical grants on local public sector efficiency. Our model deviates from the one by Kalb (2010) in a number of aspects. Most importantly, we do not use a take-it-or-leave-it model in the tradition of Niskanen (1971). Instead, we follow Breton and Wintrobe (1975) and Bendor et al. (1985) who draw on the standard model of monopoly and assume that the bureaucrat uses his monopoly power to set the tax price while the sponsor chooses the quantity.¹ Consider a certain municipality M situated in a federalist country with two layers of government – a federal and a municipal level. For reasons of simplicity, we assume that the federal level does not produce public services but merely collects taxes

¹ The main difference between the models is the following: The bureaucrat claims the entire consumer's surplus in the take-it-or-leave-it model. In the price-setting model, voters receive some of the consumer's surplus and thus their welfare increases albeit by less than it could. Wyckhoff (1990) argues that the sponsor may reject the offer if he is not left with some positive reservation utility from public services. Even in this case, however, voters' welfare in the end does not depend on the amount of public services produced.

and provides municipalities with vertical grants. We also assume that the overall amount of federal revenues is fixed but the government can decide how to distribute these funds among municipalities. The citizens living in municipality M derive utility from the amount of private goods (x) they consume and from the amount Q of non-rival public services provided on the local level. The bureaucrat heading the local public authorities sets the tax price τ (per capita and unit) at which his bureau provides local public services. We assume that the sponsor is equivalent to the median voter in municipality M . Given the tax prize τ , the local median voter chooses the amount of local public services Q that maximizes his utility.

Figure 1:
Structure of the game

Stage	Activities
1	The local bureaucrat announces a tax price τ for the local public services.
2	The local median voter chooses the quantity Q that maximizes his utility.
3	Public services are produced and consumed. The local bureaucrat uses up the fiscal residual.

Source: Authors' compilation.

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 per capita. The local bureaucrat and the local median voter take the decisions made on the federal level as given. Hereafter, we drop the specification "local" when referring to the local median voter and bureaucrat and their activities. Figure 1 captures the sequential game in which these two agents interact and determine the public budget and the amount of public services. Given his informational advantage, the bureaucrat can solve the game by backward induction. He anticipates the median voter's reaction to the tax price τ and chooses the tax price that maximizes his own utility.

In stage 2, the median voter takes the tax prize τ as given and votes for the amount of local public services that maximize his utility. His optimization problem reads:

$$Q^v(\tau, g, \mathbf{m}) = \arg \max \{U^v(x, Q) : y + \phi g = p_x x + \tau Q\} \quad (1)$$

Here, y stands for the median voter's income (net of federal taxes), p_x is the price of private goods (hereafter normalized to 1), and g denotes the amount of vertical grants per capita that the local authorities receive from the federal level. From the perspective of the individual municipality M , the amount of grants g can vary at the expense of other municipalities. As the overall amount of federal revenues is fixed, variations in g do not influence the median voter's income y . The vector \mathbf{m} is a vector representing all other exogenous variables influencing the demand for Q . The parameter ϕ accounts for a pos-

sible grant illusion among voters, i.e. a systematic misperception of the amount of vertical grants (e. g. Mitias and Turnbull 2001).

We assume that the bureaucrat's utility function is given by

$$U^B = Q^\alpha FR^{1-\alpha}, \quad 0 < \alpha < 1 \quad (2)$$

Accounting for a possible grant illusion, the fiscal residual FR is given by

$$FR = (1 - \phi)g + \tau Q - C(Q) \quad (3)$$

The bureaucrat's maximization problem reads:

$$\tau^* = \arg \max \{U^B(FR, Q) : Q^v(\tau, g, \mathbf{m}); FR = (1 - \phi)g + \tau Q - C(Q)\} \quad (4)$$

Substituting the solution into the median voter's demand function for Q (see expression (1)) yields the corresponding amount of public services:

$$Q^* = Q^v(\tau^*, g, \mathbf{m}) \quad (5)$$

The resulting fiscal residual FR^* in equilibrium is given by

$$FR^* = (1 - \phi)g + \tau^* Q^* - C(Q^*) \quad (6)$$

Looking at expressions (1) and (6), we can see that grant illusion is a mixed blessing for the bureaucrat. To illustrate this, let us consider the two effects of parameter ϕ separately. First, grant illusion influences the marginal willingness to pay for public services. If $\phi = 1$, the median voter is correctly informed about the amount of grants the local authorities receives. If $\phi < 1$, the voter underestimates the amount of grants available. If private goods and public services are normal goods, this reduces the willingness to pay for both. In situations where $\phi > 1$, the median voter overestimates the amount of vertical grants and has an overly high willingness to pay for both private goods and public services.

Besides this effect on the median voter's willingness to pay (hereafter WTP-effect), grant illusion influences bureaucratic behaviour in a second way. We will call the corresponding effect unobserved-budget effect. To illustrate this effect, we must take a closer look at the relationship between the tax price τ , the vertical grants g , the degree of grant illusion and the budget that the bureaucrat receives. The median voter perceives to have resources that amount to $y + \phi g$. He is willing to spend $\tau^* Q^*$ on public services. If $\tau^* Q^* < \phi g$, the median voter expects a per capita transfer of $(\phi g - \tau^* Q^*)$ from the local government; if $\tau^* Q^* > \phi g$, the median voter is willing to pay per capita taxes amounting to $(\tau^* Q^* - \phi g)$. Thus, the municipal budget restriction as perceived by the median voter reads:

$$t + \phi g = \tau^* Q^* \quad (7)$$

Here, t stands for the net local taxes the median voter has to pay ($t > 0$) respectively the net transfer payment he receives ($t < 0$). His private consumption is thus given by $x = y - t$. Expression (7) nicely illustrates the fact that the median voter's willingness to pay local taxes decreases in the grant-illusion parameter ϕ . If $\phi < 1$, the bureaucrat receives public revenues of $(1-\phi)g$ for the use of which he is not accountable to the median voter because the latter does not observe them. The lower ϕ , the lower the transfers the median voter demands respectively the higher his willingness to pay local taxes, other things equal. If, on the other hand, $\phi > 1$, the median voter overestimates the amount of vertical grants and thus the first term in expression (6) becomes negative; in other words: the median voter holds the bureaucrat accountable for an amount of resources that exceeds the true amount of grants received. The higher ϕ , the higher the expected transfers respectively the lower the willingness to pay local taxes. In sum, the WTP-effect and the unobserved-budget effect work against each other and make grant-illusion a mixed blessing for the bureaucrat.

If $\phi > 1$, the median voter overestimates the degree to which the costs of local public service production can be covered by vertical grants. Thus, he underestimates the amount of taxes he has to pay in addition to the grants. Instead of $(\tau Q - g)$, he is willing to pay only $(\tau Q - \phi g)$. In case he expects transfers, he expects them to amount to $(\phi g - \tau Q)$ rather than $(g - \tau Q)$. The case where $\phi > 1$ therefore captures the essential feature of the fiscal illusion: the tax price voters have to pay *in addition* to the grants is underestimated.²

Having these preliminaries settled, we can return to the main question of the model: How do vertical grants influence the efficiency of local public service production? We use the ratio of fiscal residual and quantity of public services in equilibrium (FR^*/Q^*) and ask whether vertical grants raise or reduce this ratio. To answer this question, we need to specify the median voter's demand for public services $Q^v(\cdot)$. We follow the standard model proposed by Niskanen (1975) and assume the following utility function for the voters' utility:

$$U^v = x - \frac{(Q - \rho)^2}{2\nu} \quad (8)$$

Substituting a for ρ/ν and b for $1/\nu$ and solving for the quantity Q^v , we arrive at the following expression for the median voter's demand for public services (see expression (1)):

² *Moesen and van Cauwenberge* (2000) and *Kalb* (2010) argue that fiscal illusion implies that voters underestimate τ . This assumption is only consistent with a take-it-or-leave-it model of bureaucracy. It is, however, incompatible with the game structure proposed in figure 1 because here τ is explicitly and publicly announced.

