

Partial Fiscal Decentralization and Demand Responsiveness of the Local Public Sector: Theory and Evidence from Norway

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Abstract

This paper provides an empirical test of a principal tenet of fiscal federalism: that spending discretion, when granted to localities, allows public-good levels to adjust to suit local demands. The test is based on a simple model of partial fiscal decentralization, under which earmarking of central transfers for particular uses is eliminated, allowing funds to be spent according to local tastes. The greater role of local demand determinants following partial decentralization is confirmed by the paper's empirical results, which show the effects of the 1986 Norwegian reform.

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1. Introduction

With fiscal decentralization, subnational governments gain autonomy in the provision and financing of public goods. Such autonomy has been a longtime feature of fiscal arrangements in the United States, Canada and a few other countries. A greater degree of central management of the public sector, however, is common elsewhere, especially in developing countries. But partly in response to advice from the World Bank and other international agencies, many countries are embracing fiscal decentralization by attempting to devolve spending and taxing authority to subnational governments. This movement is motivated in part by the lessons of the Tiebout (1956) model, which show that local control of spending allows the public sector to better respond to heterogeneous demands for public goods.

Despite these developments, the fiscal decentralization pursued in other parts of the world often fails to match the North American pattern, being only partial in nature. Rather than gaining autonomy to set both spending and taxes, subnational governments often must rely on transfers from the central government to finance the provision of public goods.¹ With fixed transfers, subnational governments often have little latitude in choosing the levels of public goods, especially when transfers are accompanied by mandates that specify how the money is to be allocated across spending categories. This reliance on transfers, and the lack of discretion it entails, is often a result of a lack of tax capacity at the subnational level. For either historical or constitutional reasons, subnational governments may not have access to taxes capable of generating substantial revenue, in contrast to the situation in North America, where subnational income, sales and property taxes generate enormous revenue. Alternatively, productive subnational taxes may exist but their rates may be centrally controlled.²

Despite its relevance in much of the world, partial fiscal decentralization has received only

limited treatment in the public economics literature. One purpose of the present paper is to offer a simple new model that compares public-good provision under partial decentralization to the outcomes under centralized provision and, alternatively, “full” decentralization, where subnational governments gain complete fiscal autonomy. The model yields clearcut predictions showing how a movement from centralization to partial decentralization affects public-good provision, and these predictions are then tested using data from Norway. A 1986 Norwegian reform gave local governments more control over spending decisions while maintaining their reliance on central transfers as a source of funds, and the empirical work investigates the effect of this reform.

The model builds on the analysis of Brueckner (2009), which also compared outcomes under centralization, partial, and full decentralization. In a model like Brueckner’s that has only a single public good (denoted z), a local government relying on a fixed central transfer under partial decentralization would ordinarily have no discretion in its choices, with the z level automatically determined by the transfer amount. However, public-good levels in Brueckner’s model are determined both by spending and by the “effort” level of local governments, breaking the direct link between the transfer and z .³ The present model differs fundamentally by assuming provision of two distinct public goods (x and z) rather than one, with local-government effort dropped as an input. Local discretion under partial decentralization now exists despite the fixed transfer because local governments are free to choose the *mix of the two public goods*, varying the levels of x and z to suit local preferences while holding total spending constant at the amount of the transfer. The simple prediction of the model is that, with per capita spending held fixed, moving from centralization (where the center sets uniform levels of the two public goods) to partial decentralization leads to heterogeneity in the levels of the goods. Under partial decentralization, the x and z levels in different localities diverge from the common level under centralization, reflecting local demand differences, even though total spending is held constant.

The model thus predicts that, following partial decentralization, local characteristics affecting the demand for public goods play a greater role in determining provision levels than before. Evidence for this enhanced role comes from studying the effects of the 1986 Norwegian

reform, which relaxed the spending mandates for individual public goods that were part of the previous system of intergovernmental grants. This change allowed new local discretion in the choice of the public-good mix while keeping the size of grants constant, representing the kind of partial decentralization envisioned in the model. In effect, the 1986 reform offers a natural experiment that allows a rare test of the effects of local discretion. Pre- and post-reform demand estimates show that local characteristics gained explanatory power following the reform, indicating that the reform allowed public-good provision to adjust in response to demand heterogeneity across jurisdictions. By allowing greater local discretion, the reform may have also raised the incentives for the sorting of the population according to preferences for public goods. The paper offers evidence that intercity migration increased following the reform, which may reflect greater sorting incentives.

The paper's demonstration of the enhanced role of local demand determinants following the reform offers support for a fundamental tenet of fiscal federalism, namely, that local fiscal discretion enables the public sector to better respond to consumer preferences for public goods. Despite this idea's central importance in the vast literature on the Tiebout hypothesis, empirical work designed to explicitly test it is scarce. In one study, Ahlin and Mork (2008) exploit a similar natural experiment in Sweden that allowed greater local discretion in the determination of school spending, although they find mixed results that lend little support for the hypothesis. Earlier work by Borge and Rattsø (1993) also explored the effects of the Norwegian reform, but their approach did not deliver clearcut findings like those presented below. In contrast, Faguet (2004) found that when a Bolivian reform raised central-government transfers and gave localities more control over investment projects, investment levels changed in ways that reflected local characteristics.⁴ With only one prior empirical study establishing such a conclusion, more evidence is needed, and this paper provides it. Note also that the current evidence relates to public-service provision, not public investment.

Instead of addressing the role of local demand determinants and exploiting such natural experiments, most previous work in the Tiebout tradition has investigated the foundational aspects of the theory. Oates (1969) and the vast ensuing literature on capitalization validates the premise that public goods matter to consumers and that interjurisdictional mobility regis-

ters these preferences, with house prices high in places with high public-good levels. Another foundational notion, that consumers vote with their feet in pursuing ideal levels of public spending, is tested in various studies. Some papers, including Pack and Pack (1978), Eberts and Gronberg (1981) and Rhode and Strumpf (2003), carry out tests for convergence toward a homogeneous community structure (an implication of voting with one's feet), while Banzhaf and Walsh (2008) look more explicitly for evidence of such behavior. A related literature explores intercommunity residence patterns using more-sophisticated econometric methods, with the goal of inferring the existence of consumer sorting across jurisdictions (see, for example, Bayer and Timmins (2007)). The present paper complements all of this previous work by providing a more-direct test of a core idea of fiscal federalism.

