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Agglomeration, Population Size, and the Cost of Providing Public Services: An Empirical Analysis for German States

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Nontechnical Summary

There is a tradition in the public finance literature claiming that higher population density is associated with higher public expenditures. Typically, this literature defines crowding as the extent to which the cost of providing a certain level of public services depends on the population size of jurisdictions. If we consider jurisdictions of the same size in terms of area the distinction between crowding effects from population and population density effects is not important. This is different in a setting where jurisdictions face rather different endowments of land and jurisdictional boundaries are fixed.

Whereas jurisdictional boundaries of municipalities in many cases are subject to change, boundaries of subnational units such as Provinces in Canada, States in the U.S., Cantons in Switzerland, and States (Länder) in Germany, are almost completely fixed. In the German case these boundaries define drastically different units in terms of both population size and density. This is most obvious from the presence of so-called "city states" – cities which experience considerable independence in the German constitution. At the same time there exists a great deal of fiscal redistribution within the German federation aiming at the allocation of public funds according to the fiscal needs of the states. The corresponding fiscal equalization scheme favors in particular small and densely populated jurisdictions, assuming that they face higher per capita cost of providing public goods.

Focusing on the case of Germany, this paper reconsiders the empirical relevance of density and population size effects on the cost of providing public services. For this purpose, it develops an approach for an empirical determination of cost functions of public services and applies it to the German states (Länder), aiming at empirical estimates of the impact of both density and population size on the per capita cost of public services. The specific contribution of the paper is twofold. First it explicitly distinguishes between population size and density as determinants of the cost of public services. Second, it takes a disaggregate approach to the public budget, estimating separate cost equations for about 40 government functions instead of dealing with the aggregate cost from the outset.

The results indicate that while there is evidence in favor of crowding effects in population no general relationship is found between density and the cost of public goods provided. Thus, in accordance with the literature on local public finance, goods provided by state governments in Germany are found to be rather quasi-private. However, our empirical results vary across functions of government. Some public services, for instance the public provision of university education, display a significantly positive impact of population density on the per capita cost of provision. Other items in the public budget like general government affairs or housing can be provided at significantly and substantially lower per capita cost in more densely populated regions. For many functions

of government, the impact of population density on the cost of public services proved to be insignificant. In the budget as a whole, positive and negative effects almost cancel out. Hence, a privileged treatment of highly urbanized or sparsely populated jurisdictions in fiscal equalization systems cannot be justified by a cost disadvantage of these regions. However, with regard to population size the results suggest that small states have some cost disadvantage. Thus, at given state boundaries a preferential treatment of smaller states in the fiscal equalization system seems justifiable.

To put these findings into perspective, it is important to keep in mind that the analysis refers to the state and not to the local level. It is left for future research to find out whether the scarcity of land at the level of municipalities may well induce increasing cost in the provision of public goods.

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Agglomeration, Population Size, and the Cost of Providing Public Services: An Empirical Analysis for German States

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Abstract

This paper is concerned with the question as to what extent population size and density affect the cost of providing public services at the subnational level. Empirical estimates of cost functions are obtained from an analysis of the expenditures of German states disaggregated into about 40 functions of government. The empirical results indicate that generally there is no significant relationship between population density and the cost of public goods. At the same time, cost are almost proportionately related to population size indicating that goods and services provided by the German states display only a limited degree of publicness.

Keywords: agglomeration, cost of public services, local public goods

JEL: H72, H73, H41

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1 Introduction

There is a tradition in public finance claiming that higher population density is associated with higher public expenditures. This hypothesis has been put forward in particular by Brecht (1932) in his empirical study of public expenditures in Germany. However, the German literature has criticized this result because of lacking theoretical foundation and because the empirical evidence is doubtful (see Kuhn, 1993, for a survey). The presumption of Brecht is, however, related to the crowding cost which are also at the center stage in the more recent theory of local public finance (Wildasin, 1986). Typically, this literature defines crowding as the extent to which the cost of providing a certain level of public services depends on the population size of jurisdictions. If we consider jurisdictions of the same size in terms of area and if land available to each jurisdiction is fixed the distinction between crowding effects from population and population density effects is not important. This is different in a setting where jurisdictions face rather different endowments of land and jurisdictional boundaries are fixed.

Whereas jurisdictional boundaries of municipalities in many cases are subject to change, boundaries of subnational units such as Provinces in Canada, States in the U.S., Cantons in Switzerland, and States (Länder) in Germany, are almost completely fixed. In the German case these boundaries define drastically different units in terms of both population size and density. This is most obvious from the presence of so-called "city states" – cities which experience considerable independence in the German constitution. At the same time there exists a great deal of fiscal redistribution within the German federation aiming at the allocation of public funds according to the fiscal needs of the states. The corresponding fiscal equalization scheme favors in particular small and densely populated jurisdictions, assuming that they face higher per capita cost of providing public goods.

