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Abstract:
Many countries apply cost-equalization and/or fiscal capacity equalization formulas to enable sub-national governments to provide comparable service standards at comparable tax rates. This paper demonstrates how measures of expenditure needs and fiscal capacity can be derived from a structural model of local government spending and taxing behavior. The structural parameters are shown to provide the information required to implement equalization according to the principle of horizontal equity.

Keywords: Fiscal Equalization, Expenditure Needs, Fiscal Capacity, Structural Modeling

JEL classification: H71, H72

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Sammendrag

Mange land benytter formler for utgiftsutjevning og/eller inntektsutjevning for å sikre at kommunene kan tilby et likeverdig tjenestetilbud for et gitt nivå på skattesatsene. Denne studien diskuterer hvordan mål på utgiftsbehov og fiskal kapasitet kan utledes fra en strukturell modell for kommunenes økonomiske atferd. Det blir vist at strukturparametrene i modellen gir oss den informasjonen som er nødvendig for å gjennomføre utjevning i samsvar med prinsippet om horisontal likhet.

Introduction

Intergovernmental transfers are a major source of sub-national government financing in many countries around the world. Central governments frequently refer to equity goals to justify the distributional profiles of the grants to local governments. Therefore, a common purpose of intergovernmental transfers is to enable local authorities to provide a standard package of public services at an equal local tax rate or tax effort. Such policies, which are termed *fiscal equalization*, seek to compensate local governments with high expenditure needs or low fiscal capacity. *Expenditure needs* are defined as the costs of providing a standard package of public services. These costs may vary due to environmental factors and demographic characteristics that are beyond the control of local authorities.[1] *Fiscal capacity* is defined as the ability of local governments to raise revenues from local resources. The present paper aims to develop a theory–consistent framework for measuring expenditure needs and fiscal capacity.

Conventional approaches. Measures of expenditure needs are frequently derived by employing regression-based methods. As indicated by MacNevin (2004) and Reschovsky (2007), there are two regression-based approaches: one relies on service-specific cost functions which typically depend on output of a given service, input prices and environmental factors.[2] A limitation of this approach is that measures of public output are only accessible in exceptional cases. Given the demanding data requirements of the cost function approach, economists have introduced an alternative method called the reduced form expenditure function approach.[3] This approach uses single-equation methods to assess expenditures as a function of input prices, environmental factors and taste variables that explain public preferences for different publicly provided goods. A concern with this method is how to provide a valid definition of expenditure needs as a function of reduced form parameters.

A structural modeling approach. The present paper discusses a third approach for estimating expenditure needs, called the structural modeling approach.[4] The structural approach specifies a complete model of local government fiscal and spending behavior and estimates parameters that characterize preferences and cost functions of local governments. In other areas of research, advocates

[1] Bradford, Malt and Oates (1969) developed the concept of environmental variables affecting the production functions for local public services.

[2] See e.g. Downes and Pogue (1994), Reschovsky and Imazeki (2003) and Duncombe and Yinger (2005). These studies focus on special-purpose jurisdictions such as American school districts for which output measures are available.

[3] For discussions of reduced form regression analysis, see e.g. Auten (1974), Bradbury et al. (1984), Ladd (1994) and Shah (1996).

[4] See Yinger (1986) and Aaberge and Langørgen (2003) for structural analyses of the spending behavior of local governments.

of structural modeling have criticized the reduced form approach for estimating statistics that are not policy-invariant parameters of economic models and therefore have limited relevance for policy and welfare analysis. (See e.g. Rosenzweig and Wolpin, 2000; Heckman and Vytlacil, 2005; Deaton, 2010). The present paper investigates what can be gained from structural modeling when the topic is fiscal equalization and measurement of local public expenditure needs and fiscal capacity.

Local government behavior. This paper employs a model of local government spending and taxing behavior as a basis for defining measures of expenditure needs and fiscal capacity. It is demonstrated that target-group-specific production can be identified within a structural expenditure system where local governments have preferences over the allocation of production to service sectors and target groups. Local government utility is maximized subject to a budget constraint which includes specification of fixed costs and costs per unit of output by service sector, and where locally imposed taxes are treated as endogenous. The identification strategy is based on observable heterogeneity in fiscal capacity, fixed costs, and costs per unit of output.

Horizontal equity. Identification of target-group-specific and sector-specific production forms the basis for providing a precise definition of horizontal equity. *Horizontal equity* is obtained when the output received per person in a given target group is equal across municipalities. A corresponding equalization scheme is derived, which allows local governments to provide services to all target groups to satisfy the principle of horizontal equity. This scheme is a function of the structural parameters in the model. Thus, a main contribution of this paper is to develop methods for designing fiscal equalization policies by utilizing parameters derived from economic theory.

Comparison with reduced form. A second purpose of the paper is to compare structural model estimates to reduced form estimates. It is argued that reduced form parameters are not the relevant parameters of interest, since they mix together expenditure needs from different service sectors. Moreover, the empirical analysis based on Norwegian data finds that reduced form parameter estimates are biased for measuring the expenditure needs included in the compensation rule. Consequently, reduced form parameters do not provide the information required to simulate (or implement) the counterfactual equalization policy.

The paper is organized as follows: Section I presents the structural model derived from maximization of a Stone–Geary utility function for a given budget constraint. Section II derives a scheme for fiscal equalization from the structural model under the condition that the allocation of intergovernmental

grants is based on the principle of horizontal equity. Section III provides a comparison of structural and reduced form parameters. Section IV gives an account for the responsibilities and institutional features of local government in Norway, while Section V presents results of an empirical analysis using Norwegian data. A brief summary is given in Section VI.

I. The structural model

As demonstrated by Aaberge and Langørgen (2003) and Aaberge et al. (2010), the linear expenditure system (LES) is a helpful model for describing the spending behavior of Norwegian municipalities, provided that the model accounts for heterogeneity in expenditure needs and preferences for allocation of income to different services.[5] Local governments are assumed to have preferences regarding tax burden and over levels of output on *S* service sectors distributed to *J* different target groups. Tax burden is treated as a negative good and depends both on the local tax rate and the size of the local tax base. It is a common result of empirical analyses of local government behavior that unrestricted intergovernmental grants stimulate much more local public spending per unit of grants than do income transfers to the households within the community.[6] By allowing lump sum grants and local tax bases to have different effects on local government fiscal choices, the treatment of tax burden as a negative good accommodates the well-known flypaper effect ("money sticks where it hits").[7] The utility U_k of local government *k* is assumed to be given by the following specification of a Stone–Geary utility function:

$$U_k = \theta_k \log\left(\kappa_k - v_k\right) + \sum_{i=1}^{S}\sum_{j=1}^{J} \beta_{ijk} \log\left(x_{ijk} - \gamma_{ij}\right), \tag{1}$$

where

$$\theta_k + \sum_{i=1}^{S}\sum_{j=1}^{J} \beta_{ijk} = 1, \tag{2}$$

[5] The model, which can be considered as a "community preference" model, treats public authorities as economic agents that maximize utility under the condition of a given budget constraint. For a discussion of the community preference model, see Wildasin (1986). In the present paper the model is further developed by allowing for a distinction between fixed and variable costs.

[6] A survey of this literature is provided in Hines and Thaler (1995).

[7] See Johnson (1979).

where v_k denotes the tax income, and x_{ijk} is the production of service *i* per person of target group *j* in municipality *k*. The parameter γ_{ij} is interpreted as the minimum quantity per person of service *i* targeted to group *j* and can also be considered as a measure of the local governments' common assessment of the need for different services targeted to different population subgroups. By contrast, the parameter β_{ijk}, which can be interpreted as the marginal budget share for spending on group *j* in service sector *i*, is allowed to vary across municipalities. The parameter θ_k is equal to the marginal budget share distributed to the private sector as a reduction in the tax burden. Similar to Johnson (1979), the parameter κ_k is interpreted as the maximum acceptable level of local taxes.

Local governments face fixed costs in the production of public services, simply because municipalities need administrative and political management, they have a legal duty to keep accounts, and they have to maintain a basic stock of buildings and service functions to be able to operate. These costs are fixed in the sense that they, in the short run, do not vary with the amount of production of different services. Fixed costs accrue for all municipalities irrespective of any production activity and do not increase with the size of the municipality. Fixed costs are therefore relatively high for small municipalities.