The paper also adds to a recent resurgence of theoretical research on fiscal decentralization, which builds on the classic treatment of Oates (1972) (see also Wildasin (1986)). Recent papers include Lockwood (2002), Besley and Coate (2003), Brueckner (2004), Lorz and Willman (2005), and Arzaghi and Henderson (2005), among others. The models of Besley and Coate and Lockwood offer a contrast to the present approach by assuming that, when it exercises control, the central government can differentiate the provision of public goods across local jurisdictions, blurring the distinction between the centralized and decentralized cases.

In addition to Brueckner (2009), recent work that explicitly focuses on partial fiscal decentralization includes an earlier paper by Schwager (1999), who analyzes what he calls “administrative federalism.”⁵ Peralta (2012) constructs a related model with imperfect information and rent-seeking politicians, where partial decentralization allows more scope for this activity than full decentralization.⁶ The analysis of Hatfield and Padró i Miguel (2011) reflects a different view of partial decentralization. In their model, which has a continuum of public goods, partial decentralization emerges when a portion of the continuum is provided locally, with the remainder provided by the central government.⁷ In addition to these papers and those cited above, many more recent studies bear some connection to the present work.⁸

The plan of the paper is as follows. Section 2 presents the model, and section 3 gives an overview of the Norwegian reform on which the empirical work is based. Section 4 discusses the data and presents the regression results on the role of demand determinants. Section 5

presents the migration results, and conclusions are offered in section 6.

2. The Model

Consider an economy where individuals consume two public goods, x and z , along with a private good e . In order to avoid consideration of jurisdiction sizes, each public good is assumed to be a publicly produced private good with cost per capita equal to 1 (the model's main implications would hold more generally). The economy has two consumer types denoted by $i = 1, 2$, who have different Cobb-Douglas preferences given by

$$u_i = \alpha_i \log(e) + \beta_i \log(x) + (1 - \alpha_i - \beta_i) \log(z), \quad i = 1, 2, \quad (1)$$

and common incomes equal to I . The share of the type-1 consumers in the overall population equals δ , with the type-2 population share equal to $1 - \delta$. The economy contains a number of local jurisdictions (referred to subsequently as “cities”), with decisions on their public-good levels made by majority voting in situations where local control is allowed. In “type-1” cities, type-1 consumers are in the majority, with public-good levels chosen to reflect their preferences, while type-2 cities have type-2 majorities. Although, in an extreme case, cities could be homogeneous, with the consumer types segregated in separate jurisdictions, the analysis applies regardless of the degree of intermixing of the types. But cities of both types are assumed to exist, so that one type of consumer is not in the majority everywhere. This latter outcome would emerge, for example, if cities were identical, with their common composition reflecting the overall population shares of the types. Once the analysis is complete, an extension to an economy with more than two consumer types is discussed.

2.1. Public-good levels under different degrees of decentralization

The goal of the analysis is to compare the levels of the public goods under three regimes: centralization, partial decentralization and full decentralization. The comparison between centralization and partial decentralization is the relevant one for the empirical work, but the other comparisons yield some additional useful conclusions.

In the case of full decentralization, public-good choices are made locally, with spending financed by head taxes. The chosen levels of the goods in the different city types are given by

familiar demand functions associated with Cobb-Douglas preferences. In a type- i city, the z and x choices are

$$x_i^* = \beta_i I, \quad z_i^* = (1 - \alpha_i - \beta_i)I, \quad i = 1, 2. \quad (2)$$

Total per capita spending on the goods (equal to the city head tax T_i^*) is

$$x_i^* + z_i^* = T_i^* = (1 - \alpha_i)I, \quad i = 1, 2. \quad (3)$$

Note from (3) that a type's total spending on public goods varies inversely with its strength of preference for the private good e , as represented by α_i .

Suppose, on the other hand, that public-good levels are dictated by the central government, with the goods still provided locally but at levels that are uniform across cities despite differing majority preferences. The local expenditure is financed by uniform per capita grants (supported by nationally uniform head taxes) sufficient to fund the specified public-good levels.

The mandated public-good levels set by the central government are assumed to equal weighted averages of the x and z levels that would be chosen under full decentralization, with the type-1 weight equal to θ . Thus,

$$x^* = \theta x_1^* + (1 - \theta)x_2^*, \quad z^* = \theta z_1^* + (1 - \theta)z_2^*. \quad (4)$$

This rule could reflect the choices of a benevolent central government that knows individual preferences and seeks to maximize total utility in the economy. In this case, θ would equal δ , the type-1 population share, as can be seen by computing this welfare-maximizing solution. Alternatively, (5) could be the result of a political process in which θ captures the extent of political influence of the type-1 consumers in the centralized choice process ($\theta > \delta$ would indicate outside influence).

Given (4), total per capita spending T^* on the public goods under centralization (equal to the uniform grant and head tax) is a weighted average of the T_i^* from (3). It equals

$$T^* = \theta T_1^* + (1 - \theta)T_2^* = x^* + z^*. \quad (5)$$

Suppose now that the central government switches to partial fiscal decentralization by providing the cities with equal per capita grants of T^* (again financed by uniform head taxes) *without specifying the particular levels of public goods that must be provided*. In other words, the central government allows freedom of choice in selecting public-good levels, subject to the requirement that total spending is the same as under centralization. Again, the goods must be entirely paid for with grant funds. Each city faces the following constraints:

$$e = y - T^*, \quad x + z = T^*. \quad (6)$$

The chosen public-good levels for the two city types are now

$$\widehat{z}_i = \frac{1 - \alpha_i - \beta_i}{1 - \alpha_i} T^* = \left(1 - \frac{\beta_i}{1 - \alpha_i}\right) T^*, \quad \widehat{x}_i = \frac{\beta_i}{1 - \alpha_i} T^*, \quad i = 1, 2. \quad (7)$$

Note that each public-good level equals T^* times the relative preference weight for that good within the set of public goods. This weight equals the good's preference coefficient in (1) divided the sum of x and z coefficients, a sum that equals $1 - \alpha_i - \beta_i + \beta_i = 1 - \alpha_i$.