Focusing on the case of Germany, this paper reconsiders the empirical relevance of density and population size effects on the cost of providing public services. It develops an approach for an empirical determination of cost functions of public services and applies it to the German states (Länder), aiming at empirical estimates of the impact of both density and population size on the per capita cost of public services. The specific contribution of the paper is twofold. First it explicitly distinguishes between population size and density as determinants of the cost of public services. Second, it takes a disaggregate approach to the public budget, estimating a separate cost equation for each government function instead of dealing with the aggregate cost from the outset. This is important, because as emphasized by Oates (1988) the bundle of public services provided by jurisdictions will tend to differ between jurisdictions of different size.

The focus of the empirical analysis is on the state level, ignoring municipal expenditures. This choice of topic is motivated by the quantitative importance of

the states which accounted for 34.4% of non-social security public spending in 1998. Moreover, there is a fierce political debate on transfers between the German states, and in particular on the treatment of densely and sparsely populated states in the fiscal equalization scheme.[1]

The results indicate that while there is evidence in favor of crowding effects in population no general relationship is found between density and the cost of public goods provided. Thus, in accordance with the literature on local public finance, goods provided by state governments in Germany are found to be rather quasi-private. This conforms with Litvack and Oates (1970) who argue with regard to the U.S. states that government spending varies inversely with the size of the population while spending by local governments is positively and significantly related to the concentration of population as measured by the degree of urbanization. However, our empirical results vary across functions of government. Some public services, for instance the public provision of university education, display a significantly positive impact of population density on the per capita cost of provision. Other items in the public budget like general government affairs or housing can be provided at significantly and substantially lower per capita cost in more densely populated regions. For many functions of government, the impact of population density on the cost of public services proved to be insignificant. In the budget as a whole, positive and negative effects almost cancel out. Hence, a privileged treatment of densely populated jurisdictions in fiscal equalization systems cannot be justified by a cost disadvantage of these regions. But, abstracting of their possible disincentive effects differences in the population size of states may justify extended transfers to smaller states.

The rest of the paper is organized as follows. The next section discusses some theoretical and methodological issues involved. Section 3 discusses the investigation approach and the data in more detail. Section 4 presents the empirical results. Section 5 gives a short conclusion.

2 Theoretical and Methodological Issues

The provision of local public services q_i in state i is assumed to be determined by the level of public spending G_i, by the size of the population N_i, and by population density d_i, formally

$$q_i \;=\; q\left(G_i, N_i, d_i\right)$$

[1]The Federal Constitutional Court ruled on November 11, 1999 that the impact of agglomeration on expenditure needs should be examined before a reform of the transfer system is conceived (BVerfG, 2 BvF 2/98, 319).

where the partial derivatives are

$$q_G > 0,\ q_N \leq 0.$$

In case of pure public goods $q_N = 0$. The effect of population density on the supply of local public services q_d rests uncertain. The German fiscal equalization system assumes that both densely and sparsely populated regions face higher per capita cost of providing public goods. The supply function can be used to derive an expenditure function

$$G_i \ = \ G\left(q_i, N_i, d_i\right) \quad \text{where} \quad G_q > 0,\ G_N \geq 0,$$

and in terms of per capita expenditures $g_i = G_i/N_i$

$$g_i = g\left(q_i, N_i, d_i\right) \quad \text{where} \quad g_q > 0,\ g_N = [G_N - (G_i/N_i)]/N_i. \tag{1}$$

In case of pure public goods $g_N < 0$ since $G_N = 0$. Equation (1) suggests to verify empirically the impact of population size and agglomeration on the cost of public services by relating per capita expenditures to measures of population size and density. This approach, however, has to face two methodological problems, related to the budget identity and to the difficulty to observe the supply of public services.

Due to the budget identity a regression of expenditures on indicators of agglomeration and size might reflect the impact of the local conditions on revenue rather than on cost. Since urbanized regions typically have a higher per capita GDP it is quite plausible that more densely populated states will gather higher per capita tax revenues and, correspondingly, will disburse higher expenditures than rural states. However, it would be misleading to interpret this result as a confirmation of higher cost (*e.g.*, Hansmeyer, 1980, and Oates, 1988).