For variable costs it is assumed that the cost per unit of service production may vary across municipalities and service sectors. Note, however, that unit costs do not vary as a function of output in the model, which is based on the assumption that production functions exhibit constant returns to scale.[8] In order to distinguish between fixed and variable costs, total expenditure in service sector *i* is assumed to satisfy the following decomposition:

$$u_{ik} = \frac{\alpha_{ik}^F}{n_k} + \pi_{ik} x_{ik}, \quad i = 1, 2, ..., S, \tag{3}$$

where u_{ik} is expenditure per capita in service sector *i*. Fixed costs in service sector *i* are denoted α_{ik}^F, n_k is the population size of municipality *k*, the costs per unit in the production of service *i* are π_{ik}, and x_{ik} is production per capita in service *i*. Thus, the variable costs in sector *i* are defined by $\pi_{ik} x_{ik}$. Furthermore, the production in service sector *i* is allocated to target groups as follows:

[8] In case unit costs depend on output the analysis becomes more complex since outputs are unobserved and endogenous.

(4) $$x_{ik} = \sum_{j=1}^{J} x_{ijk} z_{jk}, \quad i = 1, 2, ..., S,$$

where z_{jk} is the population share that belongs to target group *j*.[9] The specification of production, unit costs and fixed costs is used to decompose the budget of the local governments. The budget constraint requires total incomes to be allocated to spending on different service sectors. By utilizing the definitions in (3) and (4), it also requires resources to be allocated to fixed and variable costs and to different target groups:

(5) $$y_k + v_k = \sum_{i=1}^{S} u_{ik} = \sum_{i=1}^{S} \frac{\alpha_{ik}^F}{n_k} + \sum_{i=1}^{S} \pi_{ik} x_{ik} = \sum_{i=1}^{S} \frac{\alpha_{ik}^F}{n_k} + \sum_{i=1}^{S} \pi_{ik} \sum_{j=1}^{J} x_{ijk} z_{jk},$$

where y_k is the block grant per capita received by local government *k*. Total income ($y_k + v_k$) is the sum of block grant and tax income. By maximizing (1) subject to (5), the following expenditure system is obtained:

(6) $$\begin{aligned} \pi_{ik} x_{ijk} z_{jk} &= \alpha_{ijk}^V + \beta_{ijk} \left(y_k + \kappa_k - \frac{\alpha_{+k}^F}{n_k} - \alpha_{++k}^V \right), \quad i = 1, 2, ..., S, \quad j = 1, 2, ..., J, \\ v_k &= \kappa_k - \theta_k \left(y_k + \kappa_k - \frac{\alpha_{+k}^F}{n_k} - \alpha_{++k}^V \right), \end{aligned}$$

where $\alpha_{ijk}^V = \pi_{ik} \gamma_{ij} z_{jk}$ is minimum variable cost in sector *i* targeted to group *j*, $\alpha_{++k}^V = \sum_{i=1}^{S} \pi_{ik} \sum_{j=1}^{J} \gamma_{ij} z_{jk}$ is total minimum variable cost in municipality *k*, and $\alpha_{+k}^F = \sum_{i=1}^{S} \alpha_{ik}^F$ is total fixed cost in municipality *k*.

Discretionary income is defined by $y_k + \kappa_k - \frac{\alpha_{+k}^F}{n_k} - \alpha_{++k}^V$, which is the income potential remaining when the fixed costs and minimum variable costs have been covered. Exclusion restrictions of the type $\gamma_{ij} = 0$ capture the fact that all target groups do not necessarily receive all services.

---

[9] Note that multiplication by z_{jk} changes the normalization of x_{ijk}, since x_{ijk} is measured per person in the target group subpopulation, whereas $x_{ijk} z_{jk}$ is measured per person in the entire local population.

In normal circumstances, the allocation of expenditures and production to target groups is unobserved. However, the model is identified by imposing the following multiplicative structure on the marginal budget shares:

$$
\begin{aligned}
&\beta_{ijk} = \beta_{ik}\delta_{ijk}, \quad i = 1,2,...,S, \quad j = 1,2,...,J, \\
&\theta_k + \sum_{i=1}^{S} \beta_{ik} = 1, \\
&\sum_{j=1}^{J} \delta_{ijk} = 1, \quad i = 1,2,...,S,
\end{aligned} \tag{7}
$$

where β_{ik} is the marginal budget share for service sector *i*, and δ_{ijk} is the share of sector-specific discretionary income in service sector *i* that is allocated to target group *j*. Inserting (7) into (6) and aggregating across target groups within each service sector yields

$$
\begin{aligned}
&\pi_{ik} x_{ik} = \alpha_{i+k}^{V} + \beta_{ik}\left(y_k + \kappa_k - \frac{\alpha_{+k}^{F}}{n_k} - \alpha_{++k}^{V} \right), \quad i = 1,2,...,S, \\
&v_k = \kappa_k - \theta_k\left(y_k + \kappa_k - \frac{\alpha_{+k}^{F}}{n_k} - \alpha_{++k}^{V} \right),
\end{aligned} \tag{8}
$$

where

$$
\alpha_{i+k}^{V} = \pi_{ik} \sum_{j=1}^{J} \gamma_{ij} z_{jk}, \quad i = 1,2,...,S. \tag{9}
$$

Thus α_{i+k}^{V} is by definition equal to the minimum variable cost in service sector *i*.

In the normal case, estimation of the model as specified in (8) is not possible, since it is difficult to find measures of public outputs. For local governments, given their wide array of responsibilities, it is not feasible to measure all the relevant outputs. Thus, the variable costs on the left-hand side of expression (8) are unobserved. However, by inserting (3) into (8) the model is expressed in terms of expenditures rather than in terms of unobserved outputs:

$$
\begin{aligned}
u_{ik} &= \frac{\alpha_{ik}^{F}}{n_k} + \alpha_{i+k}^{V} + \beta_{ik}\left(y_k + \kappa_k - \frac{\alpha_{+k}^{F}}{n_k} - \alpha_{++k}^{V} \right), \quad i = 1,2,...,S, \\
v_k &= \kappa_k - \theta_k \left(y_k + \kappa_k - \frac{\alpha_{+k}^{F}}{n_k} - \alpha_{++k}^{V} \right).
\end{aligned} \tag{10}
$$

By allowing the minimum quantity parameters γ_{ij} to vary across target groups, the modeling framework is flexible in the sense that it accounts for different needs for public services across different demographic groups. Moreover, the marginal budget share parameters of the model are allowed to vary as a function of observed heterogeneity:

$$
\begin{aligned}
\beta_{ik} &= \tilde{\beta}_{i0} + \sum_h \tilde{\beta}_{ih} t_{hk}, \ (i = 1,2,...,S), \\
\theta_k &= \tilde{\theta}_0 + \sum_h \tilde{\theta}_h t_{hk},
\end{aligned} \tag{11}
$$

where t_{hk} is a taste variable that affects the preferences for allocating discretionary income. For instance, the party composition of the local government council may influence such service priorities. This specification allows for different political priorities over service sectors across local governments. Such priorities are assumed to affect the allocation of discretionary income to services sectors. Since the marginal budget share parameters have to satisfy the adding-up conditions in (2) and (7), it is assumed that $\tilde{\theta}_0 + \sum_{i=1}^{S} \tilde{\beta}_{i0} = 1$ and $\tilde{\theta}_h + \sum_{i=1}^{S} \tilde{\beta}_{ih} = 0$ for $h \neq 0$.

Similarly as for the marginal budget share parameters, one may allow the fiscal capacity parameter κ_k, the fixed cost parameters α_{ik}^{F} and the unit cost parameters π_{ik} to vary as functions of observed characteristics.[10] Fiscal capacity (κ_k) may depend on more than one variable if local governments have access to more than one tax base or the tax function is non-linear.

Environmental factors such as population density and travelling distances may affect both fixed costs and unit costs, while unit costs may also vary as a function of factor input prices. Note that a fixed cost that is constant across municipalities implies that the per capita fixed cost is decreasing as a function of population size. Thus fixed costs are specified as follows:

[10] The specification of unit cost parameters is discussed in Aaberge et al. (2010).

(12) $$\frac{\alpha_{ik}^F}{n_k} = \tilde{\alpha}_{i0}^F \frac{1}{n_k} + \sum_{h=1}^{H} \tilde{\alpha}_{ih}^F \frac{c_{hk}}{n_k}, \quad i = 1,2,...,S,$$

where $\tilde{\alpha}_{i0}^F$ is the constant component[11] of fixed cost in sector *i*, c_{hk} is a variable that affects fixed costs, and $\tilde{\alpha}_{ih}^F$ is the corresponding parameter for service sector *i*. By inserting the parameter heterogeneity specifications in (9), (11) and (12) into (10), and moreover specifying fiscal capacity (κ_k) and unit costs (π_{ik}) as functions of observable characteristics, an expenditure system is obtained where all parameters are identified.[12]

II. Fiscal equalization

"Expenditure need" in the context of the model presented in Section I can be defined as the sum of fixed costs and minimum variable costs, and can thus be interpreted as the expenditure that is required to obtain a minimum standard γ_{ij} of public services for different target groups. Alternatively, expenditure needs might be defined for average service standards, which are discussed below.