2.2. Moving from centralization to partial decentralization

The following analysis carries out comparisons of public-good levels under the three regimes, moving from centralization to partial decentralization to full decentralization, and this section focuses on the first of these movements. To compare x values between centralization and partial decentralization, (2) and (3) can be used to write $x_i^* = \beta_i T_i^* / (1 - \alpha_i)$. Substituting in (4) and assuming

$$\frac{\beta_1}{1 - \alpha_1} < \frac{\beta_2}{1 - \alpha_2} \quad (8)$$

yields

$$x^* = \frac{\beta_1}{1 - \alpha_1} \theta T_1^* + \frac{\beta_2}{1 - \alpha_2} (1 - \theta) T_2^* > \frac{\beta_1}{1 - \alpha_1} \theta T_1^* + \frac{\beta_1}{1 - \alpha_1} (1 - \theta) T_2^* = \frac{\beta_1}{1 - \alpha_1} \theta T^* = \widehat{x}_1. \quad (9)$$

If $\beta_2/(1 - \alpha_2)$ appears in place of $\beta_1/(1 - \alpha_1)$ in the last two expressions in (9), then the reverse inequality holds, so that $x^* < \hat{x}_2$. Since a parallel argument establishes the opposite relationship among the \hat{z}_i 's, it follows that

$$\frac{\beta_1}{1 - \alpha_1} < \frac{\beta_2}{1 - \alpha_2} \implies \hat{x}_1 < x^* < \hat{x}_2, \quad \hat{z}_1 > z^* > \hat{z}_2, \quad (10)$$

with the x and z inequalities reversed if $\beta_1/(1 - \alpha_1) > \beta_2/(1 - \alpha_2)$.

Therefore, in moving from centralization to partial decentralization, the public-good levels diverge from the common centralized level, with x falling (rising) in the city type with the weaker (stronger) relative preference weight for x . The levels of z move in the opposite directions. Since total spending on public goods remains fixed at the centralized level T^* in moving to partial decentralization, private-good consumption remains at the centralized level e^* , with adjustment occurring only in the mix of public goods in response to the relative preference weights for x and z in the two types of cities. In Figure 1, the movement from the C to PD outcomes illustrates the pattern in (10). Note that $x^* > z^*$ is assumed in the figure in locating the starting point under centralization, and that the FD case is yet to be discussed.

Empirically, (10) and Figure 1 predict that, when partial decentralization occurs, public-good levels diverge from the common centralized levels in ways that reflect local preferences for the two goods, leading to different mixes of x and z in across cities. This conclusion clearly generalizes to a situation with more than two preference types,⁹ and it forms the basis for the ensuing empirical work.

2.3. Moving from partial to full decentralization

The movement from partial to full decentralization is more easily analyzed, focusing first on the case where $\alpha_1 > \alpha_2$. First, note that $\alpha_1 > \alpha_2$ implies $T_1^* < T_2^*$ from (3), so that total spending on public goods under full decentralization is higher in type-2 cities. Since T^* is a weighted average of the T_i^* from (5), it then follows that $T_1^* < T^* < T_2^*$. Next, using (3) to replace I in (2) with $T_i^*/(1 - \alpha_i)$, it follows that x_i^* and z_i^* are proportional to T_i^* , with the same proportionality factors that relate \hat{x}_i and \hat{z}_i to T^* in (7). Since the movement from a common spending level of T^* under partial decentralization raises (lowers) total spending on

public goods in type-2 (type-1) cities, and since x and z are given by constant proportions of total spending in both cases, this movement leads to a increase (decrease) in the levels of both public goods in type-2 (type-1) cities. Thus,

$$\alpha_1 > \alpha_2 \implies x_1^* < \hat{x}_1, z_1^* < \hat{z}_1; \quad x_2^* > \hat{x}_2, z_2^* > \hat{z}_2, \quad (12)$$

with the inequalities reversed when $\alpha_1 < \alpha_2$.

The conclusion in (12) follows because total spending on public goods is lower in type-1 than in type-2 cities under full decentralization ($T_1^* < T_2^*$) as a result of their stronger preference for the private good e , while the x/z mix remains under local control. The conclusion is illustrated in Figure 1 by the movements from PD to FD. The figure shows that the increase in x_2 in moving from C to PD is amplified by the further movement to FD, and that the decline in x_1 is also amplified, widening the gap between the x 's. But the left side of the figure shows that the gap between z_1 and z_2 resulting from the C-to-PD movement is *narrowed* by the further movement from PD to FD, leaving the z comparison across the city types ambiguous without further information (the figure is drawn with $z_2^* > z_1^*$).

These conclusions can be seen directly from the solutions, given the assumptions reflected in the figure. With $\alpha_1 > \alpha_2$, satisfaction of $\beta_1/(1 - \alpha_1) < \beta_2/(1 - \alpha_2)$ requires $\beta_1 < \beta_2$, so that $x_1^* < x_2^*$ holds from (2). But the first and third inequalities imply that the comparison between $1 - \alpha_1 - \beta_1$ and $1 - \alpha_2 - \beta_2$, and thus the comparison between z_1^* and z_2^* from (2), is ambiguous. Therefore, comparison of z_1^* and z_2^* requires an additional explicit assumption about the relative magnitudes of $1 - \alpha_i - \beta_i$, $i = 1, 2$. In general, these findings imply that the high- α type will have the lower x level under FD if its public-good preferences favor z , with the z comparison being ambiguous without an additional assumption. If its preferences instead favor x , the high- α type will have the lower z level under FD, with the x comparison being ambiguous.