$$Q^v = \frac{a - \tau}{b} \quad (9)$$

In this specification, the amount of grants has no impact on the median voter's willingness to pay for public services. Thus, an increase in vertical grants increases only the consumption of private goods unless they cause a) the bureaucrat to offer a different tax price τ , or b) change the perceived tax price $\tau(g)$ due to fiscal illusion. We assume that private goods and public services are normal goods. Thus, an increase in available funds must have a directly positive effect on the median voter's willingness to pay for public services. We account for this by assuming parameter a to be a positive function of the perceived budget ($y + \phi g$) and thus vertical grants ($\partial a / \partial g > 0$).³ This specification implies that, depending on ϕ , income and grants have a different impact on the demand for public services (i.e. $\partial a / \partial g = \phi \partial a / \partial y$). If $\phi > 1$, the WTP-effect causes an additional unit of grants to have a larger impact than an additional unit of income – other things equal. This regularity is responsible for a possible flypaper effect.⁴

Finally, we follow the standard models in the literature by assuming a quadratic cost function:

$$C(Q) = cQ + dQ^2, \quad c, d > 0 \quad (10)$$

The amount of public services that maximizes the median voter's utility is then given by

$$Q^{opt} = \frac{a - c}{b + 2d} \quad (11)$$

The bureaucrat will propose a tax price that leads to the following amount of public services in equilibrium:

$$Q^* = \begin{cases} \frac{a - c + \sqrt{(a - c)^2 + 4\alpha(2 - \alpha)(b + d)g(1 - \phi)}}{2(2 - \alpha)(b + d)} & \text{if } a > c \\ 0 & \text{else} \end{cases} \quad (12)$$

Without grant illusion (i.e. if $\phi = 1$), this simplifies to:

³ Note that expression (9) implies the standard linear demand function $\tau = a - bQ^v$. For this demand function, an increase in income is usually modeled by an upward shift of the curve, i.e. a change in parameter a . This implies that the willingness to pay for any amount of public services increases in income.

⁴ A value of $\phi > 1$ does not automatically cause a flypaper-effect because the unobserved budget effect may offset the WTP-effect.

$$Q^*|_{\phi=1} = \begin{cases} \frac{a-c}{(2-\alpha)(b+d)} & \text{if } a > c \\ 0 & \text{else} \end{cases} \quad (13)$$

Hereafter, we focus on those cases where an interior solution exists (i.e. $Q^* > 0$).⁵ From expression (12), we can see how the two effects of grant-illusion influence the amount of public services in equilibrium. The WTP-effect causes parameter a to be higher the larger g and thus elevates Q^* . The unobserved-budget effect reduces the second term under the square root and thereby has a mitigating effect on Q^* . The net-effect is positive if $\partial a / \partial \phi > \alpha g / Q^*$.

The degree of inefficiency is given by FR^*/Q^* . If we assume that $\phi = 1$ and differentiate this ratio with respect to g , we get:

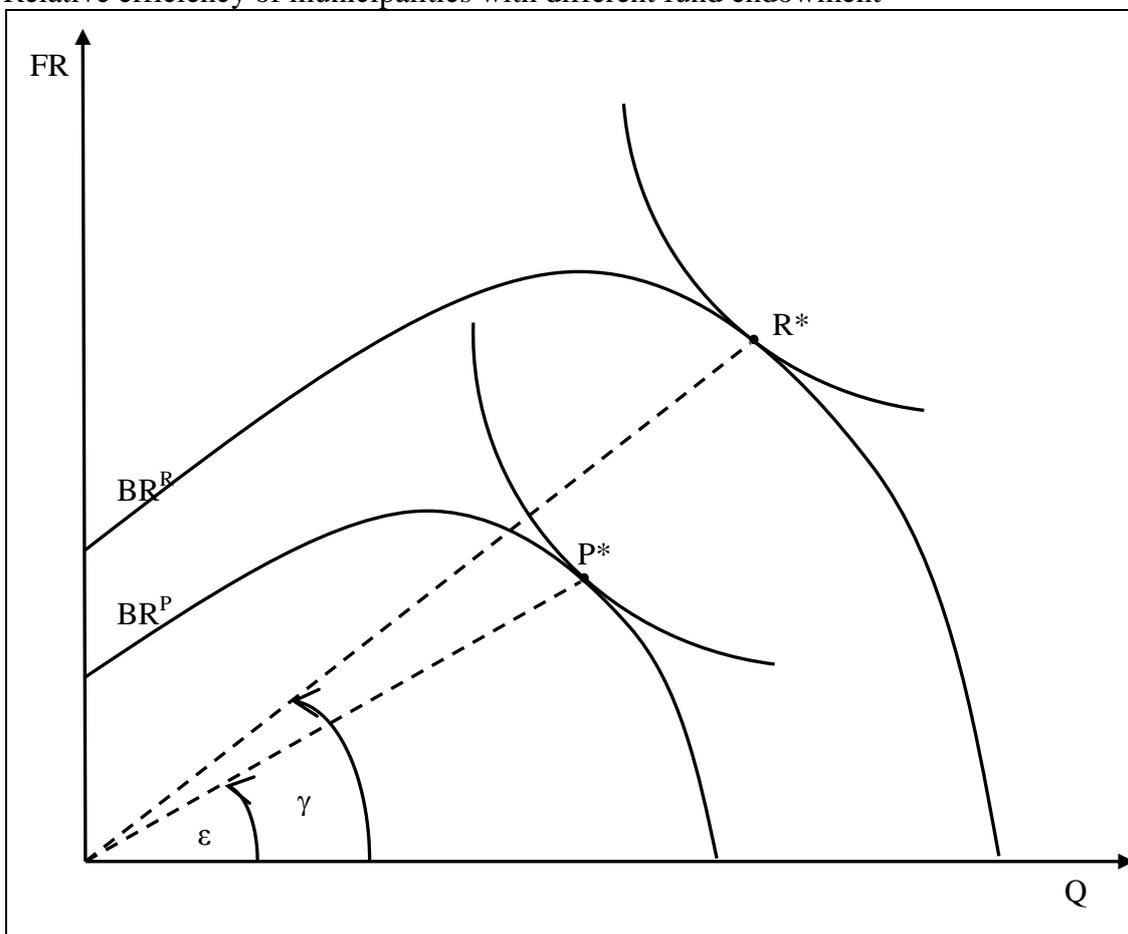
$$\frac{\partial (FR^*/Q^*)}{\partial g} = \frac{\partial a}{\partial g} \left[1 - \frac{1}{2-\alpha} \right] > 0 \quad (14)$$

Thus, we arrive at our first major result: Vertical grants reduce relative efficiency when voters are correctly informed about the amount of grants that local authorities receive.

This result is illustrated in figure 2 for two municipalities P and R whose citizens have the same income ($y_P = y_R$). For some reason municipality R receives more grants than municipality P so that $g_P + y_P < g_R + y_R$. As a consequence, the bureaucrat in P faces a stricter budget restriction (BR^P) than the bureaucrat in R whose budget restriction is given by BR^R . Point R* (P*) represents the combination of fiscal residual and quantity chosen by municipality R (P). The degree of inefficiency is given by the slope of the radius vector to point R* resp. P*. The results above imply a higher slope for municipality R than for municipality P ($\tan \gamma > \tan \varepsilon$).

⁵ An interior solution also implies that $(a-c)^2 > -4\alpha(2-\alpha)(b+d)g(1-\phi)$.

Figure 2:
Relative efficiency of municipalities with different fund endowment



Source: Authors' illustration.

If we account for grant illusion, the derivative becomes more complex:

$$\frac{\partial(FR^*/Q^*)}{\partial g} = \frac{(1-\phi)}{Q^*} [1-\alpha B] + \frac{\partial a}{\partial g} [1-B] \quad (15)$$

$$\text{with } B = \left(\frac{(1-\phi)}{Q^*} + (b+d)Q^* \right) / \sqrt{(a-c)^2 + 4\alpha(2-\alpha)(b+d)g(1-\phi)}$$

Due to the fact that several terms in this expression switch signs if ϕ passes the threshold of 1, it is not possible to derive a general answer to question whether this expression is positive or negative. A substantial number of cases have to be differentiated (see figure 3).