In the German case, matters are slightly different due to the system of intergovernmental transfers between the states *(Länderfinanzausgleich)*. This system is characterized by a differential treatment of city states compared to non-city states. The per capita revenues of the non-city states are more or less equalized by taxing (subsidizing) their own tax revenues at marginal rates going up to 92% (Lichtblau, 1999). On the other hand, 35% higher than average per capita revenues are accorded to the three city states Hamburg, Bremen, and Berlin. It is thus no surprise if the city states were found to spend roughly 35% more per capita than the other states. In a simple comparison of expenditures between these two groups, the higher density of the city states would seem to imply higher cost per capita, whereas the comparison might simply reveal the special treatment in the fiscal equalization scheme. The present analysis ignores the city states because they do not have separate budgets for the state and the municipal level. The problem caused by the budget identity is however not solved by excluding the city states. Rather, it reappears with the sign reversed. Since

now all states in the sample get more or less the same revenues after equalization (Sachverständigenrat, 2001) one might find no impact of agglomeration on expenditure even if there is an effect on cost.

Wrong conclusions like this arise because the naive approach does not distinguish observed expenditures from the cost of providing a given level of public goods. To illustrate this, consider two states, a densely populated one, and a rural one, and assume that the more urbanized state displays higher expenditures per capita. This may well be due to the fact that it is more expensive to provide a given level of public goods in agglomerated regions. It may however just as well reflect more or better services provided by the urbanized state out of its higher revenues or due to different preferences of the residents.[2] Similarly, it may also be that the state with the higher degree of agglomeration allows more slack in its production of public goods, *e.g.*, by overstaffing the administration. Only the first explanation would qualify as a cost disadvantage of agglomerations. Thus, to identify the cost impact of agglomeration, one should control for differences in the level of public services provided.

Typically, the level of public services cannot be observed directly. This is due to the very nature of public goods: they are not traded on a market. The quality of a unit of a private firm's product is readily measured by the price at which it sells, since it reflects the corresponding marginal willingness to pay. For public goods, the marginal willingness to pay is unknown since nobody has to pay for them, directly. Notice that this is not only true for genuinely non-excludable goods. It also holds for those goods which are provided for free by the state although it would in principle be possible to levy a positive price. As a consequence, there is no ready quantification of public service provision. One possible remedy is to approximate the level of public goods supplied using indicators (*e.g.*, Brueckner, 1981, Loehman and Emerson, 1985, Craig and Heikkila, 1989, or Castells and Solé Ollé, 2000). These indicators will sometimes capture the sheer quantity of public services provided, for instance by the intensity of utilization of a public service. But, utilization indicators will fail to express quality, which certainly is an important dimension of public services. The number of students indicates the quantity of the output of a school, but it is generally agreed that there are wide differences in the quality of education. However, appropriate data are unfortunately not always available in sufficient regional detail. Moreover, there are many other public functions such as the general administration where a suitable testing would be difficult to devise. An alternative option is to assume that the supply of public services follows the demand for public services and to explicitly introduce its determinants (*e.g.*, Borcherding and Deacon, 1972).

As a feasible solution, different types of indicators are used in the following

[2]Oates (1988) emphasizes this point with respect to the cost of local public goods. He argues that these cost are likely to be overestimated for large cities because large cities tend to provide more and better services than smaller municipalities.

depending on the specific function of government considered. For some functions of government, as for instance police protection, the level of services provided can be operationalized by measuring the level of security by means of the crime rate. Assuming that the level of services provided is positively affected by the quantity of factors used in the production of the public good, other indicators capture the employed inputs. For example, the quality of education presumably improves if there are more teachers, the quality of transportation improves if there are more roads, and public security improves if the number of police officers increases. Of course, more inputs need not necessarily indicate a higher value of services, as more inputs can simply mean more waste. However, one may also argue that it is necessary to use more inputs in an urbanized area in order to provide the same quantity and quality of the public good. This amounts to saying that public sector cost are not only higher in agglomerations because input prices are higher, but that in addition the production technology is different. While this is a theoretical possibility, given data limitations it is impossible to separate empirically such an effect from the other causes for an increased use of inputs. In particular, the distinction between a necessary, agglomeration-related increase in the demand for inputs, and inefficient production seems impossible to draw empirically. However, while indicators can only imperfectly measure the level of public services, this imperfection is mitigated in the empirical application by a disaggregate approach which employs indicators specific to each of the various functions of government. This approach allows to describe the entire budget without having to impose an arbitrary aggregation of indicators.

3 Investigation Approach

Following the preceding discussion, the empirical approach distinguishes four basic determinants of per capita expenditures:

i.) state population size,

ii.) population density,

iii.) per capita level of service provided, and

iv.) unobserved characteristics.