2.4. Empirical framework

The divergence in public-good levels that occurs in moving from centralization to partial decentralization, as seen in (10) and Figure 1, motivates the ensuing empirical work. However,

the empirical context differs from the stylized model in a number of ways, which must be taken into account. First, cities have different incomes in addition to differences in preferences. In Norway, however, the effect of income variation is muted by equalization grants, which partly offset income differences across localities. Second, public goods are financed partly by local tax revenue in addition to central transfers.

While more detail on these institutional factors is given in section 3 below, it is useful to generalize the previous model somewhat to incorporate them. Let preferences be written more generally than in the previous framework, with utility given by $U(e, x, z; \gamma)$, where γ is a vector of K taste parameters, $(\gamma_1, \dots, \gamma_K)$. Let a city again be identified according to the type of its majority voter, with a type- i city having $\gamma = \gamma_i$ and, recognizing that incomes differ, an income level of I_i . Ignoring for the moment the presence of local tax revenue, the utility of the majority voter in a type- i city is $U(I_i - T^*, x_i, T^* - x_i; \gamma_i)$. Under centralization, $x_i = x^*$ and $z_i = z^*$, and since these centrally chosen public-good levels do not vary across cities,

$$\frac{\partial x_i}{\partial \gamma_{ik}} = 0, \quad k = 1, \dots, K; \quad \frac{\partial x_i}{\partial I_i} = 0, \quad (13)$$

with the same equalities holding for z_i .

While public-good levels are thus unresponsive to the city characteristics (those of its majority voter) under centralization, they are chosen under partial decentralization to maximize the previous utility expression in a type- i city, leading to $x_i = \hat{x}_i$. The first-order condition is $\Omega^i \equiv U_x^i - U_z^i = 0$ or $U_x^i/U_z^i = 1$, where the subscripts denote partial derivatives and the i subscript indicates that the marginal utilities are evaluated at type- i values.

The second-order condition is $\Omega_x^i < 0$, and differentiating the first-order condition, the effects of the preference parameters and income on x_i are given by

$$\frac{\partial x_i}{\partial \gamma_{ik}} = -\frac{\Omega_{\gamma_{ik}}^i}{\Omega_x^i} \simeq U_{z\gamma_{ik}}^i - U_{x\gamma_{ik}}^i, \quad k = 1, \dots, K \quad (14)$$

$$\frac{\partial x_i}{\partial I_i} = -\frac{\Omega_e^i}{\Omega_x^i} \simeq U_{ze}^i - U_{xe}^i, \quad (15)$$

where \simeq means “has same sign as.” Analogous equations give impacts on z_i . Therefore, under partial decentralization, city characteristics affect public-good levels, as seen in the previous analysis. Eq. (14) shows that the impact of the taste parameter γ_{ik} on x_i depends on the difference between its effects on the marginal utilities of z and x , capturing the taste effects seen in the earlier analysis. While income differences were previously suppressed, (15) shows that the effect of a higher income on x_i depends on the difference between the effects of private consumption e on the marginal utilities of z and x . Note that since total public spending is fixed at the central-transfer amount T^* , the usual income effect that shifts this total is absent.

Suppose now that cities raise local tax revenue in addition to spending transfer funds. Letting this revenue, which is raised as a local head tax, be denoted R_i for city i , utility is now written $U(I_i - T^* - R_i, x_i, T^* + R_i - x_i; \gamma_i)$. With local taxes, x_i under centralization is composed of the fixed level x^* mandated by the central government plus an incremental amount \tilde{x}_i over which local discretion may be exercised, so that $x_i = x^* + \tilde{x}_i$. If cities are completely free to set R_i and \tilde{x}_i , then the utility expression under centralization is maximized by choice of these variables.¹⁰ Given this freedom of choice, x_i (as well as z_i) will vary with city characteristics under centralization, in contrast to case without local revenue, where the zero effects in (13) apply.

In moving to partial decentralization, T^* remains fixed, but cities now have full discretion in spending their combined local and transfer revenue. As a result, compared to the centralization case, *the effects of city characteristics on public-good levels will be more pronounced under partial decentralization* given that the previously mandated components are no longer fixed.

2.5. Intercity migration

The analysis of the simple model with two city types made no assumptions on the makeup of city populations aside from assuming that cities of both types exist. The movement to partial decentralization, however, would generate the usual kinds of Tiebout forces toward homogenization of the jurisdiction structure, regardless of the number of consumer types. With public goods no longer uniform across cities, minority residents of a city, whose tastes are not represented in its choices, would have an incentive to move to a city where their type is in the majority. So, in addition to generating divergence in public-good levels, partial

decentralization would be expected to create migration incentives, leading to more-extensive sorting of the population. In section 5, the paper offers evidence suggesting that intercity migration may have indeed increased following the reform.

3. Norwegian Institutional Setting

The public sector in Norway is large and decentralized, with the sector's local component accounting for about one-fifth of GDP. The major source of tax financing is the income tax paid by individuals. Income-tax revenue is shared between municipalities, counties and the central government, with revenue shares determined each year by the Parliament. Since the 1992 tax reform, income has been taxed at an overall flat rate of 28%, which decomposes into rates of about 13% for municipalities, 3% for counties and 12% for the central government. Municipalities and counties are allowed to set their own tax rates within a narrow band, but they all use the maximum rate.

While the income levels available for taxation are very different in urban and rural areas, a comprehensive tax equalization system ensures that a locality is not penalized by a low income-tax base. This system lifts localities at the bottom to 90% of the average tax base while reducing tax bases at the top. In addition, a comprehensive system of expenditure equalization grants is designed to neutralize the effect of variation in local cost conditions, which arise partly due to differences in population age distributions.

In addition to income taxation, which accounts for 45% of local revenue, localities receive revenue from a voluntary property tax and user fees. The property tax is regulated and small for most municipalities, but revenue can be large in cities with substantial hydroelectric energy production. While local discretion leads to some variation across cities in the share of revenue from these sources, the property tax and user fees generate about 15% of total local revenue, with most of this amount coming from user fees. The remaining portion of local revenue consists of grants from the central government, about 40% of the total.