Figure 3:
The impact of vertical grants when $\phi \neq 1$: Cases to differentiate

		$sgn(\partial(FR^*/Q^*)/\partial g)$ if $\partial a/\partial g > 0$	Restrictions on $\partial a/\partial g$ so that $\partial(FR^*/Q^*)/\partial g > 0$
$\phi < 1$	$1-\alpha B > 0$	$1-B > 0$	positive $\partial a/\partial g > D_{crit}$ (here, $D_{crit} < 0$)
		$1-B = 0$	positive no limitations
		$1-B < 0$	undetermined $\partial a/\partial g < D_{crit}$ (here, $D_{crit} > 0$)
	$1-\alpha B = 0$	$1-B < 0$	negative $\partial a/\partial g > 0$
	$1-\alpha B < 0$	$1-B < 0$	negative $\partial a/\partial g < D_{crit}$ (here, $D_{crit} < 0$)
	$\phi > 1$	$1-\alpha B > 0$	$1-B > 0$
		$1-B = 0$	negative not possible
		$1-B < 0$	negative $\partial a/\partial g < D_{crit}$ (here, $D_{crit} < 0$)
$1-\alpha B = 0$		$1-B < 0$	negative $\partial a/\partial g > 0$
$1-\alpha B < 0$		$1-B < 0$	undetermined $\partial a/\partial g < D_{crit}$ (here, $D_{crit} > 0$)

Notes: as $\alpha < 1$, $(1-B) < 0$ if $(1-\alpha B) \leq 0$; with $D_{crit} = \frac{(\phi-1)}{Q^*} [1-\alpha B] / [1-B]$

Source: Authors' calculations

The last column of figure 3 informs us about the critical values that the derivative $\partial a/\partial g$ has to take on in order to yield a positive value for expression (15). The second column in figure 3 shows that it is not sufficient to assume $\partial a/\partial g > 0$. In the majority of cases, $\partial a/\partial g > 0$ implies that expression (15) is negative. This is true especially in case voters suffer from fiscal illusion ($\phi > 1$). Here, it never suffices to assume $\partial a/\partial g > 0$. In a substantial number of cases, an efficiency-reducing effect only occurs if public services are inferior goods (i.e. if $\partial a/\partial g < 0$). In other words, vertical grants are likely to have a positive effect on efficiency if voters suffer from fiscal illusion. On the other hand, an efficiency-reducing effect becomes more likely if voters underestimate the amount of grants (i.e. if $\phi < 1$). While there is no way to differentiate between parameter constellations that are empirically likely and constellations that are seldom or even impossible, we can nevertheless conclude that our model does not support the conclusion of Kalb's model. Grants do not have an efficiency-reducing effect. In fact, our model suggests that an efficiency-enhancing effect is more likely when voters fall victim of fiscal illusion (i.e. $\phi > 1$).

The rationale behind this result is the following: If the amount of grants increases by a certain amount Δg and $\phi > 1$, voters assume the influx to be larger by $\phi \Delta g$ than it really is. The bureaucrat is held accountable for additional funds he has never received. In case the WTP-effect of these additional funds is strong, the bureaucrat can raise the tax prize and produce more public services. At the same time, a high WTP-effect also implies a high value of overestimation in grants and makes voters demand more public services but reluctant to pay more taxes respectively accept a reduction in transfers (due to the unobserved-budget effect). Again, WTP-effect and unobserved-budget effect work against each other. An increase in grants increases the bureaucrat's utility but may lead him to sacrifice some of the fiscal residual per unit output.⁶

In sum, our model predicts that a negative effect of grants on efficiency can only be assumed if voters do not misperceive grants or tax prices. Once fiscal illusion is accounted for, our model does not predict an efficiency-reducing effect. On the contrary, it gives some indication that an efficiency-enhancing effect is likely.

⁶ This raises the question why bureaucrats cannot reduce ϕ to 1 by informing voters about the true amount of grants. The problem is the lack of demand for this information among voters. Informed voters can access this information easily by viewing publicly available budget information (nowadays via internet). The fact that fiscal and grant illusion are found to be wide-spread tells us that a substantial share of voters is not interested in this type of information. Thus, bureaucrats cannot expect to reach many voters with their informational campaigns. Instead, the level of fiscal illusion is exogenous to the bureaucrat.

3. Vertical grants as part of a fiscal equalization system and their impact on efficiency

In section 2, we assumed vertical grants to be unrelated to all other variables that determine the quantity of public services, the budget and the fiscal residual. This assumption helps to emphasize the isolated impact of an increase in grants on efficiency in a certain municipality M . This is why the theoretical considerations in many other studies use a similar *ceteris-paribus* assumption when deriving their central hypothesis. In their empirical analyses, these authors generally use cross-sectional data on municipalities within a certain country or state to test for the impact of vertical grants on efficiency. In this section, we will argue that this type of cross-sectional data may not provide an adequate basis for testing the *causal impact* of grants on efficiency. For reasons of simplicity, we assume in this section that the median voter does not fall victim of grant illusion. Our argument builds on the fact that supra-ordinate governments do not distribute vertical grants randomly among municipalities but follow formulae or legally defined procedures which discriminate deliberately between them. In many cases, vertical grants are part of a fiscal equalization system. Fiscal equalization systems account for vertical fiscal imbalances by distributing substantial amounts of funds on a per-capita basis. These transfers are intended to cover a normalized fiscal need of municipalities (e. g. Boadway and Shah 2009). Many fiscal equalization systems also account for horizontal fiscal imbalances and discriminate in favor of financially weak municipalities. These receive higher per capita grants than financially strong municipalities. In some countries, financially strong municipalities even have to contribute parts of their own revenues to the fiscal equalization system. Such procedures produce an important regularity: The amount of vertical grants per capita g_i municipality i receives is likely to be higher the lower the private and public means per capita in this municipality. In the context of the model in section 2, these means are closely related to the median voter's income y_i , albeit that in section 2 we did not differentiate between different sources of means that the median voter can use to buy private goods and public services. In real-life situations, the means comprise the individual's own income and the means that come from local business taxes, land taxes etc. Using this broader definition of y_i , 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 per capita means available to the representative (median) voter before grants in this municipality (i.e. $\rho(g_i, y_i) < 0$). This does not necessarily imply that lining up municipalities by grants per capita g_i yields an ordering that is the exact reverse of the ordering by income or means y_i . However, we expect that for most pairs i, j the following relationship holds:

$$g_i > g_j \quad \text{if} \quad y_i < y_j \tag{16}$$

The essential question now is: How are grants per capita and the amount of available means after grants correlated? If the correlation is negative (i.e. $\rho(g_i, y_i + g_i) < 0$), mu-

municipalities that receive high per capita grants are still – on average – financially weaker than municipalities receiving lower per capita grants and thus have a lower demand for public services. The model developed above implies that these financially weak municipalities will waste less resources per unit output (i.e. FR^*/Q^*). Again, figure 2 can be used to illustrate this relationship. In the context of the current section, municipality R is not richer than municipality P *because* it receives *more* grants per capita. Instead, R is richer *despite* the fact that it receives *less* grants. The budgetary restriction BR^R runs above BR^P because – even after grants have been concentrated in municipality P (i.e. $g_P > g_R$) – the overall funds are still larger in municipality R (i.e. $g_P + y_P < g_R + y_R$). Thus, municipality P is more efficient because the median voter in P has less overall means.

With respect to empirical tests for the impact of per capita grants on efficiency, we arrive at the following conclusion: It is misleading to draw inference on the causal relationship between vertical grants and efficiency by using cross-sectional data from federations that operate fiscal equalization systems which account for horizontal fiscal imbalances.⁷ The strength of the inference-disturbing effect of the fiscal equalization system is larger the more the correlation $\rho(g_i, y_i + g_i)$ approaches -1. It is important to note that this argumentation by no means implies that vertical grants are not efficiency-reducing. However, it shows that the relationship between vertical grants and efficiency as observed in cross-sectional studies does not necessarily inform us about the impact of vertical grants on technical efficiency in local public service production. A positive empirical relationship may emerge even if grants have a negative impact on efficiency. Similarly, insignificant coefficients may occur even if the underlying causal relationship is strongly negative. This note of caution applies despite the fact that the empirical studies used a number of control variables to account for inter-municipal heterogeneity because these variables do not neutralize the inference-disturbing effect described here.