Note that the population of the state is distinguished from population density. This allows to capture the presence of economies of scale in the provision of at least partly non-rival public goods independently of the issue of how strong citizens are concentrated in space. This is in accordance with the local public

finance literature on congestion[3] which emphasizes that the per capita cost of public goods provision will generally decline with the number of residents if one holds constant the level of public services provided, as long as public goods are not completely rival in consumption. The last item in the list of determinants refers to specific cost enhancing factors, such as the reconstruction of public infrastructure in East Germany. Since the expenditure structure of the East German states, especially at the beginning of the period of observation, is barely comparable to that of the West German states, the regression employs time-specific coefficients for the former. Finally, time-specific constants are used in order to catch overall trends in the expenditures of all states, *e.g.* due to federal wage agreements in the public sector.

With regard to functional forms the literature often assumes that per capita expenditure is a loglinear function of population size. However, in order to properly deal with the differences in the size of jurisdictions such a specification is much too restrictive because it implies that the degree of publicness of public services is constant even if jurisdictions show strong differences in population size. Instead, it seems more reasonabe to employ some nonlinear specification. Facing a setting with a very small number of observations we employ the following separable functional form

$$EXP_{it} = \beta_{0t} + \beta_1 \left(\frac{1}{POP_{it}} \right) + \beta_2 DENS_{it} + \beta_3 SERV_{it} + \beta_{4t} EAST_i + u_{it},$$

such that population size (POP_{it}) is accounted for using a standard cost degression effect. For a given land area, an increase in population affects per capita cost in two ways, quantified by the coefficients β_1 and β_2. First, the fixed cost are shared by more inhabitants, and, second, there may be higher or lower cost because of higher density ($DENS_{it}$). The proposed specification allows for a separation of these two effects.

Since the level of public goods supply (iii) and the unobserved cost component (iv) may differ for government functions as well as for states, the quantitative analysis will be carried out for the single functions separately. This yields a separate regression for each state government function $k = 1, ..., n$ with a function specific indicator for the level of services provided $SERV\,[k]_{it}$. It provides an estimate of the impact $\beta\,[k]_1$ of population size and $\beta\,[k]_2$ of population density on the per capita expenditures $EXP\,[k]_{it}$ for this function. In a second step, then, the elasticities of per capita expenditures with respect to population

[3]For a survey, see Reiter and Weichenrieder (1997).

size and population density are calculated for each government function.[4] The specific elasticities are finally aggregated across functions in order to assess the respective effects on the total state budget. For this purpose, a weighted average is computed using the expenditure shares in the states' budgets as weights resulting in a measure of the aggregate effects.

The basic dataset provides information on a large number of spending categories. In the analysis minor spending categories are excluded where not all states report positive expenditures. In addition, categories are neglected which could not be clearly assigned to specific public services or to a specific period. Out of the total number of 70 spending categories[5] the analysis focuses on nearly 40 categories, which together represent 75-80% of the total direct state expenditures.[6] As the focus is on the state level, the three city states Hamburg, Bremen and Berlin are neglected, where the finances of the respective municipalities are merged with those of the state, and the analysis focuses on 13 states. In order to remove the specific development in the New Länder and other periodical fluctuations, the analysis uses repeated cross-sections over 6 years, 1992-1997. The data are used in per capita terms and in constant prices of 1995.

As a measure of the degree of agglomeration, population density is used, defined by the ratio of a state's population over the area claimed for settlement and transportation purposes (*Siedlungsdichte*). This indicator is quite independent of the administrative territorial organization and appears to be more reasonable than raw population density, since the citizens as beneficiaries of public goods concentrate on the area used for settlement and transportation. However, about 93% of cross-sectional variation in population density is explained by this measure of density in the settlement area. Table 1 shows the statistics on population, population density and per capita expenditure for the German states.

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[4]Relying on the per capita expenditure equation the elasticity of public expenditures with respect to population size, the degree of "publicness" $\alpha[k]$ of the public service k, is defined as

$$\alpha[k] \equiv 1 - g_N[k]\frac{N}{g[k]}.$$

Using the above non-linear specification,

$$\alpha[k] = 1 - \frac{\beta[k]_1}{EXP[k]\,POP},$$

where $EXP[k]$ and $POP[k]$ are average figures. The elasticity with respect to density is computed from

$$\gamma[k] = g_d[k]\frac{d}{g[k]} = \beta[k]_2\frac{DENS}{EXP[k]}.$$

[5]Source: Statistisches Bundesamt, Fachserie 14 (Finanzen und Steuern), Reihe 3.1 Rechnungsergebnisse des öffentlichen Gesamthaushalts.

[6]Direct expenditures are analyzed, reporting expenditures taken by the state government itself, thus excluding intergovernmental transfers between the different levels of government.