The current system is the legacy of public-sector decentralization during the 1980s, which occurred in Norway and several other Nordic countries (see Lotz (1998) for an overview). Our analysis concentrates on the major 1986 reform in the control and financing of the Norwegian lo-

cal public sector. The historical background was a centralized system of sectoral control where national ministries controlled local spending within their own sector through mandating and the use of earmarked grants, usually arranged as matching grants. Ministries responsible for education and health care in particular exercised strong control over local spending, attempting to equalize service levels across jurisdictions. The reform was designed by a government commission with the broad goal of strengthening local democracy and improving efficiency by giving local governments more discretion in the allocation of resources. The reform changed the expenditure equalization grants from earmarked transfers to general-purpose grants, with relatively few restrictions on the use of funds (the grants were still adjusted for the local age distribution and other cost-shifting municipal characteristics). About 50 earmarked grants were replaced by general-purpose grants based on objective criteria. The result was a simpler and more transparent grant system.

The reform represented a shift in the design of fiscal federalism similar to the shift from centralization to partial decentralization in the model of section 2. The centralized regime before 1986 attempted to control local government spending with sectoral mandating and earmarking. Although localities were required, under the system's matching arrangements, to supplement central transfers with their own funds, these required contributions (and the taxes supporting them) were effectively determined by the center. As a result, the system was roughly equivalent to the full-centralization regime in the model, where the center collects all taxes, dictates public-good levels, and fully funds the localities by transfers. However, it should be noted that, because of imperfect income and cost equalization, local property-tax revenues from hydroelectric plants, and the existence of some regionally targeted grants, the levels of provision of public goods and services were not uniform prior to the reform, unlike in the model. Nevertheless, the reform greatly relaxed the extent of central control thus mirroring the case of partial decentralization.

4. Demand Regressions

4.1. Data

The dataset covers all 443 municipalities in Norway during the period 1980-1991. The analysis compares the 1980-1985 pre-reform period to the 1986-1991 post-reform period using data for five social-service sectors: child care, primary and secondary education, elderly care, cultural services, and parks. Selection of these periods was carried out recognizing that some effects of the reform may not materialize quickly enough to be apparent in the first five years following its implementation. However, choice of a longer post-reform period would risk the inclusion of other secular changes that might obscure the effects of interest. The relative importance of the chosen sectors is indicated by the average municipal budget shares, which are approximately 4% for child care, 43% for education, 18% for health (which includes elderly care) and 6% for culture (which includes both cultural and park services). The remaining categories are administration (12%) and infrastructure (17%, which includes fire protection). Police services are the responsibility of the central government.

The provision of child care in a municipality is captured by three different variables: child-care coverage (the share of children in child care), child-care employment per child in child care, and employment per young child (1-6 years of age). Provision of primary and lower (pre-high-school) secondary education is captured by three interrelated variables: class size, teachers per class (a class may have more than one teacher), and teachers per student.¹¹ The provision of elderly care is the percentage of households with elderly inhabitants 67 years or older that are covered by home-base nursing services. Provision levels in the last two public-good categories, cultural services and parks, are measured by per capita spending levels for general cultural services and park services, both adjusted for inflation. Table 1 presents summary statistics.

4.2. The setup

In a previous analysis of the reform, Borge and Rattsø (1993) estimate a demand system based on budget shares in order to investigate parameter stability across the pre- and post-reform periods. They find a shift in parameters from 1984-85 to 1986-87, indicating some change in behavior. But they do not find significant changes in short-run and long-run expen-

diture elasticities or changes in the effects of demographic variables that are consistent with the predicted effects of the reform. The present analysis, however, relies on the measures of local service provision described above, which are more detailed than those in previous studies and thus better able to capture the quantitative and qualitative aspects of the services. Note that because most of these variables measure service levels rather than spending, estimation of a demand system becomes infeasible.

The estimated demand model follows the usual approaches in the literature while also mirroring previous demand studies for local governments in Norway, including Borge and Rattsø (1993, 1995). A key demand variable is per capita income for the municipality, which is denoted PINC and measured on an after-tax basis. Since services are oriented toward specific age groups in the population, demographic factors will also be important determinants of demand. The demographic variables are the child share of the population, measured by the fraction below 7 years of age (CH), the ‘youth’ share of the population, measured by the fraction between 7 and 15 years of age (YO), and the elderly share of the population, representing individuals aged 67 years and above (EL). In addition, population size (POP) is included to control for possible scale effects in service production, which may reduce unit costs and thus raise provision levels. Summary statistics for these variables are shown in Table 1.

The demand model is estimated to allow different coefficients to emerge in the pre- and post-reform periods, 1980-85 and 1986-1990. The main prediction is that local demand determinants should play a more important role in determining public-good levels after the reform than before it, a consequence of the relaxation of central controls over local resource allocation. In other words, the estimated coefficients of the local characteristics are expected to be higher in absolute value and more statistically significant after the reform.

Another observation concerns the interpretation of the effects of income on demand. Since the reform simply removed spending mandates while holding grant amounts fixed, it should not have led to a stronger association between a city’s income and its public-good levels through the usual purchasing-power channel, as explained above. However, in addition to the income impact captured in (15), the level of income may be a proxy for other unmeasured household characteristics that affect preferences (education, say), possibly strengthening the association

between provision levels and income.

Estimation of the pre- and post-reform demand coefficients is carried out within a single regression model, where interaction terms allow different coefficients for the two periods while the error variance is constrained to be the same across periods. The model, which facilitates inter-period hypothesis tests on the coefficients, is

$$S_{it} = \alpha_t + D_t^{pre} \{ \eta_i^{pre} + \beta_1^{pre} \log(\text{PINC}_{it}) + \beta_2^{pre} \text{CH}_{it} + \beta_3^{pre} \text{YO}_{it} + \beta_4^{pre} \text{EL}_{it} + \beta_5^{pre} \log(\text{POP}_{it}) \} + (1 - D_t^{pre}) \{ \eta_i^{post} + \beta_1^{post} \log(\text{PINC}_{it}) + \beta_2^{post} \text{CH}_{it} + \beta_3^{post} \text{YO}_{it} + \beta_4^{post} \text{EL}_{it} + \beta_5^{post} \log(\text{POP}_{it}) \} + \epsilon_{it} \quad (16)$$

In (16), i denotes the municipality and t denotes the year, with the dummy variable D_t^{pre} taking the value one when t is a pre-reform year and zero otherwise. Year fixed effects are denoted by α_t , while η_i^{pre} and η_i^{post} give municipality fixed effects that may vary between the periods. The other demand coefficients are also allowed to differ between the periods, and ϵ_{it} is the error term.