The widely acknowledged demand for fiscal equalization is commonly justified by referring to the principle of *horizontal equity*.[13] This principle states that individuals who are equal or have equal needs should be given equal treatment. In the context of the structural model above, this means that individuals who belong to the same target group should receive equal public service production regardless of where they reside. Municipalities should therefore have equal economic opportunity to provide a standard package of public services. In order to achieve horizontal equity one may also require citizens to be exposed to equal tax rates or equal tax burdens across jurisdictions.

Before defining the standard package of public services, it is convenient to make the following assumption about the unidentified parameters in the expenditure system:

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[11] The component is constant on the municipal level. The constant component is multiplied by inverse population size since the equations are normalized on a per capita basis. Thus the inverse population size is included as an artifact of normalization.

[12] Before estimation the equation system is extended with additive stochastic error terms, accounting for unexplained variation in the model. Thus the left-hand side variables in the theory model discussed above should be interpreted as expected values.

[13] *Fiscal equity* is defined as a modified form of horizontal equity, in which the aim is to equalize the *potential* of sub-national governments to provide equal service levels at equal tax rates, without compelling them to do so. In some countries (e.g. Canada and Germany) this principle is enshrined in the constitution. Economists have put forward efficiency and equity arguments in favor of equalization, see e.g. Buchanan (1950), Mieszkowski and Musgrave (1999), Boadway (2004) and Allers (2012).

(13) $$\delta_{ijk} = \frac{\gamma_{ij} z_{jk}}{\sum_{j=1}^{J} \gamma_{ij} z_{jk}} = \frac{\alpha_{ijk}^{V}}{\alpha_{i+k}^{V}}, \quad i = 1, 2, ..., S, \quad j = 1, 2, ..., J.$$

Recall that δ_{ijk} is the share received by target group *j* of the discretionary income that is allocated to service sector *i*. This share is assumed to be equal to target group *j*'s share of the total minimum required quantities in sector *i*. Stated equivalently, municipalities allocate sector-specific discretionary income to target groups proportional to each target group's share of minimum variable costs in each service sector. This assumption is relatively simple and plausible, although other types of allocation are possible. However, it is not plausible to assume that discretionary income is used to finance fixed costs, since fixed costs are already subtracted in the definition of discretionary income. Consequently, it is assumed that discretionary income is used to increase variable costs above minimum expenditures, and thereby increase the output received by different target groups.

The structural model includes sector-specific marginal budget shares (β_{ik} and θ_k) that vary across municipalities as a function of taste variables that account for different preferences for allocating discretionary incomes. Equalization systems are normally meant to compensate for different economic circumstances, but not for different local priorities. Local governments in many countries are responsible for providing several different services. Decentralized decision-making means that local governments are allowed to make different priorities across service sectors. Consequently, fiscal equalization is generally aimed at equalizing the economic choice opportunities for local public service production, whereas local governments enjoy wide discretion to make their own priorities over different services. To facilitate accountability, the ambition is restricted to compensate for cost factors and fiscal capacity that are largely or entirely beyond the control of local authorities. Equalization grants are only allowed to affect local government priorities in a lump-sum manner that expands the available economic resources.

To focus on the goal of equity rather than decentralization, horizontal equity is defined for the case where preferences for allocating discretionary incomes are proportional to the sector-specific shares of minimum variable costs. This hypothetical benchmark is based on the view that minimum quantity, unit cost, and fixed cost parameters provide sufficient information to evaluate expenditure needs.

Condition 1: (Marginal budget shares equal minimum variable cost shares) Minimum variable cost shares are defined as the shares of total minimum variable costs that are allocated to each service

sector. Thus it is assumed that $\beta_{ik} = \alpha^V_{i+k} / \alpha^V_{++k}$, ($i = 1, 2, ..., S$). The corresponding benchmark for the marginal budget share allocated to tax reduction is $\theta_k = 0$.

Marginal budget shares equal to minimum variable cost shares implies that discretionary incomes are allocated to service sectors (and target groups) in the same proportion as minimum variable costs. Note also that equation (13) and Condition 1 satisfy the adding-up conditions in equation (7). Inserting Condition 1 and equation (13) into (7) and (6) yields $v_k = \kappa_k$ and

$$(14) \qquad \frac{x_{ijk} - \gamma_{ij}}{\gamma_{ij}} = \frac{y_k + \kappa_k - \frac{\alpha^F_{+k}}{n_k} - \alpha^V_{++k}}{\alpha^V_{++k}} = a_k, \quad i = 1, 2, ..., S, \quad j = 1, 2, ..., J.$$

The ratio a_k will in general vary across municipalities. However, a special case relevant for fiscal equalization is defined by

Condition 2: (Horizontal equity) In this case the ratio a_k is constant across municipalities, and expressed as $a_k = a$. This means that members of the same target group are treated equally across municipalities. Moreover, tax rates are equal at the maximum acceptable level, which defines fiscal capacity κ_k .

From the condition of horizontal equity it follows that x_{ijk} is equalized across municipalities, since $x^*_{ij} = (1 + a)\gamma_{ij}$ is a constant which is defined as the standard package of public services for service *i* targeted to group *j*. Thus the output per person in all target groups is constant across all municipalities in all the service sectors. To derive the ratio a it is necessary to take into account the central government budget constraint for allocating incomes to municipalities

$$(15) \qquad y = \sum_{k=1}^{K} \frac{n_k}{n} y_k,$$

where y is total per capita block grants from the central government, and n is total population in the country. Inserting Condition 2 into equation (14) and aggregating across municipalities yields

(16) $$\frac{y+\kappa-\frac{\alpha^F}{n}-\alpha^V}{\alpha^V}=a,$$

where $\kappa=\sum_{k=1}^{K}\frac{n_k}{n}\kappa_k$ is total per capita fiscal capacity in the whole country, $\alpha^F=\sum_{k=1}^{K}\alpha_{+k}^F$ is total fixed cost in the whole country, and $\alpha^V=\sum_{k=1}^{K}\frac{n_k}{n}\sum_{i=1}^{S}\pi_{ik}\sum_{j=1}^{J}\gamma_{ij}z_{jk}$ is total per capita minimum variable cost in the whole country. Inserting Condition 2 and equation (16) into (14) yields

(17) $$y_k^*=-\kappa_k+\frac{\alpha_{+k}^F}{n_k}+\alpha_{++k}^V+\frac{\alpha_{++k}^V}{\alpha^V}\left(y+\kappa-\frac{\alpha^F}{n}-\alpha^V\right),$$

where y_k^* is the allocation of central government funding to municipalities that satisfies the condition of horizontal equity. Equation (17) shows that to obtain horizontal equity, each municipality should receive funding for its fixed costs and variable minimum costs subtracted local fiscal capacity. It should also receive total per capita discretionary income in the whole country multiplied by a cost index for minimum variable costs (α_{++k}^V/α^V). If minimum variable costs in municipality *k* are above (below) the national average, municipality *k* receives higher (lower) than average discretionary incomes.

Finally, from equation (17) one may denote $\frac{\alpha_{+k}^F}{n_k}+\frac{\alpha_{++k}^V}{\alpha^V}\left(y-\frac{\alpha^F}{n}\right)$ as the "expenditure need" of municipality *k* in the case where expenditure needs are defined for average service standards provided to all target groups. According to this definition, the central government should provide compensation for the fixed costs of each municipality. Aggregate incomes over and above aggregate fixed costs should be allocated in proportion to per capita minimum variable costs in different municipalities.[14]

If equation (13) and/or Condition 1 is violated, the allocation may of course not satisfy horizontal equity even if (17) is satisfied. Nevertheless, the central government could apply the equalization rule

[14] Boadway (2004) argues that for some cost factors, the equity advantage of more equal provision must be weighted against the efficiency costs. If it is more costly to deliver public services in rural areas than urban areas, it is inefficient for an equalization program to neutralize these cost differences. For instance, equalization payments favoring small municipalities could prevent them from amalgamating. To accommodate this criticism, the equalization formula in (17) could be adjusted by reducing or eliminating compensation for variation in fixed costs and unit costs.

in (17) based on the view that it would equalize the economic opportunities to provide the standard package of public services. That being the case, it would be relevant to control for taste variables in the estimation of the structural model, although we do not want to compensate municipalities for different priorities or variation in taste variables.