Table 1: Population, population density, and per capita expenditure of the German Länder, 1997

State	Population	Pop. per total area	Pop. per settlement area	Expenditure per capita
Schleswig-Holstein	2750	0.174	1.618	4.217
Hamburg[a]	1707	2.261	3.998	11.800
Lower Saxony	7831	0.164	1.354	3.996
Bremen[a]	676	1.673	3.101	13.162
Nordrhine-Westphalia	17963	0.527	2.601	3.707
Hesse	6031	0.286	1.966	4.003
Rhineland-Palatinate	4010	0.202	1.556	4.348
Baden-Württemberg	10387	0.291	2.286	3.972
Bavaria	12056	0.171	1.740	3.895
Saarland	1083	0.421	2.183	5.139
Berlin[a]	3445	3.866	5.800	13.309
Brandenburg	2563	0.087	1.124	5.285
Meckl.-Westpommerania	1814	0.078	1.259	5.369
Saxony	4536	0.246	2.323	4.404
Anhalt-Saxony	2714	0.133	1.533	5.400
Thuringia	2485	0.154	1.820	5.394
Mean	5128	0.671	2.266	6.088
Mean (excl. City st.)	5863	0.226	1.797	4.548
Mean East Germany	2822	0.140	1.612	5.171

Note: Yearly average population in 1000; population density in 1000 inhabitants per square kilometre regarding the entire state surface, and, alternatively, regarding the area claimed for settlement and transportation purposes; state government direct expenditures per capita in 1000 DM; [a] including state and local government. Source: Statistisches Bundesamt, own calculations.

As far as possible, suitable indicators for the level of public supply are associated specifically to the different functions. But, as outlined above, there are serious problems due to the lack of adequate data and different types of indicators are chosen for this study. For some functions of government reasonable proxies for the level of services provided are available, as for instance the crime rate as a proxy of the level of security. For other functions of government, the analysis proceeds by assuming that the level of public supply varies proportionally with the observable quantitative indicators of public activity, such as the personnel employed in different functions. In the area of education this can be the number of teachers per inhabitant, in the area of justice the number of judges per inhabitant. The number of public institutions can be used alternatively, too, such as universities or prisons. Finally, assuming that the level of public ser-

vices provided is proportional to the respective demand, demand indicators are employed, such as the number of students.[7]

4 Results

The empirical analysis is concerned with the effects of population size and agglomeration on the per capita expenditures of the German Länder governments for individual functions of governments. The first aspect accounts for economies of scale and the degree of "publicness" of publicly provided goods as described in the literature on local public finance. The second aspect investigates the role of the spatial distribution of the population for the cost of providing public goods. For each function of government the analysis proceeds as follows. First, other potential determinants of per capita expenditures besides population density and population size, such as indicators for the level of public services are included. Because of the small number of observations, indicators are dropped if they do not contribute to the goodness of fit. Then, function specific elasticities of public expenditures are calculated using the average state expenditures of 1997 and the estimated coefficients for both the population size and the population density effect. The results of the estimates (Table 2) together with the elasticities (Table 3) are listed below.[8]

According to the coefficient of determination (not shown) agglomeration together with population size and the indicators of the level of public services explain in most cases nearly half of the interstate variation in per capita spending. The employed indicators generally show the expected expenditure enhancing effects. Across functions of governments, however, agglomeration and population size show different effects.

A positive significant impact of population density on public spending is only found for some important areas, such as *universities*, *support of education*, *other social affairs*, and *food and agriculture*. Note that in the German federation expenditures on universities are fully assigned to the state governments and represent an important expenditure category. According to the results for the elasticities, a doubling of population density increases expenditures for universities by 27.8%. The effects of an increase in population density amount to 45% in the case of *other social affairs* which contain especially labor market policy and respectively 35.7% for *food and agriculture*.

In contrast, in several areas a negative significant effect of population density is found, which indicates that stronger agglomeration causes cost advantages

[7]See Table 4 for an overview of the function specific indicators for the level of public supply employed.

[8]The estimated coefficients of the indicators are available upon request.

in the provision of public goods. For instance, this is the case with *general government affairs*, *ordinary* and *other courts*, *other cultural affairs* apart from theatre and music, and *housing*. Public spending on *general government affairs* is lower by 62.5% if density doubles. The reductions in the fields of *ordinary* and *other courts* are comparatively less pronounced with 6.4%, and, respectively, 18.3%. The strong negative effect in the field of *housing* (110.6%), also mainly a function of the state government, indicates density advantages, too. Finally, however, many important areas do not show significant density effects.

With regard to the degree of "publicness", the estimates support mainly elasticities of expenditures with respect to population size around unity. Accordingly, per capita expenditures are almost constant in the size of the population, indicating that most of the goods provided by the state governments tend to be quasi-private goods. Certain cost degression effects and elasticities significantly smaller than unity are especially found for public spending on *other administration*, *general government*, *theatre and music*, *social welfare*, *other health affairs*, and *regional development*. In most cases, however, the hypothesis of an elasticity equal to unity cannot be rejected, as for example in the case of *general education* and *vocational schools*, *other social affairs*, *other family benefits*, *housing*, *food and agriculture*, and *railways and public transport*.