A strictly negative correlation between grants and final amount of means $\rho(g_i, y_i + g_i)$ can be assumed for the typical system of vertical grants in Germany. This uses the largest share of its grants – in a formula-based fiscal equalization system – to reduce the fiscal gap. The fiscal gap FG_i in municipality i is defined to be the positive difference between municipality i 's fiscal need FN_i and its fiscal capacity FC_i .

$$FG_i = \min\{FN_i - FC_i, 0\} \quad (17)$$

Municipalities with $FG_i = 0$ (so-called abundant municipalities) do not receive formula-based grants (so-called “Schlüsselzuweisungen”). Formula-based grants fill up the fiscal gap in municipalities where $FG_i > 0$. Most fiscal equalization systems use a fill-up rate (“Ausgleichssatz”) of less than 100 percent (e. g. Lenk and Rudolph 2004). Thus, a certain degree of fiscal shortage remains even after key grants have been distributed. The fiscal need is calculated by assuming a fixed amount per capita and largely disregarding

⁷ The argument still holds if pooled panel data are used.

the specific situation of the municipality. The specific situation is considered when estimating fiscal capacity. The fiscal capacity is calculated as follows:

$$FC_i = \sum_{r=1}^R TB_i^r \cdot \bar{t}^r \quad (18)$$

Here, TB_i^r represents the tax base of local tax r ($r = 1, 2, \dots, R$) 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 up across all R local taxes yields a standardized measure for the fiscal capacity for municipalities operating with different local tax rates.

It seems reasonable to assume that the tax bases TB_i^r 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, i.e. $\rho(g_i, y_i + g_i) < 0$. This holds for the relationship between abundant and non-abundant municipalities as well as for the relationship between municipalities within these categories. Given these characteristics, it seems problematic to use data from German states to test for the impact of vertical grants on efficiency. In the empirical part of the paper starting in section 4, we illustrate this by using data from the East-German state Saxony-Anhalt. Saxony-Anhalt is especially suitable for this purpose because a) the vast majority of municipalities rely heavily on formula-based grants, and b) the correlation $\rho(g_i, y_i + g_i) < 0$ is strongly negative. Besides, the special organizational structure of local public service provision in Saxony-Anhalt allows for a nice additional test for the role of institutional arrangements on efficiency and the impact of grants.

4. Data and method

4.1. Data: Saxony-Anhalt in 2004

Saxony-Anhalt consists of more than 1,000 mostly small municipalities. Only few of them provide the whole bundle of public goods and services on their own. The overwhelming majority of municipalities are organized in so-called municipal associations. The single municipality is not free to decide whether to join a municipal association or remain independent. Instead, it has to follow different state regulations. According to § 10 (1) of the local government law of Saxony-Anhalt, municipalities with less than 8,000 inhabitants have to join a municipal association or can even be forced by the Ministry of the Interior (§ 76a) to join a certain association. The main purpose of municipal associations is to provide public goods and services to the citizens in their member municipalities. The members of a municipal association pool their resources in order to realize economies of scale without giving up their status as (legally, not necessarily fiscally or economically) autonomous municipalities. At the same time, the main political decisions with regard to the whole association are made by a council formed of the mayors of the member municipalities. Thus, although there is no directly elected council or mayor at the association level, there is a strongly institutionalized decision-making process. By forming a municipal association, the member municipalities give up a substantial part of their autonomy with respect to the amount of public services provided to their citizens and the decisions that determine the efficiency of public service production. Therefore, it is necessary to treat a municipal association as one single budget and production unit.

In the empirical analysis to follow, we assess the efficiency of municipal associations and those municipalities that provide the whole bundle of public goods and services on their own (hereafter independent municipalities). 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 local government reform that brought a fundamental change in the structure of local government entities and reduced the number of municipalities from 1118 to 218 in 2010. This leaves us with 203 observations for 2004: 46 independent municipalities and 157 municipal associations.

The fiscal equalization system in Saxony-Anhalt follows the general lines sketched in the previous section. The fill-up rate for the unconditional formula-based grants is 70 % and thus aims at reducing the fiscal stress in financially weak municipalities while leaving the initial ordering in municipalities intact. These formula-based grants dominate the total amount of vertical grants and make up for 36 percent of all municipal revenues in 2004 on average. The vast majority of municipalities in Saxony-Anhalt suffer from fis-

cal stress and 97% of them receive unconditional formula-based grants.⁸ The correlation between unconditional formula-based grants per capita (resp. overall grants for current expenditures per capita) and total municipal tax revenues is -0.65 (-0.51).⁹ This implies that the correlation between grants per capita and total means per capita $\rho(g_i, y_i + g_i)$ is negative even for the unlikely case that municipal tax revenues and per capita household income on the municipal level should be uncorrelated.¹⁰

As information on the physical amount of inputs employed by the municipalities is not available¹¹, we use costs to approximate physical inputs. Since all municipalities within Saxony-Anhalt are parties to the same collective wage agreement and have access to the same capital market, we assume that the unobserved input prices are the same for all municipalities in our data set. To approximate 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. The sum of interest payments and expenditures for rent and lease make up capital expenditures. Resources and intermediate inputs consist of all other current expenditures.¹²

The outputs correspond to the municipalities' tasks and are very similar to those used in other global municipal efficiency studies (e. g. Geys and Moesen 2009, Geys et al. 2007, Kalb 2010). A large expenditure block is social security with 87% of all funds being spent on childcare. Therefore we use the number of approved places in childcare centers as output measure.¹³ Similarly, the students in elementary school are used as a proxy for municipal tasks related to schools. Other municipal tasks are local public

⁸ For a detailed description of the fiscal equalization system and the situation of municipalities in Saxony-Anhalt, please refer to *Haug* (2013).

⁹ The coefficients are calculated using the method of Spearman. In contrast to the current grants hardly any correlation can be found between the investment grants and the local tax revenues per inhabitant (-0.07).

¹⁰ Due to the lack of adequate data the correlation between municipal tax revenues per capita and the average household income cannot be tested at the municipal level. However, for 2004 we find a strong positive correlation (Spearman rho +0.84) between these two variables at the level of the districts and district-free towns in Germany (438 observations).

¹¹ That physical input quantities as well as input prices are not available is a problem common to most studies analyzing global efficiency at the municipal level, e. g. *Kalb et al.* (2012), *Geys et al.* (2010), and *Kalb* (2010).

¹² A few exceptions are made to ensure that all expenditures included contribute to measurable municipal output. Expenditures for financial management (except interest payments) and expenditures recorded for book-keeping purposes like internal offsets are excluded. Finally, expenditures are corrected for double cost counting which mainly results from the aggregation of the budgets of the member municipalities and their municipal association. These aggregation and adjustment procedures are closely related to the calculation formula of the *Statistical Office of Saxony-Anhalt* (2009).

¹³ These numbers are available only for 2006. The statistics show that the number of available/approved places has increased somewhat over the period 2002 to 2006 and also afterwards. No information on the actual number of children in childcare centers is available before 2006 (*Statistical Office Saxony-Anhalt* 2010).

health, sport, and recreation facilities and municipal streets. These outputs are approximated with the recreational and traffic area. While these tasks and the corresponding outputs can be measured fairly well, a number of public consumption goods for private households and public inputs for the private enterprise sector cannot be measured properly (or adequate data has not been published). This problem arises for services like public safety, economic development or business-related infrastructure. Here, some rough proxies have to be used. Following the literature (e. g. De Borger und Kerstens 1996, Balaguer-Coll et al. 2007, Geys et al. 2010, Kalb 2010), we 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 and thus corresponding output measures are not available.