III. Reduced form

A conventional procedure in the economic literature and also applied by practitioners in the design of national grant systems, is to derive expenditure needs from reduced form models. An advantage of the reduced form approach is that it can be applied in cases where measures of output are not observed, as opposed to the cost function approach which requires observed outputs. However, the absence of reliable output measures does not concern the choice between a reduced form and a structural approach, since neither approach requires observed outputs.

To apply the fiscal equalization formula in equation (17) it is necessary to estimate the structural LES system. An interesting question is whether reduced form parameters can be given a meaningful interpretation as measures of expenditure needs, i.e., we have to explore whether the fiscal equalization condition (17) can be expressed in terms of the reduced form parameters.

Recall that structural and reduced form parameters differ by definition, inasmuch as structural parameters are defined to characterize preferences and cost functions. By contrast, reduced form parameters are measuring the partial marginal effect of a change in a given exogenous variable on different endogenous variables. Reduced form parameters are commonly estimated in partial (single-equation) regression models. However, reduced form parameters can also be derived from simultaneous equation models.

To simplify the discussion of reduced form parameters, a linear version of the simultaneous model is used, which excludes interaction effects by assuming that $\pi_{ik} = 1$, $\beta_{ik} = \beta_i$ (i=1, 2,…,S). Thus, it is assumed that unit costs and marginal budget shares are constant across municipalities. When unit costs are assumed constant it follows from (9) that variable cost is given by $\alpha_{i+k}^{V} = \sum_{j=1}^{J} \gamma_{ij} z_{jk}$. Moreover, the discussion is further simplified by assuming no local tax discretion, which means that $\nu_k = \kappa_k = \theta_k = 0$. The simplified linear version of the expenditure system (LES) is derived by inserting the specification of fixed cost parameters in (12) into (10) to get, for $i = 1,...,S$

$$(18) \qquad u_{ik} = \tilde{\alpha}_{i0}^{F} \frac{1}{n_k} + \sum_{h=1}^{H} \tilde{\alpha}_{ih}^{F} \frac{c_{hk}}{n_k} + \sum_{j=1}^{J} \gamma_{ij} z_{jk} + \beta_i \left(y_k - \sum_{i=1}^{S} \tilde{\alpha}_{i0}^{F} \frac{1}{n_k} - \sum_{i=1}^{S} \sum_{h=1}^{H} \tilde{\alpha}_{ih}^{F} \frac{c_{hk}}{n_k} - \sum_{i=1}^{S} \sum_{j=1}^{J} \gamma_{ij} z_{jk} \right).$$

In (18) the sector-specific expenditure is expressed as a function of inverse population size, other environmental cost factors, demographic variables accounting for the needs of different target groups, and local government revenue.

The reduced form parameters are defined as the marginal effects of the independent variables on the dependent variable in different equations. The reduced form for spending on service sector *i* is therefore given by

$$(19) \qquad u_{ik} = \lambda_{i0} \frac{1}{n_k} + \sum_{h=1}^{H} \lambda_{ih} \frac{c_{hk}}{n_k} + \sum_{j=1}^{J} \phi_{ij} z_{jk} + \beta_i y_k, \quad i = 1, 2, ..., S,$$

where λ_{ih} is the reduced form parameter for environmental factor *h* that affects fixed costs, and ϕ_{ij} is the reduced form parameter for the population share of target group *j*.[15] The reduced form parameter for local government revenue is equal to the marginal budget share β_i, which is also a structural parameter characterizing the preferences of local governments. From (18) and (19) it follows that the remaining reduced form parameters can be expressed as functions of structural parameters:

$$(20) \qquad \begin{aligned} \lambda_{ih} &= \tilde{\alpha}_{ih}^{F} - \beta_i \sum_{i=1}^{S} \tilde{\alpha}_{ih}^{F}, \quad h = 0, 1, 2, ..., H, \quad i = 1, 2, ..., S, \\ \phi_{ij} &= \gamma_{ij} - \beta_i \sum_{i=1}^{S} \gamma_{ij}, \quad j = 1, 2, ..., J, \quad i = 1, 2, ..., S. \end{aligned}$$

As can be seen from (20), reduced form parameters differ from the structural parameters in cases where the marginal budget share parameters are positive (which is the case for normal goods). The reduced form parameters are defined as linear combinations of structural parameters related to

[15] Although theoretical considerations or statistical testing may substantiate why a given explanatory variable is excluded from the specification of fixed cost or minimum quantity in a given service sector, this does not imply that the same variable should be excluded for this service sector when specifying the reduced form. The reason for this is that each reduced form equation includes all variables that are included in one or more of the structural equations, since all variables enter into all structural equations by being included in the discretionary income.

different service sectors. This proves that the reduced form and the structural form represent different parameterizations of the simultaneous conditional probability distribution of local public expenditures.

The effect measured by a given reduced form parameter is downward biased compared to the effect measured by the corresponding structural fixed cost or minimum quantity parameter. In particular, the downward bias is aggravated for explanatory variables that affect costs positively in several service sectors. Note also that $\sum_{i=1}^{S} \lambda_{ih} = 0$ and $\sum_{i=1}^{S} \phi_{ij} = 0$, which shows that the sum of reduced form parameters across service sectors cannot be used as a basis for assessing total expenditure need for a given cost factor or target group.

The structural fixed cost and minimum quantity parameters are interpreted as measures of minimum expenditure needs, since horizontal equity will be satisfied when all municipalities provide services to all target groups just to cover minimum quantities. This structural measure of expenditure need is included as a component in the reduced form parameters in (20), which is measured by the parameters $\tilde{\alpha}_{ih}^{F}$ and γ_{ij}, respectively. However, there is a downward bias connected to the negative terms $-\beta_i \sum_{i=1}^{S} \tilde{\alpha}_{ih}^{F}$ and $-\beta_i \sum_{i=1}^{S} \gamma_{ij}$. These terms are interpreted as the change in discretionary income allocated to service sector *i*, which results from a marginal increase in cost factor *h* or the population share of target group *j*, respectively.

Since total revenues are constant, a partial marginal increase in cost factor *h* or the population share of target group *j* implies a decrease in discretionary income, which is allocated to service sectors in line with the marginal budget shares (β_i). This negative effect is offsetting the positive effect of increased expenditure need on actual expenditure. The decrease in allocated discretionary income depends on the marginal budget share in sector *i* and on minimum expenditure needs partly from other service sectors than sector *i*. When cost factor *h* or target group *j* affects expenditure needs in more than one service sector, the corresponding reduced form parameters conflate expenditure needs from different service sectors. This is because the reduced form parameters identify marginal effects on expenditures rather than on expenditure needs. The difference between the two types of effect comes about because (i) marginal effects on expenditures capture both the change in expenditure need and the change in discretionary income and its distribution to service sectors, and (ii) marginal effects on expenditures include a share of the change in expenditure needs in other service sectors than the one that is analyzed.

Thus the information contained in reduced form parameters does not distinguish between effects on minimum expenditure needs and discretionary incomes, and it also confuses expenditure needs in different service sectors. Structural parameters are the relevant parameters for defining and measuring expenditure needs in the context of the linear expenditure system (LES).[16]

The fiscal equalization formula (17) can be considered as a counterfactual policy for distributing intergovernmental grants. Even if the reduced form model is identified and reduced form parameter estimates are consistent, they do not provide the information required to simulate (or implement) the counterfactual policy.

IV. The Norwegian case

Norway emerges as an interesting country for studying intergovernmental transfers for reasons beyond data availability and quality. First of all, Norway is a relatively large country with a dispersed population and relatively large public sector where local governments play an important role in the provision of public services. Before 1986, the grant system consisted of a large number of service-specific matching grants, but through major reforms in 1986 and 1997 the funding of local governments was changed to rely heavily on unconditional block grants combined with local government tax revenues. The reform process aimed to decentralize decision powers to the local level while at the same time increasing accountability and budget control. As part of the process the central government introduced and developed the national equalization system which compensates for different expenditure needs and fiscal capacities.

Fiscal capacity equalization in Norway means compensating for variation in income tax revenues. Expenditure need equalization accounts for demographic and geographic characteristics that affect expenditure needs according to expert judgment; they are moreover regarded "objective" in the sense that the compensation criteria are beyond the control of local governments.[17] Apart from equalization grants the system also includes unconditional grants that aim to promote regional development in Northern Norway and in small municipalities. The Northern Norway grant is a per capita lump-sum which is fixed within each of the three Counties in Northern Norway.[18] The small municipality grant is

[16] The common approach using linear reduced form single-equation models for analyzing expenditure needs can be considered as reduced form versions of the LES model. This interpretation follows from the fact that LES is the only expenditure model that is linear and consistent with utility maximization for a given budget constraint.

[17] When the compensation criteria are beyond the control of local governments the received equalization grants can be considered as exogenous.