The elasticities of expenditures with regard to population size and population density for single government functions are finally weighted with budgetary shares and added in order to illustrate the implications for the overall state budget.[9] The aggregate effects indicate as to which extent an increment in population size or density increases or lowers the state per capita expenditures on aggregate. Despite of the exclusion of certain functions of government, this overall figure can be considered as representative for about four fifth of the state government expenditure. The last two lines in Table 3 present the results.

Accordingly, due to the systematic effect of an increment of population density by 100% a state government spends about 5.7% less if the budgetary structure over all states is taken for reference. However, this effect is not significant. Hence, the hypothesis that state expenditures are independent of population density cannot be rejected. With regard to the degree of "publicness", the aggregate elasticity is slightly below unity at the 1% level of significance. This indicates that public services provided by the states do show some degree of publicness. Yet, the degree of publicness is rather small. Accordingly, large states have some minor cost advantages in the provision of public services as compared to small states. As the expenditure structure of the East German states is still biased by the process of transition, it appears reasonable to apply not only the average budgetary shares of all German states, but alternatively, the budgetary structure

[9]The budget share is defined as the expenditure share of a government function in total expenditures considered in the estimations. The elasticities are related to the expenditure figures of 1997. Therefore the single functions are weighted by this year's average expenditure shares, as well.

of the former West German states. However, this does not show a significant effect on the result.

Since some part of the state government functions is probably carried out by local governments, which are reimbursed with specific vertical grants, it seems possible that the influence of population size and agglomeration is stronger if a more comprehensive concept of expenditures is used, which includes transfers to lower level governments. More specifically, the alternative concept measures the impact on expenditures inclusive of intergovernmental expenditures but exclusive of intergovernmental revenues. Therefore, sensitivity analyses have been carried out for this alternative expenditure concept, the results, however, being in general very similar.[10]

In order to deal with the problem of pooling data of heterogeneous states, a random-effects estimation has been carried out, too. Hausman tests indicated that the unobserved characteristics of the states are correlated with the employed indicators. Alternatively, the fixed-effects method is not convincing in the present case, since invariable characteristics are excluded from the estimation, whereas population density and size is barely changing in the course of time. This is also made clear by a cross-sectional (between groups) estimation with mean values for the single states over the six years, which yields quite identical results (available upon request). But, in comparison to the standard regression, the between groups regression has the disadvantage of not capturing the process of adjustment in East Germany and the variation in agglomeration.

Even if unobserved heterogeneity in the estimation cannot be tackled directly due to the restrictions of the analysis, it is however possible to robustify inference. For that purpose, the regressions have been run using standard errors according to White (1980). In all cases the confidence intervals appear to be smaller than in the standard estimation. Therefore, the results of the standard estimation can be considered as conservative estimates. Even if the heteroscedasticity-consistent estimation might be superior to the standard estimation from a theoretical point of view, preference is given to the latter in the present case because of the limited number of observations.[11]

5 Conclusion

This paper has analyzed the impact of both population size and population density on the per capita cost of public goods provided by the German states. For this purpose, a framework of per capita expenditures was presented featuring the

[10] The results of the different sensitivity analyses are available upon request.

[11] According to Davidson and MacKinnon (1993), the reliability of the heteroscedasticity-consistent matrix of covariance is questionable in the case of small samples, see ibd., p.553.

degree of agglomeration and the size of population as main explanatory variables. The approach suggested takes account of the level of public services provided, as well as of trends and of specific conditions in East Germany. This model was estimated separately for about 40 government functions. While the results differ across functions, the aggregated effect of agglomeration on the budget is insignificant. This implies that, in the aggregate, per capita cost of public services are constant, *i.e.* there is no cost disadvantage for highly urbanized nor for sparsely populated regions. Hence a preferential treatment of such states in fiscal equalization schemes as in Germany cannot be justified by referring to the cost of providing public goods. However, with regard to population size the results suggest that small states have some cost disadvantage. A state with half the average size of 5.9 million inhabitants will have about 4 % higher cost than the average state. Thus, at given state boundaries a preferential treatment of smaller states in the fiscal equalization system seems justifiable. Of course, from an efficiency point of view an alternative option is to rearrange state boundaries.