Note that the inclusion of pre- and post-reform city fixed effects means that the impact of the demand determinants is identified only through intraperiod, within-city variation in the levels of the determinants. Small intertemporal variation in these covariates might then militate against the emergence of significant demand effects.

4.3. Estimation results

The estimated demand models for the three child-care measures are presented in Table 2. The results show that child-care coverage was independent of income and the age composition of the population before the reform. For the post-reform period, however, the estimates show that income became a significant determinant of coverage, with the share of children in the population becoming a marginally significant negative factor. This CH effect is consistent with recent evidence from Borge and Rattsø (2008), who conclude using data from Denmark that being part of a large cohort is a disadvantage in terms of child-care service levels.¹² The remaining columns of Table 2 show that the regressions for employment per child in child care

and employment per young child have mostly insignificant coefficients prior to the reform. But both variables respond positively to income in the post-reform period, although one income coefficient is only marginally significant.

To better judge whether the reform strengthened the link between service levels and the determinants of demand in an overall sense, Table 3 provides several F tests, with the first panel focusing on child care. The first column provides a test of the null hypothesis that the vector of pre-reform coefficients equals the vector of post-reform coefficients. None of the F statistics for the three child-care regressions allows rejection of this hypothesis, although the statistic for coverage is marginally significant. Rather than testing for coefficient equality, a different approach is to ask whether the coefficient vector is zero, both before and after the reform. As can be seen in the second and third columns, this hypothesis can be rejected in both the pre- and post-reform cases for child-care coverage and employment per young child.

These results, which give a somewhat mixed picture of the effects of the reform, appear to be driven by the population coefficients (meant to capture the effects of scale economies), which are significant or nearly so in the pre-reform period. Since population can be viewed as a less-central determinant of demand than the remaining demographic variables in the regression, the last three columns of Table 3 carry out the previous F tests with the population coefficient excluded. Now the picture provided by the tests is clearer. Coefficient equality across periods is rejected for child-care coverage and nearly rejected for employment per young child. In addition, the hypothesis that the pre-reform coefficient vector is zero cannot be rejected for any of the child-care measures, while the post-reform vector is significantly different from zero for coverage and employment per young child and marginally significant for the remaining measure. Thus, this second set of tests suggests that the reform strengthened the link between child-care services and the determinants of demand.

Table 4 shows the regression results for the three education measures. For the class-size measure, the YO coefficient gains significance in the post-reform period and has the expected positive sign (showing that more school-age children raise class sizes). For teachers per student, higher income has a positive effect in the post-reform period but no pre-reform effect. A large youth share reduces both teachers per class and per student in the post-reform period, with the

effect changing from insignificant to significant in the case of teachers per class. In addition, for both service measures, YO's coefficient magnitude is much larger in the post-reform period.¹³

Turning to the F tests in Table 3 and focusing on the tests that exclude the population coefficient, pre- and post-reform coefficient equality is rejected for both teachers per class and per student. In addition, whereas the coefficient vectors for all three service measures are significantly different from zero in the post-reform period, two out of three are indistinguishable from zero in the pre-reform period. Thus, as in the case of child care, the F tests suggest that the reform strengthened the link between education services and the determinants of demand.

The elderly-care, culture and parks regressions are shown in Table 5. Somewhat surprisingly, only one coefficient in the two elderly care regressions is significant, that of population in the pre-reform period. In the case of cultural services, income becomes a significant determinant of cultural spending in the post-reform period, with its effect much larger than the marginally significant pre-reform impact. In addition, an increase in the elderly share reduces cultural spending in the post-reform period, whereas no pre-reform effect exists. This negative effect might seem counterintuitive, but it likely reflects competition for funds between cultural services and services for the elderly in the local budget. In the park-spending regression, the only significant effect is POP's negative post-reform impact. Although both effects are only marginally significant, a higher youth share raises park spending before and after the reform, a natural outcome.

The F tests shown in the second half of the last panel of Table 3 do not allow rejection of coefficient equality for any of the three services from Table 5. However, the post-reform coefficient vector for cultural spending is significantly different from zero while the pre-reform vector is not, suggesting that the reform strengthened the link between cultural spending and the determinants of demand (despite the failure to reject coefficient equality). Note that neither coefficient vector is significantly different from zero in the cases of elderly care and parks.

Overall, the results in Tables 2–5 offer support for the model's prediction that local demographic characteristics should matter more in the determination of public-service levels after the reform than before it. In six out of the nine cases in Table 5, the demographic variables show no combined effect on service levels prior to the reform while exhibiting a statistically

significant impact after the reform. In particular, the F tests for child-care coverage and employment per young child, class size, teachers per class, and cultural spending show a nonzero vector of demographics coefficients in the post-reform period, while failing in each case to reject the null hypothesis of no demographic effects in the pre-reform period. The income variable, which never has an effect on public-service provision prior to the reform, emerges after the reform as a determinant of child-care coverage and employment per young child, teachers per student, and cultural spending. In addition, larger cohort sizes (for children, youth, and elderly) lead to reductions in post-reform levels for some services, when effects were absent prior to the reform. This pattern is seen for CH in child-care coverage (being marginally significant), YO in class size and teachers per class, and EL in cultural spending. The results thus suggest that local discretion granted under partial decentralization allows public-service levels to respond to local demand.