The main purpose of our empirical study is to identify municipal characteristics that are related to the municipalities' efficiency scores. In particular, we are interested in the relationship between efficiency scores and vertical grants. Inspired by the empirical regularity described in the introduction, we use two different measures to capture the impact of vertical grants: grant dependency, measured as percentage of total adjusted current income, and grants per capita. We also account for the impact of differences in the institutionalized decision making processes between independent municipalities and municipal associations. The Public Choice literature tells us that controlling the local bureaucracy (or government) is a municipal-wide public good (e. g. Besley and Case 1995). Thus, other things equal, democratic control by voters is more intensive in the 46 independent municipalities than in municipal associations. On the other hand, there is an additional institution that controls public service production in municipal associations: While the local authorities are only controlled by a large number of voters with small individual stakes, the municipal association is also and primarily controlled by the politicians of the member municipalities. These have substantial incentives to control production in municipal associations regardless of their motivation: Benevolent politicians will control to pursue public interest and opportunistic politicians will control to prevent unnecessary transfer payments to the associations that reduce their own funds. To test for the impact of municipal associations, we introduce a dummy variable for them. This dummy is interacted with the grant variable to see how the specific relationship between grants and efficiency depends on the organizational structure of public service provision. We also use the number of member municipalities in municipal associations as explanatory variable. For independent municipalities this variable takes on the value one. The larger the number of municipalities, the less intensive is the degree of democratic control – other things equal.

Finally, we introduce a number of control variables. Debt per capita and unemployment rate are used to capture municipalities' fiscal stress respectively income. Demography is controlled for by a number of variables. First, we introduce population density and its

square as explanatory variables. The share of senior citizens is used to account for the impact of the age composition on democratic control and composition of public services. We also account for the impact of overall population decline by using the relative population change between 1995 and 2004. Descriptive statistics of all variables are presented in table 1.

Table 1:
Descriptive statistics (N=203)

Variable	Mean	Std. dev.	Min	Max
<i>Inputs:</i>				
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 1995-2004	34,370	24720.86	4,185	147,400
Resources and intermediate inputs (in €)	2,212,260	2,430,012	347,249	17,800,000
<i>Outputs:</i>				
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 s.t. social security contribution (at place of work)	2,508.83	3,169.39	213.00	17,918.00
<i>Environmental variables:</i>				
Grants as share of total adjusted current income	0.31	0.09	0	0.48
Grants per capita	246.7	53.98	0	315.8
Fiscal capacity per capita (in 1,000 €)	0.3691	0.4735	0.1626	5.1450
Debt per capita	942.90	657.11	24.14	4,041.48
Municipal association	0.7734	0.4197	0	1
Municipal association*grants	0.2506	0.1512	0	0.48
Municipal association*grants p.c.	197.0	112.77	0	315.8
Municipal associations*fiscal capacity	0.2538	0.3815	0	5.1450
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 1995-2004	-0.04516	0.1029	-0.3527	0.5530
Unemployment rate (unemployed divided by population between 15 and 64)	0.10	0.02	0.01	0.15

Source: Authors' calculations.

4.2. Method

In the following, efficiency of a municipal unit is defined as the radial distance from the technological frontier. In order to measure relative municipal efficiency, we chose a non-parametric approach, the DEA-model suggested by Banker, Charnes, and Cooper (1984). The main advantage of this linear-programming based method is that no production or cost function has to be specified. Due to our assumption of identical factor prices for all municipalities it is possible to replace the (unobservable) physical input quantities with cost data (Färe and Primont 1988) in the DEA-program.

To analyse the impact of exogenous variables on municipal efficiency, we apply the two-stage procedure suggested by Simar and Wilson (2007). Essentially, it consists of a truncated regression of the input distance measures with the environmental variables introduced in 4.1. In stage 1 of the procedure, the bias-corrected estimator of the DEA measures for each municipal unit is calculated. In stage 2, the confidence intervals for the coefficients of the truncated regression are calculated.¹⁴ The calculations involve a bootstrap procedure that remedies the severe problems of unmodified two-stage approaches (e. g. serial correlation of the dependent variables, general upward-bias of non-parametric efficiency measures because the true production possibility set and the true production frontier are unobservable (Bogetoft and Otto 2011: 156-157) or the correlation between error term and the environmental variables).

¹⁴ For further methodological details see the appendix.

5. Results

In step 1 of our empirical analysis, we calculated the bias-corrected relative (global) input efficiency measures for the municipalities in Saxony-Anhalt. We find a median value of 1.18 (mean: 1.23), meaning that the median municipal unit could reduce its inputs by 15.25% while keeping output constant. The corresponding standard deviation of 0.15 is relatively low. By definition, there are no fully efficient municipal units when we use the bias-corrected hull. Even with the original scores, only 36% of the municipalities were found to be efficient.

In step 2 of our empirical analysis, we use the bias-corrected technical efficiency scores to evaluate the impact of environmental variables on municipal efficiency (see table 2) by a truncated regression analysis. Our baseline models (model I and II) use grant-dependency and grants per capita, respectively, as primary variable of interest. To test for the robustness of the results, we estimate two additional model specifications. In models Ia and IIa, the interest and rent expenditures are replaced by the aggregate real investments since 1995 as an alternative proxy for the capital input. In models Ib and IIb, we restrict the sample in the baseline model to municipalities with less than 20,000 inhabitants to further improve homogeneity in outputs.

Table 2:
Results of the second-stage truncated regression

Variable	Model I	Model Ia	Model Ib	Model II	Model IIa	Model IIb	Model III
Constant	0.7058 *	1.0525 *	0.8182 *	0.7324 *	1.1212 *	0.9080 *	0.5829 *
Grant dependency	-0.8987 *	-1.4216 *	-0.9868 *	-	-	-	-
Grants per capita	-	-	-	-0.0008 *	-0.0016 *	-0.0012 *	-
Fiscal capacity p.c.	-	-	-	-	-	-	0.1792 *
Dummy municipal association	-0.2666 *	-0.3315 *	-0.3218 *	-0.3634 *	-0.4350 *	-0.4851 *	-0.0086
Municipal assoc.*	0.5626	1.1118 *	0.7071 *	-	-	-	-
grant dep. Municipal assoc.*	-	-	-	0.0011 *	0.0017 *	0.0016 *	-
grants p.c Municipal assoc.*	-	-	-	-	-	-	-0.1972 *
fiscal capacity p.c	-	-	-	-	-	-	-
Number of municipalities	0.0099 *	0.0010	0.0087	0.0088	-0.0001	0.0074	0.0089
Population density	-0.0009 *	-0.0015 *	-0.0013 *	-0.0009 *	-0.0014 *	-0.0012 *	-0.0009 *
Population density squared	0.000004	0.000001 *	0.000001	0.000004	0.000001 *	0.000001	0.000005
Share of senior citizens	3.9273 *	1.7982 *	3.9331 *	3.5529 *	1.4235	3.4736 *	2.7880 *
Debt per capita	0.00008 *	0.00009 *	0.00008 *	0.0001 *	0.0001 *	0.0001 *	0.0001 *
Unemployment rate	0.1740	1.7103 *	-0.2116	-0.0852	1.4072	-0.5164	-0.1520
Relative pop. change	0.2651	0.2489	0.3086	0.3007	0.2574	0.3127	-0.1211
	N=203	N=203	N=181	N=203	N=203	N=181	N=203

Notes: * indicates significance at the 5% level based on the 95% confidence intervals calculated by Efron's percentile method. - In model a, the capital input variable is replaced by aggregated real investment expenditures; in model b, the sample is restricted to municipal units with less than 20,000 inhabitants. - For the interpretation of the results it should be kept in mind that a negative sign of the coefficient indicates a reduction of the relative distance to the estimated production frontier, i.e. an efficiency improvement.