To put these findings into perspective, it is important to keep in mind that the analysis refers to the state and not to the local level. Now, if states in Germany follow the advice of the classical writers in fiscal federalism such as Musgrave (1959) and Oates (1972), they provide public goods whose benefits exert significant effects across their whole territory, irrespective of the place where they are provided. Thus, it is not too surprising that local conditions like population density are found not to affect the overall cost of public services at the state level. Consequently, one should be careful when applying the current results to the level of municipalities. There, the scarcity of land may well induce increasing cost in the provision of public goods. It is left for future research to find out whether this is indeed the case. The approach taken in this paper could prove useful in such an exercise as well.

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Table 2: Estimates for direct expenditures, by government function

Function	Exp. per capita	Pop. density		1/Population		Indicator
Other administration	14.1	0.001	(0.001)	0.024***	(0.002)	no
General government	108.3	-0.037***	(0.006)	0.148***	(0.011)	no
Internal admin.	35.0	0.007	(0.007)	-0.010	(0.015)	yes
Building admin.	29.0	-0.017***	(0.004)	-0.002	(0.007)	no
Tax, financial admin.	121.8	0.004	(0.003)	0.029***	(0.009)	yes
External affairs	1.1	-0.000	(0.000)	-0.001 **	(0.001)	no
Other publ. security	8.6	-0.005***	(0.001)	0.002	(0.002)	no
Police	228.7	-0.007	(0.006)	0.019 *	(0.010)	yes
Other courts	17.7	-0.002 **	(0.001)	-0.002	(0.002)	yes
Ordinary courts, attorneys	138.3	-0.005 **	(0.002)	-0.013***	(0.004)	yes
Prisons	40.8	0.000	(0.003)	0.012***	(0.005)	yes
Gen. education schools	652.3	-0.048	(0.048)	-0.034	(0.086)	yes
Vocational schools	175.4	0.059	(0.049)	0.063	(0.095)	yes
Universities	588.3	0.090 **	(0.045)	0.183 **	(0.079)	yes
Support of education	39.0	0.013***	(0.002)	-0.009 **	(0.004)	no
Other education	24.6	-0.001	(0.003)	0.002	(0.006)	yes
Extra-univ. science	69.6	-0.004	(0.005)	-0.017 *	(0.010)	no
Other cultural affairs	50.6	-0.017***	(0.005)	-0.006	(0.010)	no
Theatre, music	20.8	-0.001	(0.006)	0.018 **	(0.008)	yes
Other social affairs	117.6	0.029***	(0.009)	-0.007	(0.020)	yes
Other familiy benefits	105.0	0.003	(0.012)	0.021	(0.024)	yes
Social welfare	67.2	-0.003	(0.021)	0.319***	(0.048)	yes
Youth welfare	18.9	-0.004	(0.007)	-0.013	(0.019)	yes
War effects	26.6	-0.004	(0.007)	-0.012	(0.013)	no
Other health affairs	15.0	0.001	(0.002)	0.020***	(0.004)	no
Hospitals	89.8	-0.016	(0.010)	0.010	(0.020)	yes
Sports, recreation	8.2	0.001	(0.001)	-0.004 **	(0.002)	yes
Environm. protection	29.0	-0.010 *	(0.006)	-0.017	(0.011)	no
Housing	157.6	-0.096***	(0.022)	0.005	(0.043)	no
Area planning, etc.	24.9	-0.014***	(0.002)	0.006	(0.005)	no
Food, agriculture	123.9	0.024 *	(0.015)	-0.005	(0.018)	yes
Other manufact., services	36.2	-0.007 **	(0.004)	0.002	(0.007)	no
Energy and water supply	25.7	-0.017 **	(0.007)	-0.005	(0.013)	no
Regional development	151.7	0.002	(0.013)	0.100***	(0.025)	no
Roads (incl. admin.)	48.9	-0.012	(0.009)	0.017	(0.017)	yes
Railways, publ. transp.	157.6	-0.020	(0.013)	0.033	(0.025)	no
Agricultural enterprises	44.4	-0.000	(0.010)	0.006	(0.009)	yes
Total (all states)	*3612.2*					
Total (West German states)	*3041.6*					

Note: Average direct per capita expenditure (in DM) of the 13 non-city states in 1997. Standard errors are in brackets. ***, **, and * indicate significance at 1%, 5% and 10% levels, respectively.