[18] The per capita grant in 2008 was 1457 NOK in Nordland, 2795 NOK in Troms and 6828 NOK in Finnmark.

given as a lump-sum to municipalities with less than 3,200 residents and less than 110 percent of the national average of income tax per capita.[19]

Local governments in Norway have several sources of tax revenues. Income taxes make up a large share of local public taxes in Norway. The average share is 64 percent in 2008. However, the local income tax base as well as the tax rate is determined by the central government, which means that the tax is not really a local tax, since local authorities have little opportunity to affect the collected taxes. These taxes should therefore be regarded as an integrated element of the centralized system of financing. Since local tax discretion is severely limited, it makes sense to define fiscal capacity for local income tax simply by observed tax revenues. Fiscal capacity equalization in Norway is restricted to redistribution of income taxes.

The second most important source of local tax revenue is user fees paid by the recipients of local public services. User fees on average account for 28 percent of local public taxes in 2008. Local governments are allowed to charge user fees for childcare, day-care facilities for school children, elderly care and utilities such as water supply, sewage treatment, and refuse collection. The tax base for user fees is the production of services that are subject to such charges. The extra revenue generated from increasing the output of services subject to user fees must be positive if the user charges per unit of output are kept constant. As discussed by Aaberge and Langørgen (2003), this means that an increase in intergovernmental grants may induce user fee hikes if the positive volume effect is greater than the negative price effect.

A third source of taxation is taxes paid by power plants, where the tax base is natural resources such as waterfalls that are utilized in the production of hydroelectric power. The tax bases include production of energy and property values of the power plants. Similar to the income tax, the tax bases as well as the tax rates are determined by the central government, and therefore beyond the control of local governments.

A fourth source of taxation is property taxes on housing. Until recently municipalities were only allowed to collect housing property taxes in densely populated areas. The tax base is derived from appraised property values. The rates are allowed to vary between 0 and 0.7 percent of the appraised property value, which means that local governments have tax discretion for this revenue type.

[19] The lump sum does not vary with municipality size. In 2008, the grant was 10.4 million NOK per municipality in the northernmost zone (Finnmark) and 5.3 million NOK per municipality in the rest of the country.

Although local governments in Norway have some revenue-related discretion, the scope for decentralized decision-making is more extensive when it comes to spending money on different services. Local governments are legally responsible for providing certain services, but they also enjoy the freedom to prioritize between different services while taking into account the budget constraint. According to the services that are typically provided by local governments in Norway, their activities are classified in 12 service sectors. Table 1 displays the allocation of spending to the different services. There are considerable differences in per capita expenditure shares in all service sectors.

Table 1. Summary statistics of public spending on different services, in percent, 2008

Sector	Mean	Standard deviation	Minimum	Maximum
Administration	10.2	3.1	3.7	20.0
Primary education	20.8	2.7	12.2	30.4
Other education	2.4	1.0	0.5	9.0
Childcare	10.5	3.1	4.6	20.7
Health care	4.8	1.4	2.7	10.3
Social services	2.8	1.4	0.1	8.2
Child protection	2.5	1.0	0.2	10.8
Long-term care	30.7	4.5	19.1	46.7
Culture	3.6	1.1	1.5	10.3
Road maintenance	1.7	0.7	0.0	3.8
Water, sewage, and refuse	3.9	1.7	0.0	13.9
Other infrastructure	6.2	2.3	0.3	18.9

Note: Number of observations = 402. Local public expenditure shares are measured inclusive of user fees.

The largest expenditure component is care for the elderly and disabled (long-term care), followed by primary education which provides ten years of education for children aged 6–15. The child-care sector provides daycare facilities for children aged 1–5. Other education is associated with after-school education and adult education. Local governments are responsible for health care provided by general practitioners. Social services include social assistance and temperance support to disadvantaged families, while child protection includes investigation of alleged child abuse, orphan homes, foster care, adoption services, and services aimed at supporting at-risk families so they can remain intact. The culture sector takes responsibility for sports, arts, museums, libraries, cinemas and churches. Other infrastructure includes municipal housing and commercial development.

V. Empirical results

The model which is derived by inserting parameter heterogeneity such as specified in equations (9), (11) and (12) into equation (10), is estimated based on detailed local government accounts and community characteristics of Norwegian municipalities in 2008. The model accounts for spending on the twelve service sectors displayed in Table 1, and the estimation also includes the budget surplus

(net operating result) as a sector in the model. The budget surplus is treated as a residual sector, which means that the model represents an extended linear expenditure system, see Lluch (1973).

Two different versions of the model are estimated to account for endogenous income components. Model 1 includes an equation for housing property taxes and another equation for user fees. Thus expenditures are defined inclusive of user fees in Model 1. Model 2 includes the same equations as Model 1, except that there is no equation for user fees in Model 2. Thus expenditures and incomes are defined exclusive of user fees in Model 2. Each of the two models is estimated simultaneously by the method of maximum likelihood, after including error terms in the equation system that are assumed to have a multinormal distribution with mean 0 and unrestricted covariance matrix. Table 2 reports R^2-adjusted as a measure of model fit, which shows that the goodness of fit is fairly high for most of the model equations, not least for larger service sectors such as long-term care, primary education, administration and childcare.

Table 2. Model fit measured by R^2 adjusted, 2008

Sector	1	2	3	4	5	6	7	8	9	10	11	12	Prop-erty taxes	User fees
Model 1	0.89	0.80	0.35	0.64	0.74	0.57	0.16	0.88	0.58	0.65	0.26	0.55	0.16	0.43
Model 2	0.89	0.80	0.39	0.62	0.73	0.57	0.16	0.86	0.64	0.67	0.01	0.49	0.16	–

Note: Number of observations = 402. The dependent variables are per capita expenditures in equation 1-12, and per capita incomes in the remaining equations. The model equation and sector numbers refer to

Equation 1: Administration	Equation 5: Health care	Equation 9: Culture
Equation 2: Primary education	Equation 6: Social assistance	Equation 10: Road maintenance
Equation 3: Other Education	Equation 7: Child protection	Equation 11: Water, sewage and refuse treatment
Equation 4: Childcare	Equation 8: Long-term care	Equation 12: Other infrastructure

Since labor is the main input in local public service production, the unit cost parameters may vary as a function of local wages. In Norway, local government wage rates are set in a centralized system of bargaining. It is assumed that that wage rates do not vary across municipalities. However, a factor that may affect unit costs is the dispersion of the local settlement pattern. The dispersion of settlements is accounted for by a variable defined as the average distance to the centre of the municipal sub-district.[20] Higher travelling distances may increase unit costs in primary education, elderly care and health care. For example, when it comes to primary education, municipalities with high settlement dispersion tend to supply a decentralized school structure with relatively few students per school and rather small classes. Moreover, higher settlement dispersion may increase unit costs in ambulant home care for the elderly and disabled, because staff travelling time between recipient homes increases with dispersion.

[20] The distance variable is based on administrative register data for the entire Norwegian population combining information on roads and household location by geographical coordinates.

Similarly, patients in primary health care are entitled to a general practitioner with a surgery within reasonable travelling distance. The costs of maintaining such services are therefore higher in sparsely populated areas.

The distance variable may also affect fixed costs in service production. Higher fixed costs may accrue when travelling distances are higher. That notwithstanding, when the distance variable is included in both unit cost and fixed cost parameters, it turns out that the parameter estimates for the distance variable display instability and large standard errors, an indication of multicollinearity. We have therefore simplified the analysis by assuming that the impact of the distance variable is operating through an effect on fixed costs, which means that unit costs are assumed to be constant ($\pi_{ik} = 1$, i=1, 2,…,12) across municipalities in the Norwegian case. The impact of this assumption on the derived fiscal equalization scheme is tested against an alternative assumption in the sensitivity analysis below.

Estimation of minimum quantities

The target groups included in the analysis are derived from knowledge of Norwegian institutions and central government regulations of local government responsibilities. For each service sector certain exclusion restrictions are imposed, since all target groups do not necessarily receive every one of the different services. For instance, the elderly receive long-term care, but they are not included as recipients of child care services or primary education, since they are not entitled to such services. Thus the included effects of explanatory variables have to be theoretically plausible. Furthermore, the target groups that are affecting minimum quantities in different service sectors are largely the same as those compensated for in the Norwegian cost-equalization formula. Broadly speaking, the included explanatory variables may therefore express a national expert consensus about heterogeneity in expenditure needs. The relevant target groups have been subject to extensive testing, which means that the hypothesized explanatory variables are included in the model when the estimated effects on spending are significant.