Source: Authors' calculation

We find a significantly negative coefficient for the grant variable on inefficiency regardless of the model specification and for both grant dependency and per capita grants. This indicates a positive relationship between efficiency and the amount of grants. The dummy for municipal associations is significantly negative in all six models. Hence, other things equal, the two-stage decentralized decision making in municipal associations leads to higher efficiency in public service production.¹⁵ The interactions of grants and municipal associations are significantly positive (with the exception of model I) – indicating that the positive effect of grant dependency is highest for independent municipalities. Finally, the number of member municipalities in municipal associations decreases efficiency in model I but has no significant effect in all other specifications. Turning to the other control variables, we find a positive effect of population density. The squared population density is also significant in some models. However, the turning point is beyond the sample maximum. The share of senior citizens (except in model IIa) and debt per capita exert a negative influence on efficiency. The coefficients of the unemployment rate and the relative population change are not significant in any model specification except for a negative effect of unemployment in model Ia.

Our central hypothesis in section 3 states that the empirical relationship between grants and efficiency may be driven by the fact that both depend on the means that the median voter can use to buy private goods and public services (i.e. his own income and the means that come from local business taxes, land taxes etc.). This raises the question why we do not test for the influence of this variable directly. Unfortunately, the necessary information is not available. In particular, we do not have data on the median (or even average) household income on municipal level. We therefore use the fiscal capacity per capita as a proxy for median voter's income.¹⁶ By construction of the underlying formula-based grant system, fiscal capacity and the grants (per capita) are highly and negatively correlated. Therefore, it is not advisable to use both variables in the same regression model simultaneously. Instead, we replace the grant variable in the baseline models with the fiscal capacity per capita (see model III in table 2). We find the expected significant positive sign for the fiscal capacity variable.

¹⁵ At the mean, the overall effect – taking into account the interaction terms – is negative (efficiency-enhancing) for all specifications except models I and Ia.

¹⁶ *FC* is calculated according to equation (18) including the standardized (net) revenues of the local business tax and the property tax as well as the municipality's shares in the national income tax and the national value added tax.

6. Discussion

In our regressions, we find a stable positive relationship between vertical grants and public sector efficiency. While part of the empirical literature reports an insignificant or significantly positive relationship only for grant dependency but not for grants per capita, we find it for both variables. This result allows for two possible interpretations. Ignoring the inference-disturbing effect of fiscal equalization systems, it supports the notion that vertical grants enhance the efficiency in public service production. This result is at odds with the theoretical model of Kalb (2010) while our model supports this interpretation for a large range of parameter constellations if voters suffer from fiscal illusion. However, the positive correlation between grants and efficiency may also result from the fact that the fiscal equalization system concentrates grants in financially weak municipalities. Even after fiscal equalization, these municipalities face a tighter budget constraint and thus waste fewer resources per unit output. The negative relationship between fiscal capacity and efficiency (see table 2) supports this view. Thus, it is possible that grants *cause* local authorities to reduce efficiency even though our regressions produce a coefficient that hints at an efficiency-enhancing effect.

The inference-disturbing effect of fiscal equalization systems is even stronger if they are combined with output regulation. To see why, consider figure 2 again and assume a minimum quantity Q^{min} fixed by the state or federal government. Let the state government fix Q^{min} at a level such that vertical grants are sufficient to produce Q^{min} but the bureaucrat in the poor municipality P cannot realize the utility maximum because the corresponding amount of public services Q is lower than Q^{min} . In this case, output regulation forces the local bureaucrat in this municipality to choose a point south-east of the original P^* . This leaves him with a fiscal residual that is lower than without output regulation. Bureaucrats in financially strong municipalities like municipality R in figure 2 are less likely to be limited in their choice of quantity because their optimal quantity is more likely to exceed Q^{min} .¹⁷ As a result, output regulation makes it even more likely that cross-sectional studies find a positive relationship between vertical grants and public sector efficiency even if the causal relationship is really negative.

It is important to note at this point that we cannot conclude from our results that grants do not have a positive impact on efficiency as implied by our theoretical model. There could be a positive relationship that adds to the impact of fiscal equalization. Our main point is that the inference-disturbing effect of fiscal equalization systems makes it impossible to interpret a positive relationship between grants and efficiency as an indication for a causal relationship whenever the study is based on cross-sectional data. This note of caution also applies to studies using panel-data as long as this data shows

¹⁷ It is impossible to quantify the degree to which especially financially weak municipalities have to “stretch to the ceiling” in order to meet output regulation in Saxony-Anhalt. However, the institutional facts compiled by *Haug* (2013) suggest that output regulation imposes severe restrictions on municipal budgets for at least some public services.

the primary variation between municipalities and the variation across time is low or primarily results from a general trend. At the same time, our argumentation strengthens the conclusions that can be drawn from studies that find a negative relationship even for countries or states with strong fiscal equalization schemes.

Beyond the impact of grants, our results indicate that municipal associations are more efficient than independent municipalities. This supports the notion that politicians in member municipalities are more successful in controlling municipal associations than individual voters in the independent municipalities are in controlling their local authorities. The effectiveness of control may partly result from the fact that municipalities can threaten to reduce the funds and tasks of the municipal association or leave it altogether. On the other hand, the performance of the interaction between municipal associations and grants indicates that the advantage of municipal associations is mitigated by grants. The higher the grants that municipal associations receive (via their member municipalities) the more the efficiency bonus of municipal associations is reduced. This result may be interpreted as a hint that grants have a negative impact on efficiency.

Finally, the negative effect of a high share of senior citizens on efficiency found in most of the model specifications might be explained by the fact that older people do not benefit from the main municipal expenditure categories (childcare, primary schools) and hence are not interested in efficiency to an extent that young citizens are. Alternatively, a high share of senior citizens can be interpreted as indication that the corresponding municipality is shrinking. In this case, the negative relationship results from hysteresis in cost.

7. Conclusions

The current paper makes three contributions to the literature on vertical grants and their impact on public sector efficiency. First, we develop a theoretical model of the interaction of voters and bureaucrats in local public service provision. We use this model to analyse the impact of vertical grants on efficiency. Our model differs in a number of important features from the only other formal model on this relationship proposed by Kalb (2010). Most importantly, we do not assume that bureaucrats have the power to make a take-it-or-leave-it offer but assume that the bureaucrat can set the tax price while voters choose the quantity of public services. We find that vertical grants reduce public sector efficiency if voters do not suffer from a misperception in the amount of vertical grants. In Kalb's model, it is precisely this misperception that causes the negative relationship between grants and efficiency. Once we account for this misperception, the impact of grants becomes ambiguous. It can be positive or negative depending on the parameter values in the model.

Second, we use our model together with a central feature of existing systems of vertical grants to point at a possible problem in the existing empirical literature in this field: Many fiscal equalization systems concentrate grants in financially weak municipalities but leave the initial ordering in fiscal capacity (largely) intact. Thus, per capita grants are high in municipalities which – before and even after fiscal equalization – face a tighter budget constraint than financially strong municipalities and are thus (forced to be) more efficient. As a consequence, it is misleading to draw conclusions concerning the causal link between grants and efficiency from empirical studies that rely on cross-sectional data from states or countries with this type of fiscal equalization systems. In particular, a positive relationship between grants and efficiency cannot be interpreted as evidence for a positive causal impact of grants on efficiency. The inference-disturbing effect is even stronger when there is output regulation. This argumentation provides a possible explanation for the mixed empirical evidence on the relationship between vertical grants and efficiency.

The third contribution of our paper is an empirical study for the German state of Saxony-Anhalt. Saxony-Anhalt has been chosen because vertical grants are the primary source of municipal revenues and the fiscal equalization system follows the lines sketched above. Therefore, it provides a highly suitable data-base to illustrate the point made above. As predicted, we find a positive relationship between vertical grants and efficiency. This result supports our note of caution concerning the conclusions that can be drawn from cross-sectional studies. On the other hand, we cannot exclude the possibility that the positive coefficient results from a genuinely positive influence of grants on efficiency. In any case, a careful re-assessment of the existing empirical evidence on the relationship between grants and efficiency is advised. Especially for those studies that find a positive relationship, it could be worthwhile to check whether this may be driven by the inference-disturbing effect of fiscal equalization. For countries like Bel-

gium or Spain, the inference-disturbing effect is not as obvious as in Germany. The municipal formula-based grant systems in these countries do not have built-in mechanisms that preserve the fiscal ranking among the municipalities because the grants are based either on indicators for fiscal need (e. g. population) or fiscal capacity only, but not on the gap between assumed fiscal need and fiscal capacity as in Germany. Hence, it might be possible that formerly “poor” municipalities turn into “rich” municipalities after having received grants and vice versa. A re-assessment of the data can show whether the fiscal equalization system in these countries seriously biases the coefficient estimator reported in these studies. And even for those studies that find a negative relationship, it may be interesting to explore more deeply the role of fiscal equalization.