5. The Reform's Effect on Migration

To test for a potential effect of the reform on intercity migration (a response to heightened incentives for sorting of the population), yearly rates of in- and out-migration are computed for each city in the sample and then averaged across cities. The results, which give migration as a percentage of the existing population, are shown in Table 6, along with the combined migration rate (the average of the in and out rates). All the migration rates lie between 4 and 5 percent, and the pre- and post-reform comparison at the bottom of the table suggests that migration may have increased after the reform.

To provide a proper test, a panel regression is run for each of the three migration measures, with the right-hand variables consisting of city fixed effects and a post-reform dummy variable. The coefficient of this latter variable is positive and strongly significant in the combined and out-migration regressions (t-statistics are 6.12 and 9.86 respectively), although it is insignificant in the in-migration regression, matching the pattern seen in Table 5. Therefore, although some other intertemporal cause for increased migration cannot be ruled out, these findings are consistent with the existence of a greater incentive for population sorting after the reform, as the theory would predict.¹⁴

To see whether increased migration is reflected in greater heterogeneity across cities, a dissimilarity index is computed for the sample cities for each of the three age measures as well as for all the measures together. Changes in city age distributions could perhaps capture greater incentives for age-based sorting as some cities shift resources toward education (attracting families with children) and others deemphasize education (becoming more attractive to the elderly). The dissimilarity index, which uses the formula from Rhode and Strumpf (2003), indicates the extent to which residents would need to move between cities in order to equalize the age shares, thus being an increasing measure of intercity heterogeneity.¹⁵ The results are mixed, showing greater post-reform heterogeneity for youth, less heterogeneity for the other two categories, and a slight increase in overall post-reform heterogeneity. The absence of a clearcut heterogeneity effect from the reform is not inconsistent, however, with its demonstrated impact on migration. It could be argued that a longer time interval would be needed for greater migration to notably affect city age compositions.

6. Conclusion

This paper provides an empirical test of a principal tenet of fiscal federalism: that spending discretion, when granted to localities, allows public-good levels to adjust in response to local demands. The test is based on a simple model of partial fiscal decentralization, under which earmarking of central transfers for particular uses is eliminated, allowing funds to be spent according to local tastes. The model predicts that under partial decentralization, the demographic characteristics of local jurisdictions should play a bigger role in determining the levels of public goods after a decentralization reform than before. This prediction receives support from the paper's empirical results, which show that local demand determinations matter more after the 1986 Norwegian reform than before it, and that the reform may have increased incentives for population sorting. These findings are important because they represent an affirmation of a central, but seldom-tested, principle of public economics.