Table 3: Elasticities, by government function, 1997

Function	Pop. density		Population	
Other administration	0.135	(0.154)	0.707***	(0.038)
General government	-0.625***	(0.098)	0.764***	(0.021)
Internal admin.	0.389	(0.372)	1.052	(0.074)
Building admin.	-1.059***	(0.261)	1.014	(0.041)
Tax, financial admin.	0.060	(0.039)	0.959***	(0.013)
External affairs	-0.022	(0.565)	1.204*	(0.123)
Other publ. security	-0.986***	(0.273)	0.968	(0.044)
Police	-0.059	(0.048)	0.986*	(0.007)
Other courts	-0.183**	(0.083)	1.024	(0.019)
Ordinary courts, attorneys	-0.064**	(0.026)	1.017***	(0.005)
Prisons	0.008	(0.136)	0.947***	(0.019)
Gen. education schools	-0.134	(0.135)	1.009	(0.023)
Vocational schools	0.617	(0.542)	0.938	(0.095)
Universities	0.278**	(0.139)	0.946**	(0.023)
Support of education	0.617***	(0.109)	1.042**	(0.019)
Other education	-0.092	(0.246)	0.984	(0.044)
Extra-univ. science	-0.115	(0.132)	1.043*	(0.024)
Other cultural affairs	-0.620***	(0.204)	1.021	(0.035)
Theatre, music	-0.115	(0.490)	0.851**	(0.071)
Other social affairs	0.450***	(0.147)	1.010	(0.030)
Other familiy benefits	0.051	(0.212)	0.965	(0.040)
Social welfare	-0.094	(0.570)	0.180***	(0.295)
Youth welfare	-0.361	(0.707)	1.123	(0.181)
War effects	-0.270	(0.477)	1.081	(0.089)
Other health affairs	0.149	(0.268)	0.771***	(0.060)
Hospitals	-0.321	(0.212)	0.980	(0.039)
Sports, recreation	0.239	(0.280)	1.091**	(0.044)
Environm. protection	-0.611	(0.392)	1.102	(0.071)
Housing	-1.106***	(0.308)	0.995	(0.048)
Area planning, etc.	-1.036***	(0.206)	0.960	(0.033)
Food, agriculture	0.357*	(0.216)	1.007	(0.025)
Other manufact., services	-0.375**	(0.181)	0.990	(0.032)
Energy and water supply	-1.216**	(0.597)	1.034	(0.090)
Regional development	0.027	(0.157)	0.886***	(0.031)
Roads (incl. admin.)	-0.450	(0.359)	0.940	(0.061)
Railways, publ. transp.	-0.229	(0.148)	0.964	(0.027)
Agricultural enterprises	-0.012	(0.417)	0.975	(0.036)
Total (all states)	*-0.057*	(0.050)	*0.958****	(0.010)
Total (West German states)	*-0.039*	(0.050)	*0.960****	(0.010)

Note: Standard errors are in brackets. ***, **, and * indicate significance at 1%, 5% and 10% levels, respectively, as derived from the Wald test for joint significance. In case of population the test is carried out for the hypothesis that the elasticity is equal to unity.

Table 4: Government functions and indicators of public activity

Code	Function	Indicator
1002a	Other administration	–
1003	General government	–
1004	Internal admin.	Government districts (p. inh.)
1005	Building admin.	–
1006	Tax, financial admin.	Income tax-payers (p. inh.)
1007	External affairs	–
1010a	Other publ. security	–
1011	Police	Recorded crimes (p. inh.)
1012a	Other courts	Judges at other courts (p. inh.)
1013	Ordin. courts, attorneys	Judges at ordinary courts (p. inh.)
1014	Prisons	Prisoners (p. prison); Prisons (p. inh.)
1017a	Gen. education schools	Pupils at general schools (p. inh.)
1018a	Vocational schools	Teachers at vocat. schools (p. inh.)
1019	Universities	Scientific staff (p. inh.); Universities (p. inh.)
1020	Support of education	–
1021	Other education	Further educat. colleges (p. inh.)
1022	Extra-univ. science	–
1023a	Other cultural affairs	–
1024	Theatre, music	Visitors of public theatres (p. inh.)
1025a	Other social affairs	Unemployed persons (p. inh.)
1028a	Other familiy benefits	Housing benefit receivers (p. inh.)
1029	Social welfare	Social benefits receivers (p. inh.)
1030	Youth welfare	Young people receiving educ. assist. (p. inh.)
1031	War effects	–
1032a	Other health affairs	–
1033	Hospitals	Public hospitals (p. inh.)
1034	Sports, recreation	Recreation area in km^2 (p. inh.)
1035	Environm. protection	–
1037	Housing	–
1038	Area planning, etc.	–
1045	Food, agriculture	Agric. area (p. inh.); Empl. in agric. (p. inh.)
1046a	Other manuf., services	–
1047	Energy, water supply	–
1049	Regional development	–
1051a	Roads (incl. admin.)	Licensed vehicles (p. inh.)
1057	Railways, publ. transp.	–
1059	Agricult. enterprises	Agric. area in km^2 (p. inh.)

Four-digit code according to the fiscal statistics. a indicates residual categories. Source: except for crime data, which are obtained from the Federal Police Office, all data are obtained from the German Statistical Office, various publications.