Measurement of the size of different subpopulations is mainly based on administrative register data with demographic and geographic information for the entire resident population in Norway. The subpopulations that form the target groups in the study include the population in each municipality by age groups, refugee status, employment status, marital status and poverty status.[21] The register data contain information on the composition of households and family relationships, which means that children can be related to the status

[21] To be defined as poor the household must have less than 50 percent of median cash income, using the OECD scale to make incomes comparable across households. The data on cash income is based on Tax Assessment Files, which are collected from tax records and other administrative registers, rather than interviews and self-reporting methods.

of their parents. Besides the available register data information, municipalities report additional information on the number of mentally disabled and high-needs recipients in each municipality.

The variables in Table 3 account for variation in minimum quantities across target groups as specified in equation (9), which is inserted into (10) before estimation of the model, assuming that unit costs are constant. The parameter estimates in Table 3 show the increase in minimum quantity when the target group is increased by one person. One main finding is the substantial variation in the minimum quantity estimates across target groups and service sectors. For instance, the 6–15 age-group receives primary education and other education (after-school education). The minimum quantity for this group is more than ten times higher in primary education compared to after-school education. Recently domiciled refugees receive other education (adult education) and social services. For this group, the received amount is higher in adult education.

Table 3. Estimated minimum quantity parameters and corresponding reduced form estimates, 2008

Sector	Target group	Model 1		Model 2	
		Structural form	Reduced form	Structural form	Reduced form
Administration	All residents	1391**	1748	1722**	1753
Primary education	Population aged 6–15	53186**	46113	55030**	48150
Other education	Population aged 6–15	5086**	4116	2302**	1055
	Recently domiciled refugees	93879**	91222	83748**	80509
Child care	Children aged 1–5 with full-time employed parents	108083**	102683	102717**	98424
	Remaining children aged 1–5	61441**	58371	52466**	50273
Health care	All residents	866**	988	995**	1004
Social services	Recently domiciled refugees	65638**	63822	65178**	63429
	Other refugees	7680*	7593	7062	6979
	Divorced and separated, aged 16–59	7839**	7593	8352**	6979
	Unemployed, aged 16–59	29720**	29382	28014**	27685
	Poor residents	6812*	6734	6819*	6739
Child protection	Children aged 0–15 with lone parent	23337**	22912	23394**	22954
	Poor children aged 0–15	22168*	21765	24886**	24418
Long-term care	Population aged 0–66	1765	1419	2405**	1950
	Population aged 67–79	33097**	26603	30744**	24927
	Population aged 80–89	52343**	42074	44052**	35717
	Population aged 90 and above	234260**	188301	187315**	151872
	Mentally disabled in ordinary municipalities	255149**	205092	213702**	173266
	Mentally disabled in host municipalities	949801**	763460	905123**	733859
	High-needs recipients	915619**	735984	963666**	781325
Culture	All residents	690**	839	753**	765
Road maintenance	All residents	-45	12	-38	-33
Water, sewage, and refuse	All residents	956**	1039	-701**	-701
Other infrastructure	All residents	596	928	-99	-77

Note: All estimates are in NOK. (1 Euro equals about 8 NOK). ** Significant at 1%-level. * Significant at 5%-level. Reduced form estimates are reported as mean values.

In child care the target 1–5 age-group is divided into children with or without parents in full-time employment. The marginal cost is higher for the group of full-time employed parents, since these

families depend more on professional day-care services, increasing demand for and coverage in kindergartens. In the child protection sector, the recipients are identified as children with a lone parent and children in poor households. In social services, the recipients are either refugees, divorced, separated, unemployed, or poor.

Long-term care includes nursing homes, ambulant nurses and home care. The potential recipients are the elderly and disabled. Minimum quantities are found to increase with age, and are highest for the elderly aged 90 and above. In contrast, spending needs per person are much lower in the 0–66 age group. However, three additional target groups are included to account for high expenditure needs for persons with severe disablement. The mentally disabled are divided into two groups residing in appointed host municipalities and other municipalities, respectively. The cost for clients in host municipalities is found to be relatively high. A third group including patients who are reported to have a high degree of disability and in need of intensive round-the-clock care, is found to have a large marginal impact on expenditure needs.

When it comes to administration, municipal health care, culture, road maintenance, water supply, sewage treatment, refuse collection, and other infrastructure, the target group is taken to be the entire population in each municipality. Thus, the estimated minimum quantity is a constant.

The different estimates in the structural form of Model 1 and Model 2 are interpreted as resulting from the difference between marginal effects on gross expenditures (including user fees) and net expenditures (excluding user fees). For that reason, the structural form estimates are in many cases smaller in Model 2, particularly in service sectors that are partly financed by user fees. These latter service sectors are other education, child care, long-term care and water supply, sewage treatment, and refuse collection.

Table 3 shows that the estimated reduced form parameters in many cases are smaller than the structural form estimates, as would be expected by closer inspection of equation (20). The difference between reduced form and structural form estimates is larger for service sectors with a high marginal budget share (long-term care and primary education) and for target groups that are included in more than one service sector (population aged 6–15 and recently domiciled refugees). The reduced form effect for all residents is larger than the structural form effect in some service sectors.22 For other included target groups

[22] This is due to a negative structural constant term estimate in the sector for net operating result in both models and a positive structural constant term estimate in the equation for user fees in Model 1.

besides constant terms (accounting for all residents), the reduced form estimates vary between 46 percent and 99 percent of the structural form estimates of minimum quantities.

Estimation of fixed costs

The variables in Table 4 account for variation in sector-specific fixed costs as specified in equation (12), which is inserted into (10) before estimation of the model. Thus the parameter estimates in Table 4 show the impact of variables affecting fixed costs in the estimated models. There are significant fixed costs in eight of the service sectors. Since per capita expenditures are on the left-hand side in the service sector equations, it is the effect of inverse population size that accounts for a fixed cost that is constant across municipalities. The fixed cost is estimated to be 4.4 million NOK in administration in Model 1. After aggregating over service sectors it was found that total fixed cost accounted for by inverse population size was 11.7 million NOK in Model 1 and 11.3 million NOK in Model 2. The difference between the two models may suggest that some of the fixed costs are financed by user fees, particularly in long-term care and water supply, sewage treatment, and refuse collection.

The distance to municipal sub-district centers is found to increase fixed costs in primary education, health care and long-term care. The fixed cost in road maintenance depends on the length of municipal roads measured in kilometers.[23] Furthermore, the fixed cost for keeping roads open is found to increase with the amount of snowfall during the year.[24] Local variation in requirements for sewage purification derives from national environmental regulations, and is found to affect the fixed cost in sewage disposal in Model 1.[25] However, the difference between Model 1 and 2 shows that the fixed cost for sewage purification is largely financed by user fees.

As expected, the difference between structural form and reduced form estimates is particularly large for variables featured in several service sectors, such as inverse population size and the distance variable. In administration, the reduced form effect of inverse population size is estimated to be about 60 percent of the structural form estimate. Moreover, for inverse population size, it is found that the reduced form estimates are negative in long-term care (Model 2), culture, water supply, sewage treatment, and refuse collection (Model 1) and other infrastructure, although the corresponding structural form estimates are significantly positive.[26] Thus there are substantial downward biases in reduced form estimates for fixed costs. The largest downward bias in the reduced form effect of the

[23] Data are collected by The Norwegian Public Roads Administration.

[24] The data source is The Norwegian Meteorological Institute, which observes weather conditions on a high number of metering stations around the country.

[25] Data on type and capacity for purification are reported from the treatment plants to Statistics Norway.

[26] Inverse population size has been included in the sector for water supply, sewage treatment, and refuse collection because the estimate is close to being significant at the 5%-level in Model 1.

distance variable is found in long-term care, which is due to the relatively high marginal budget share of this service sector.

Table 4. Estimated fixed cost parameters and corresponding reduced form estimates, 2008

Sector	Environmental cost factor	Model 1		Model 2	
		Structural form	Reduced form	Structural form	Reduced form
Administration	Inverse population size	4438500**	2664691	4521541**	2747859
Primary education	Inverse population size	1820863**	508092	1999152**	649176
	Distance to municipal sub-district centre	1338**	1035	1342**	1062
Health care	Inverse population size	1603941**	997628	1484281**	939118
	Distance to municipal sub-district centre	348**	209	301**	188
Long-term care	Inverse population size	2260657**	138505	1789784**	-338921
	Distance to municipal sub-district centre	807**	318	688**	247
Culture	Inverse population size	366439*	-371550	450764**	-265770
Road maintenance	Length of municipal roads	19444**	18937	19585**	19072
	Amount of snowfall	80**	78	83**	81
Water, sewage, and refuse	Inverse population size	393353	-22292	160787	164320
	Sewage purification degree	653**	628	47	47
Other infrastructure	Inverse population size	849311*	-803232	843816**	-453870

Note: All estimates are in NOK. (1 Euro equals about 8 NOK). ** Significant at 1%-level. * Significant at 5%-level. Reduced form estimates are reported as mean values.