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Appendix

Supplementary material for 4.2:

In this paper, we apply data envelopment analysis (DEA) and the two-stage procedure suggested by Simar and Wilson (2007) to calculate measures for technical efficiency and analyse the impact of several environmental variables on municipal efficiency. In this supplementary section, we briefly address some relevant methodological issues. First, we introduce the main concepts of DEA and discuss the measurement of technical efficiency when physical amounts of inputs are not available. Second, we provide a brief overview of the bootstrap algorithm proposed by Simar and Wilson (2007) for testing the impact of environmental variables on the estimated efficiency scores.

Efficiency is defined as the radial distance of a DMU from the technological frontier. Formally, each municipal unit converts a vector of p inputs $\mathbf{x} \in R_+^p$ into a vector of q outputs $\mathbf{y} \in R_+^q$. The underlying production process is described by the production set Ψ , which is the set of all feasible points (\mathbf{x}, \mathbf{y}) . That is,

$$\Psi = \{(\mathbf{x}, \mathbf{y}) \in R_+^{p+q} \mid \mathbf{x} \text{ can produce } \mathbf{y}\} \quad (19)$$

Technically efficient municipal units operate on the technology frontier of Ψ , whereas inefficient firms operate at points in the interior of Ψ . We choose an input-oriented perspective because municipalities are expected to have discretion in choosing their input mix, whereas certain outputs are subject to regulation. Hence, the Debreu-Farrell technical efficiency score $\theta(\mathbf{x}, \mathbf{y})$ is defined as

$$\theta(\mathbf{x}, \mathbf{y}) = \inf \{ \theta \mid (\theta \mathbf{x}, \mathbf{y}) \in \Psi \} \quad (20)$$

and can be interpreted as the factor by which inputs can be reduced to achieve technical efficient production of the given outputs \mathbf{y} (keeping the input and output mix fixed). Hence, for an efficient municipal unit, $\theta(\mathbf{x}, \mathbf{y}) = 1$, and otherwise $0 < \theta(\mathbf{x}, \mathbf{y}) \leq 1$.

Since in empirical studies the true production possibility set Ψ , as well as $\theta(\mathbf{x}, \mathbf{y})$ and \mathbf{x}^{eff} , are unknown we have to rely on estimators, defined below, based on the sample $\chi_n = \{(\mathbf{x}_i, \mathbf{y}_i, \mathbf{z}_i), i = 1, \dots, n\}$ where \mathbf{z}_i is a vector of observed environmental variables for the i th unit that constrain its choice of inputs and outputs. The estimator for the input-oriented efficiency score $\theta(\mathbf{x}, \mathbf{y})$ is defined by

$$\hat{\theta}(\mathbf{x}, \mathbf{y}) = \min \{ \theta > 0 \mid \theta \mathbf{x} \geq \mathbf{X}\boldsymbol{\lambda}, \mathbf{y} \leq \mathbf{Y}\boldsymbol{\lambda}, \mathbf{1}\boldsymbol{\lambda} = \mathbf{1}, \boldsymbol{\lambda} \geq 0 \} \quad (21)$$

where $\mathbf{Y} = [\mathbf{y}_1 \dots \mathbf{y}_n]$ and $\mathbf{X} = [\mathbf{x}_1 \dots \mathbf{x}_n]$, with $\mathbf{x}_i, \mathbf{y}_i$, $i = 1, \dots, n$ denoting the observed vectors of inputs and outputs, and $\boldsymbol{\lambda}$ a n -dimensional vector of intensity variables that are multiplied by a vector of ones $\mathbf{1}$. As we assume a production technology with vari-

able returns to scale,¹⁸ λ has to sum up to one for each municipality (Banker, Charnes, and Cooper 1984).

As discussed in the previous subsection, data on physical input quantities is not available. At the same time, all municipalities are subject to the same regulation and pay the same prices for all major inputs. Under these circumstances, the unobserved input quantities can be replaced with the expenditures for the respective inputs, so that cost and technical efficiency are the same by definition (Färe and Primont 1988). Hence, the following linear program is solved for each municipality:

$$\hat{\theta}(\mathbf{x}, \mathbf{y}) = \min \{ \theta > 0 \mid \theta \mathbf{c} \geq \mathbf{C}\lambda, \mathbf{y} \leq \mathbf{Y}\lambda, \mathbf{1}\lambda = 1, \lambda \geq 0 \} \quad (22)$$

where \mathbf{c} is a p -dimensional vector of expenditures associated with the elements of the input vector \mathbf{x} and $\mathbf{C} = [\mathbf{c}_1 \dots \mathbf{c}_n]$ denotes the observed vector of costs in the sample.

Given the efficiency scores, we apply the two-stage approach suggested by Simar and Wilson (2007) to analyze the relationship between vertical grants and efficiency. In this setting, the environmental variables described above do not affect the frontier of the production possibility set Ψ but the resulting efficiency scores.¹⁹ In the following, we employ the Shephard input distance function, which is defined as the reciprocal of the efficiency score $\theta(\mathbf{x}, \mathbf{y})$ used above, hence $\delta(\mathbf{x}, \mathbf{y}) = 1/\theta(\mathbf{x}, \mathbf{y})$. We assume the following relationship between the efficiency scores and the environmental variables

$$\delta(\mathbf{x}, \mathbf{y}) = \boldsymbol{\beta}'\mathbf{z} + e \geq 1 \quad (23)$$

where $\boldsymbol{\beta}$ is a vector of parameters and e is a continuous iid random error variable that is normally distributed with $N(0, \sigma_e^2)$ and left truncated at $1 - \boldsymbol{\beta}'\mathbf{z}$.

18 This assumption was tested by applying a (modified) procedure suggested by *Simar and Wilson* (2002). *Simar and Wilson* (2002) actually use a bootstrap procedure based on a smoothed kernel density estimation combined with the reflection method. That is, the density of the efficiency scores is estimated from a sample with $2n$ observations, including reflected observations around the boundary at 1. We adapt the procedure provided in *Simar and Wilson* (2007) to test for returns to scale and draw from the left-truncated normal distribution describing the impact of environmental variables on the efficiency scores. The results clearly rejected the hypothesis of constant returns to scale as well as the less restrictive hypothesis of non-decreasing returns to scale.

19 This independence assumption of environmental variables and production possibility set can be justified by the fact that none of the environmental variables - except maybe for population density - used in our estimation can be considered as a substitute for regular inputs (e. g. the external temperature in a process of heating water) or as an undesirable output (e. g. the external temperature in a cooling process) that requires additional inputs. Hence, there is no need to apply a conditional (robust) DEA framework suggested by *Daraio and Simar* (2007a, 2007b). And this is even more so because the conditional approach has several drawbacks: It cannot be applied to non-continuous variables, it is difficult to analyze the influence of more than one variable simultaneously, and there has not been (at least to our knowledge) any practicable method developed yet to calculate confidence intervals or to test for statistical significant effects of environmental variables.