Estimation of fiscal capacity

In the analysis of fiscal capacity for housing property taxation, the measurement of the tax base in different municipalities is based on hedonic estimation of property values, where the appraised property value is a function of the age, size (in square meters), and location (by neighborhood) of each dwelling. This model has been developed in Statistics Norway and is used by central government as the base for national property wealth taxation. The tax base is shared with local governments by allowing them to impose housing property taxes on local residents. However, when the estimated property values are included as heterogeneity in the fiscal capacity parameter for local housing

property taxes, it turns out that the effect of appraised property value is insignificant. This result suggests that the chosen tax rates are negatively correlated with the tax base.

Estimation results for fiscal capacity for housing property taxes are reported in Table A.1 in the Appendix. Since the local housing property tax has been legally restricted to densely populated areas, the population share in densely populated areas is included in the estimation. The results show that population density squared has a significant positive effect on municipal property tax income. The second variable included is the share of representatives from Conservative Party and Progress Party elected to the Municipal Council.[27] These two political parties are known to campaign against property taxation. The model includes a direct effect of party composition, but also an interaction effect between party composition and population density. As expected, it is found that a higher share of Conservative Party and Progress Party council members correlates with lower housing property taxes in densely populated areas. Somewhat surprisingly, the effect of higher representation of the two parties is positive in the most sparsely populated municipalities.

Estimation results for fiscal capacity for user fees are reported in Table A.2 in the Appendix. The fiscal capacity model for user fees includes target groups and variables affecting fixed costs in service sectors that are partly financed by user fees. The derived significant effects are associated to long-term care and water supply, sewage treatment, and refuse collection. Since these two service sectors collect a large share of the user fees, the fiscal capacity for user fees is related to variables accounting for expenditure needs in the two sectors. It is found that fiscal capacity for user fees is particularly high in municipalities with a high population share aged 90 and over. Many members of this age group live in nursing homes where they have to pay relatively high user fees. User fees are also found to increase as a function of inverse population size and sewage purification level, which owes to the fact that costs in water supply, sewage treatment, and refuse collection are largely financed by user fees.

Estimation of marginal budget shares

Tables B.1 and B.2 in the Appendix display the estimated coefficients of marginal budget shares in Models 1 and 2, respectively. The variables in Tables B.1 and B.2 account for variation in marginal budget shares as specified in equation (11), which is inserted into (10) before estimation of the model. Marginal budget shares are specified as depending on a constant term, the share of socialist representatives on the municipal council, and the average education level in the 30–59 age-group.[28] It

[27] The data source is The Norwegian Election Database (Statistics Norway).

[28] The data source is administrative register data.

is found that socialist parties give high priority to social services, including social assistance and temperance support to disadvantaged families. The higher the education level, the stronger the local government preference for social services, child protection, culture and other infrastructure, while the priority of administration is low in well educated communities. The estimated marginal budget shares for user fees are negative, meaning that user fees increase as a function of discretionary incomes. This result suggests that the positive volume effect prevails over the negative price effect in the response of user fees to an increase in discretionary incomes. It also implies a strong flypaper effect since local governments respond to increasing grants by crowding out private consumption rather than passing on money to the private sector.

Fiscal disparities

A relevant policy scenario is to redistribute the incomes of local governments to satisfy horizontal equity as defined in equation (17). Thus Model 1 is used to simulate the distribution of the sum of intergovernmental grants and tax incomes that satisfies the equalization formula derived above. For this purpose the fiscal capacity for housing property taxes is not compensated in the application of the equalization scheme.[29] To evaluate the policy impact of the hypothetical redistribution, we define fiscal disparity as the difference between the actual allocation and the equalizing allocation in (17).

Table 5. Summary statistics of fiscal disparities by municipality size, in percent of actual income, Model 1, 2008

Municipality size	Number of observations	Mean	Standard deviation	Minimum	Maximum
0–1999	81	16.4	12.2	-0.6	55.0
2000–4999	130	7.4	12.7	-12.4	50.4
5000–9999	90	-1.7	9.9	-16.2	38.4
10000–19999	53	-5.7	5.3	-13.8	10.6
20000–49999	36	-5.1	4.3	-14.7	6.8
50000 residents or more	12	-1.2	6.5	-9.6	9.7

Note: Fiscal disparity is defined by the difference between actual income and counterfactual income allocated to obtain horizontal equity.

In Table 5 summary statistics of fiscal disparities are reported in percent of actual income, defined by $100*\left(y_k - y_k^*\right)/y_k$, where y_k is actual income and y_k^* is counterfactual income derived from the equalization scheme. The results clearly indicate that many of the municipalities would experience a significant change in their incomes if the equalization scheme in equation (17) was implemented. This means that fiscal equalization is far from achieved in Norway. In particular, small municipalities are overrepresented among municipalities with relatively high actual incomes as compared to the

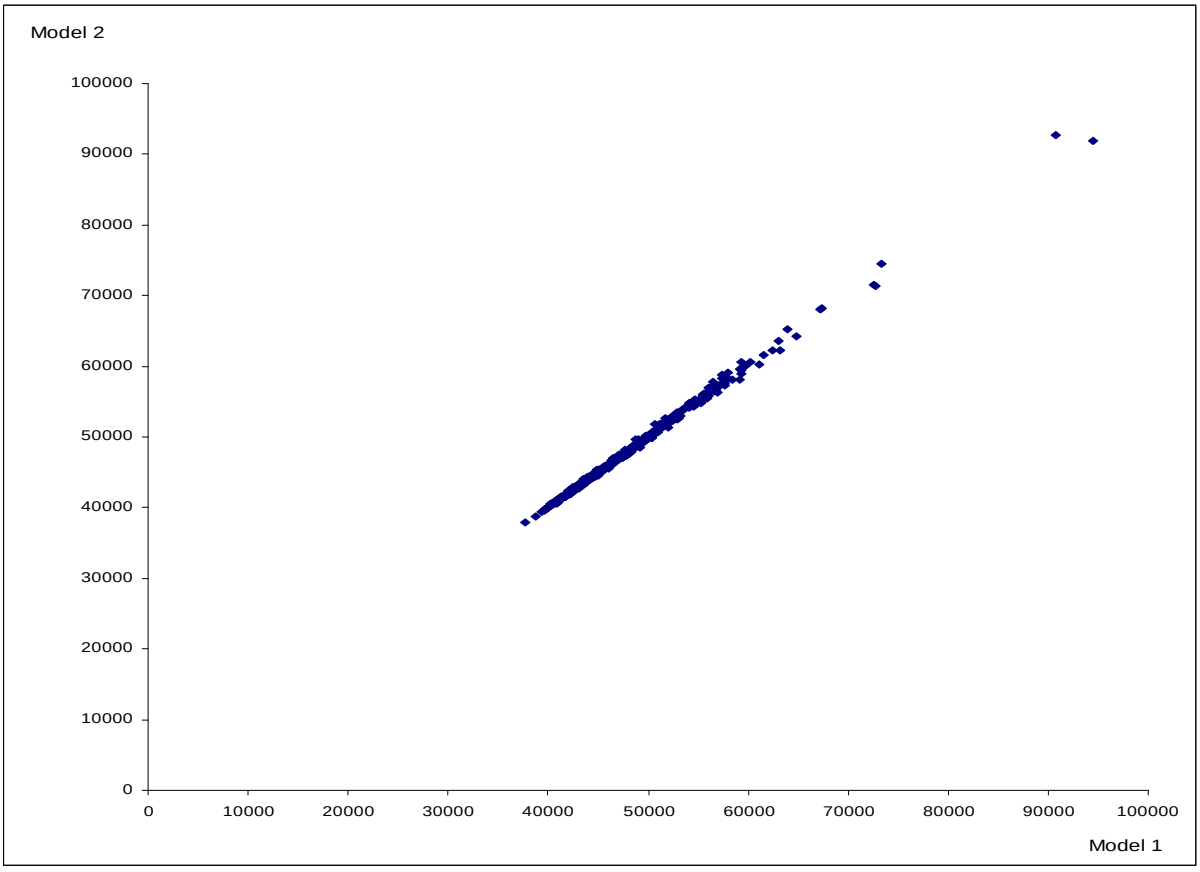
[29] This exclusion is done because the impact of appraised property value on the housing property tax is insignificant, and moreover coincides with the chosen method in the Norwegian fiscal equalization system.

counterfactual equalization policy. The privileged position of many small municipalities is mainly a result of intergovernmental grants that aim to promote regional development in Northern Norway, as well as in small municipalities in Southern Norway. Moreover, small municipalities receive relatively high incomes from local taxes on natural resources which are not subject to fiscal capacity equalization in the Norwegian grant system.

Sensitivity analysis

The two different model specifications above result in different estimates of the structural parameters. Since one important aim of the present paper is to discuss methods for fiscal equalization, it is relevant to evaluate the difference between the two models by the different counterfactual incomes the municipalities would receive if the equalization formula (17) was implemented.

Figure 1. Local government incomes distributed to allow horizontal equity in Models 1 and 2, 2008



Note: Incomes are measured in NOK per capita (1 Euro equals about 8 NOK).

The main difference between Models 1 and 2 is in the treatment of user fees. Fiscal capacity for user fees is specified in Model 1 but not in Model 2, since Model 2 excludes user fees from the expenditure

and income definition. This difference is reflected in how formula (17) is applied to the two models. Figure 1 shows a scatter plot of the local government per capita incomes that result when incomes are distributed to yield horizontal equity in Models 1 and 2, respectively. It is demonstrated that the equalizing allocations produced by the two models are very highly correlated, with a Pearson's R at 0.999. Thus the proposed equalization scheme provides approximately the same distribution of incomes based on the two different models.

As discussed above, it is difficult to determine empirically the degree to which the distance variable is affecting fixed costs or unit costs. It is assumed that the distance variable does affect fixed costs, but not unit costs in Models 1 and 2. The sensitivity of results to this assumption is studied by making the opposite assumption the basis for estimating alternative versions of the two models. The alternative models are identical to Models 1 and 2, except that the distance variable is assumed to affect unit costs instead of fixed costs in the relevant service sectors (primary education, health care and long-term care). As before, the sensitivity of results to this change in model specification is evaluated by the change in counterfactual equalization grants according to formula (17). It is found that the baseline and alternative model specifications produce allocations that are very highly correlated (Pearson's R is 0.991 in Model 1 and 0.993 in Model 2). Thus the equalizing allocation is rather insensitive to the alternative model specification with respect to the distance variable.

As a final sensitivity analysis it is of interest to investigate the stability of results over time. For this purpose, Models 1 and 2 are estimated on cross section data for 2007 in addition to 2008. The total parameter stability is evaluated by comparing the equalizing allocation of incomes when parameters are estimated on 2007 or 2008 data, respectively. To isolate the effect of changing parameter estimates from the change in independent variables, the parameter estimates for 2007 are combined with data for 2008 to simulate the equalizing allocation in 2008 based on parameter estimates in 2007. This allocation is compared to the equalizing allocation derived from 2008 parameter estimates *and* 2008 data. The results of this exercise demonstrate that the parameter estimates in general are quite stable from 2007 to 2008 (Pearson's R comparing equalizing allocations derived from 2007 and 2008 estimates is 0.999 in Model 1 and 0.998 in Model 2).[30]

[30] The party composition in Local Government Municipal Councils is changed every fourth year. Since 2007 was an election year, there was a political replacement from 2007 to 2008. Thus, it is heartening to find that parameter stability is high through this break in government. Furthermore, by comparing the estimates in this paper to estimates in Aaberge and Langørgen (2003), who estimated a similar model on data for 1993, it is found that the model is rather stable over a long time period.

The main purpose of this paper has been to compare structural and reduced form parameters, and to derive a method for fiscal equalization by means of structural modeling. This method could be further refined by utilizing panel data econometrics. Panel data allow the researcher to control for unobservable local characteristics. Nevertheless, for the purpose of fiscal equalization one could argue that only observable variation across municipalities should matter for the determination of equalization grants. For instance, in a fixed-effects model, it is not clear to what extent the local governments should be compensated for the fixed effects. A related problem is that the fixed effects wipe out the effect of any variable that is unchanging or highly correlated over time. In that sense, then, the fixed-effects model may not allow the identification of cross-sectional variation that is relevant for fiscal equalization. Further discussion of such issues is left for future research.

VI. Conclusion

Equalization systems have a substantial impact on the distribution of incomes to sub-national governments in many countries around the world. The design of equalization systems may benefit from methods that utilize parameters derived from economic theory. At the same time, it is crucial to develop methods that are feasible to implement given limitations in the data, such as the absence of reliable output measures.

The present paper shows that a structural simultaneous model can be used to analyze fiscal equalization in the common case where outputs are unobserved. This is done by invoking behavioral, technological, functional form and distributional assumptions, since such assumptions are needed to justify the interpretation of estimates as measures of expenditure need and fiscal capacity. Because fiscal equalization requires compensation for a comprehensive set of cost, need and capacity factors, it is hard to conceive that all the relevant structural parameters could be estimated by using quasi-experimental methods (e.g., Angrist and Pischke, 2010) or sufficient statistic methods (see Chetty, 2009). In contrast, a feasible strategy for the purpose of fiscal equalization is to estimate a full-fledged structural model.

The linear expenditure system provides an attractive basis for empirical applications, since it allows estimation of fixed costs, unit costs, and minimum quantities that are basic in the definition of expenditure needs. The modeling approach provides the information necessary to give a precise definition of horizontal equity, which is the explicit goal that is used to justify fiscal equalization policies in many countries. In the empirical analysis it is found that the structural modeling framework yields plausible estimation results. By simulating intergovernmental grants according to the proposed

formula it is found that the equalizing allocation is robust to changes in specification of the structural model and to a change in the year of estimation.

The structural approach proposed in this paper is compared to the common practice of using reduced form models as the basis for determining equalization grants. It is argued that the structural parameters of the linear expenditure system allow for an intuitively appealing interpretation, whereas parameters in reduced form models do not have a straightforward interpretation in terms of sector-specific expenditure needs. The estimation results show that reduced form estimates to varying degrees are smaller than the corresponding structural parameter estimates, and sometimes structural and reduced form estimates display opposite signs for a significant effect of a given explanatory variable in a given service sector. The difference between structural and reduced form estimates is relatively large in service sectors with a large marginal budget share, and for explanatory variables that affect expenditure needs in several service sectors.

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Appendix

Estimation of fiscal capacity parameters

Table A.1 Estimated fiscal capacity parameters for housing property taxes, 2008

	Model 1	Model 2
Constant	198	171
Population density (share in densely populated areas)	-62	-62
Population density squared	1471**	1451**
Conservative and Progress Party share in Municipal Council	1281**	1212*
Population density * Conservative/Progress Party share	-3434**	-3292**

Note: All estimates are in NOK. (1 Euro equals about 8 NOK). ** Significant at 1%-level. * Significant at 5%-level.

Table A.2 Estimated fiscal capacity parameters for user fees, 2008

	Model 1
Constant	3377**
Population aged 67–79	6333
Population aged 80–89	16404
Population aged 90 and above	61940*
Inverse population size	916216*
Sewage purification degree	582**

Note: All estimates are in NOK. (1 Euro equals about 8 NOK). ** Significant at 1%-level. * Significant at 5%-level.

Estimation of marginal budget share parameters

Table B.1 Estimated marginal budget share parameters in Model 1, 2008

	Constant	Share of socialists	Average education level
Administration	0.290**	-0.007	-0.043**
Primary education	0.147**	-0.013	-0.007
Other education	-0.020	0.010	0.012*
Child care	0.022	-0.013	0.011
Health care	0.077**	0.004	-0.008
Social services	-0.030	0.036**	0.010*
Child protection	-0.029	0.009	0.015**
Long-term care	0.229**	0.021	-0.014
Culture	0.008	0.022	0.018*
Road maintenance	0.020*	0.007	0.001
Water, sewage, and refuse	0.055	0.001	-0.006
Other infrastructure	0.068	-0.001	0.030*
Housing property taxes	0.045*	-0.019	-0.010
User fees	-0.060	-0.045	-0.009

Note: ** Significant at 1%-level. * Significant at 5%-level.

Table B.2 Estimated marginal budget share parameters in Model 2, 2008

	Constant	Share of socialists	Average education level
Administration	0.290**	-0.010	-0.045**
Primary education	0.136**	-0.008	-0.004
Other education	0.011	0.001	0.004
Child care	0.018	-0.022	0.011
Health care	0.071**	0.003	-0.008
Social services	-0.035	0.041**	0.011*
Child protection	-0.038*	0.012	0.018**
Long-term care	0.249**	0.012	-0.023
Culture	0.012	0.018	0.016*
Road maintenance	0.032**	0.005	-0.003
Water, sewage, and refuse	-0.004	-0.022	0.004
Other infrastructure	0.010	0.004	0.037**
Housing property taxes	0.048*	-0.019	-0.011

Note: ** Significant at 1%-level. * Significant at 5%-level.

B

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