Empirically, we replace $\delta(\mathbf{x}, \mathbf{y})$ in Equation (23) with its consistent estimator $\hat{\delta}(\mathbf{x}, \mathbf{y}) = 1/\hat{\theta}(\mathbf{x}, \mathbf{y})$ defined above. Hence, Equation (23) becomes

$$\hat{\delta}(\mathbf{x}, \mathbf{y}) \approx \boldsymbol{\beta}'\mathbf{z} + e \geq 1 \quad (24)$$

As the inference is misleading for maximum likelihood estimates for $\boldsymbol{\beta}$ and σ_e^2 , we apply the bootstrap algorithm proposed by Simar and Wilson (2007).²⁰ Furthermore, we use this method to provide bias-corrected efficiency scores $\hat{\delta}(\mathbf{x}, \mathbf{y})$ according to

$$\hat{\delta}(\mathbf{x}, \mathbf{y}) = \hat{\delta}(\mathbf{x}, \mathbf{y}) - \text{bias}(\hat{\delta}(\mathbf{x}, \mathbf{y})) = 2\hat{\delta}(\mathbf{x}, \mathbf{y}) - B_1^{-1} \sum_{b=1}^{B_1} \hat{\delta}_b^*(\mathbf{x}, \mathbf{y}) \quad (25)$$

where B_1 is the number of bootstrap replications and $\hat{\delta}_b^*(\mathbf{x}, \mathbf{y})$ is the b th simulated efficiency score based on the assumptions stated above. Hence, in a first step we estimate bias-corrected efficiency scores $\hat{\delta}(\mathbf{x}, \mathbf{y})$ as described above. In a second step, we use those efficiency scores to draw inferences from the parameter estimates of $\boldsymbol{\beta}$ by bootstrapping the empirical distribution relying on the assumption stated in Equation (24). Following Simar and Wilson (2007), we simulate $L_1 = 1,000$ draws in the first step and $L_2 = 2,000$ draws in the second step.

The complete algorithm (“algorithm#2”) for input-orientation is (Simar and Wilson 2007: 42-43):

1. Using the original Data \mathbf{X} (\mathbf{C} in our case) and \mathbf{Y} , compute $\hat{\delta}(\mathbf{x}_i, \mathbf{y}_i)$ for each municipality i using (the reciprocal) of (22).
2. Use the method of maximum likelihood to obtain an estimate $\hat{\boldsymbol{\beta}}$ of $\boldsymbol{\beta}$ as well as an estimate $\hat{\sigma}_e$ of σ_e in the truncated regression of $\hat{\delta}(\mathbf{x}_i, \mathbf{y}_i)$ on \mathbf{z}_i in (24) using the $m < n$ observations when $\hat{\delta}(\mathbf{x}_i, \mathbf{y}_i) > 1$.
3. Loop over the next four steps (3.1 – 3.4) L_1 times to obtain n sets (one for each municipality i) of bootstrap estimates $B_i = \{\hat{\delta}_{ib}^*\}_{b=1}^{L_1}$:
 - 3.1 For each $i = 1, 2, \dots, n$ draw e_i from the $N(0, \hat{\sigma}_e^2)$ distribution with left-truncation at $(1 - \mathbf{z}_i \hat{\boldsymbol{\beta}})$.
 - 3.2 Again, for each $i = 1, 2, \dots, n$ compute $\delta_i^* = \mathbf{z}_i \hat{\boldsymbol{\beta}} + e_i$.
 - 3.3 Set $\mathbf{x}_i^* = \mathbf{x}_i$, $\mathbf{y}_i^* = \mathbf{y}_i \hat{\delta}_i / \delta_i^*$ for all $i = 1, \dots, n$. [1. projection of the original inputs and outputs onto the estimated production frontier, 2. projection of the outputs (the inputs in the case of output-orientation) randomly away from the estimated frontier by using δ_i^*]

²⁰ This is because $\hat{\delta}(\mathbf{x}, \mathbf{y})$ is by construction a biased estimator of $\delta(\mathbf{x}, \mathbf{y})$, the $\hat{\delta}(\mathbf{x}, \mathbf{y})$ are serially correlated, and the error term e is correlated with \mathbf{z} via its correlation with the inputs \mathbf{x} and outputs \mathbf{y} .

3.4 Compute $\hat{\delta}_i^*(\mathbf{x}_i, \mathbf{y}_i)$ for each municipality replacing \mathbf{X} by $\mathbf{X}^* = [\mathbf{x}_1^* \dots \mathbf{x}_n^*]$ and \mathbf{Y} by $\mathbf{Y}^* = [\mathbf{y}_1^* \dots \mathbf{y}_n^*]$.

[The random draws of the error term and the reflection method in step 3 avoid the inconsistency of a naïve bootstrapping of $\hat{\delta}_i^*$ from the set $\{\hat{\delta}_i^* | i = 1, \dots, n\}$].

4. For each $i = 1, \dots, n$ compute the bias-corrected estimator $\hat{\hat{\delta}}_i$ as defined by (25).
5. Use the method of maximum likelihood to estimate the truncated regression of $\hat{\hat{\delta}}_i$ on \mathbf{z}_i , yielding estimates of $\hat{\hat{\boldsymbol{\beta}}}$ and $\hat{\hat{\sigma}}$. [These are the “bias-corrected” estimates of the regression coefficients and the standard deviation of the error term.]
6. Loop over the next three steps (6.1 – 6.3) L_2 times to obtain a set of bootstrap estimates $D = \left\{ \hat{\hat{\boldsymbol{\beta}}}, \hat{\hat{\sigma}} \right\}_{b=1}^{L_2}$.
 - 6.1 For each $i = 1, \dots, n$ draw e_i from the $N(0, \hat{\hat{\sigma}}^2)$ distribution with left-truncation at $(1 - \mathbf{z}_i \hat{\hat{\boldsymbol{\beta}}})$.
 - 6.2 Again for each $i = 1, \dots, n$ compute $\delta_i^{**} = \mathbf{z}_i \hat{\hat{\boldsymbol{\beta}}} + e_i$.
 - 6.3 Use the maximum likelihood method to estimate the truncated regression of δ_i^{**} on \mathbf{z}_i , yielding estimates of $\hat{\hat{\boldsymbol{\beta}}}$ and $\hat{\hat{\sigma}}$.
7. Use the bootstrap values in D and the original (“bias-corrected”) estimates $\hat{\hat{\boldsymbol{\beta}}}$ and $\hat{\hat{\sigma}}$ to construct confidence intervals for each element of $\boldsymbol{\beta}$ and σ_e .

The bias-corrected estimators of δ , $\boldsymbol{\beta}$ and σ_e are calculated by step 1. to 5., whereas steps 6 and 7 yield the confidence intervals for the regression coefficients of the environmental variables \mathbf{z} .

The calculation of the confidence intervals of $\hat{\hat{\boldsymbol{\beta}}}$ and $\hat{\hat{\sigma}}$ would be easy if the distribution of these variables was known. As this is not the case, according to the standard bootstrap literature, there are several methods of constructing confidence intervals by using the bootstrap values from step 6. We calculated confidence intervals based on the percentiles of the bootstrap values. (We refer to this as “Efron’s percentile method” in the main text. See Efron and Tibshirani 1993: 170-176 for further details). For a confidence interval with intended coverage of 95 % ($\alpha=0.05$), the lower bound of the confidence interval of each element of $\hat{\hat{\boldsymbol{\beta}}}$ is marked by the $L_2 \cdot 0.05/2$ th value of the ordered list of bootstrap values $\hat{\hat{\boldsymbol{\beta}}}$ in D . Accordingly, the upper bound is marked by the $L_2 \cdot (1-0.05/2)$ th value.

According to the literature (e. g. Chernick and LaBudde 2011: 90-94), the percentile method yields sufficient results for medium-sized and large samples. Problems might occur in small samples with underlying skewed or heavy-tailed distributions. However, we calculated Efron’s BCa (bias-corrected-and-accelerated)²¹ interval which is commonly considered to be more accurate, but this did not result in changes of the

²¹ The calculation of the BCa interval is more complicated, so we skip the details here. See Efron and Tibshirani (1993: 178-201) for further information.

significance level of the regression coefficients for almost all environmental variables – especially not the grant-related variables.

All steps of the estimation were programmed in R-code (R version 2.13.0) including some components of the package FEAR (Frontier Efficiency Analysis with R) version 1.15 by Paul W. Wilson and the package truncreg written by Yves Croissant.

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