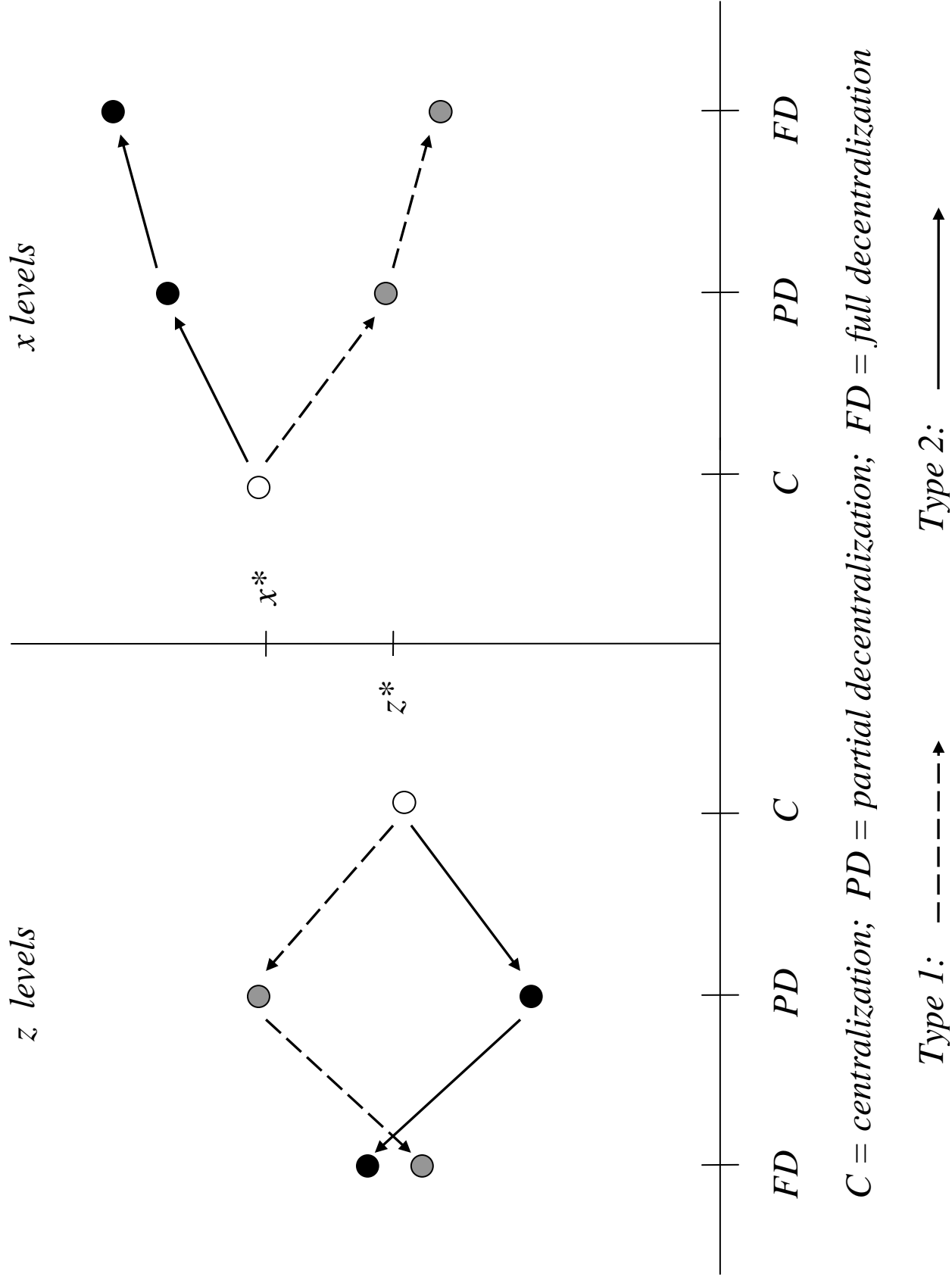


Figure 1: Effects of Decentralization

Table 1
Summary Statistics

<i>Variables</i>	<i>Before the reform</i>	<i>After the reform</i>	<i>All years</i>
Child care			
Coverage	0.261 (0.137)	0.408 (0.153)	0.328 (0.162)
Child-care employment per child	0.206 (0.073)	0.230 (0.067)	0.214 (0.072)
Employment per young child	0.051 (0.031)	0.095 (0.048)	0.071 (0.045)
Education			
Class size	18.4 (3.47)	17.2 (3.37)	17.8 (3.47)
Teachers per class	1.80 (0.21)	2.08 (0.26)	1.94 (0.28)
Teachers per student	0.102 (0.025)	0.127 (0.034)	0.114 (0.032)
Elderly Care, Culture, and Parks			
Elderly-care coverage	0.089 (0.057)	0.108 (0.058)	0.097 (0.058)
Cultural spending	390 (177)	505 (261)	436 (222)
Parks spending	32 (59)	29 (54)	31 (57)
Explanatory variables			
Private income net of taxes per capita (PINC)	21,006 (2,472)	23,313 (2,417)	22,054 (2,703)
Share of children 0-6 years (CH)	0.093 (0.015)	0.089 (0.014)	0.091 (0.015)
Share of youths 7-15 years (YO)	0.148 (0.018)	0.130 (0.017)	0.140 (0.020)
Share of elderly 67 years and above (EL)	0.141 (0.037)	0.153 (0.039)	0.146 (0.038)
Population size (POP)	8,025 (14,678)	8,196 (15,046)	8,102 (14,845)

Table 2
Child Care Regressions

	<i>Coverage (share of children in child care)</i>		<i>Child-care employment per child</i>		<i>Employment per young child (1-6 years)</i>	
	1980-85	1986-90	1980-85	1986-90	1980-85	1986-90
Log(PINC)	0.043 (0.68)	0.178 (3.02)	0.003 (0.06)	0.100 (1.77)	0.004 (0.26)	0.069 (2.43)
CH	0.855 (1.25)	-1.153 (-1.74)	-0.299 (-0.90)	-0.159 (-0.38)	-0.042 (-0.31)	-0.317 (-1.21)
YO	0.034 (0.08)	-0.645 (-1.09)	0.232 (0.81)	0.427 (1.14)	-0.150 (-1.22)	-0.065 (-0.27)
EL	0.286 (0.28)	-0.182 (-0.33)	0.304 (0.87)	0.482 (0.90)	0.178 (0.80)	0.273 (0.79)
Log(POP)	-0.396 (-2.31)	-0.288 (-2.23)	0.004 (0.07)	0.081 (0.61)	-0.080 (-1.96)	-0.074 (-1.36)
N	443	443	412	412	443	443

t-statistics in parentheses

Table 3
F-tests

	All coefficients			All coefficients except population size		
	<i>Equality before and after</i>	<i>Jointly zero before</i>	<i>Jointly zero after</i>	<i>Equality before and after</i>	<i>Jointly zero before</i>	<i>Jointly zero after</i>
Child care						
Coverage	1.90 (0.094)	3.14 (0.009)	5.59 (0.000)	2.23 (0.065)	0.053 (0.716)	3.39 (0.001)
Child-care employment per child	0.52 (0.759)	0.72 (0.612)	1.91 (0.092)	0.57 (0.688)	0.084 (0.498)	1.64 (0.165)
Employment per young child	1.55 (0.174)	3.51 (0.004)	5.29 (0.000)	1.78 (0.131)	0.74 (0.562)	2.84 (0.024)
Education						
Class size	1.07 (0.379)	4.36 (0.001)	3.05 (0.010)	0.19 (0.944)	2.19 (0.069)	3.52 (0.008)
Teachers per class	3.01 (0.011)	1.60 (0.159)	3.86 (0.011)	2.49 (0.042)	1.51 (0.199)	4.12 (0.003)
Teachers per student	7.41 (0.000)	4.85 (0.000)	15.45 (0.000)	8.73 (0.000)	2.81 (0.025)	14.99 (0.000)
Elderly Care, Culture, and Parks						
Elderly-care coverage	0.97 (0.434)	1.54 (0.175)	0.87 (0.504)	1.19 (0.313)	1.51 (0.197)	0.69 (0.599)
Culture	0.85 (0.518)	3.94 (0.002)	9.69 (0.000)	1.04 (0.388)	1.41 (0.229)	7.29 (0.000)
Parks	1.92 (0.089)	0.69 (0.628)	3.54 (0.004)	0.40 (0.812)	0.76 (0.549)	1.59 (0.176)

F statistics with p-values in parentheses

Table 4
Primary and Lower Secondary Education Regressions

	<i>Class size</i>		<i>Teachers per class</i>		<i>Teachers per student</i>	
	1980-85	1986-90	1981-85	1986-90	1981-85	1986-90
Log(PINC)	-0.971 (-0.84)	-0.945 (-0.99)	-0.063 (-0.24)	0.281 (1.42)	0.015 (1.15)	0.038 (2.83)
CH	7.38 (0.78)	-2.51 (-0.28)	0.394 (0.14)	-0.873 (-0.47)	0.001 (0.01)	0.087 (0.87)
YO	19.6 (1.76)	20.2 (2.85)	-1.33 (-0.58)	-5.31 (-3.74)	-0.108 (-2.09)	-0.556 (-5.61)
EL	3.73 (0.35)	-2.13 (-0.27)	2.26 (1.43)	-0.230 (-0.14)	0.164 (1.98)	0.025 (0.23)
Log(POP)	4.85 (2.66)	0.137 (0.08)	0.650 (1.99)	-0.075 (-0.18)	-0.017 (-0.85)	-0.072 (-2.54)
N	443	443	443	443	443	443

t-statistics in parentheses

Table 5
Elderly-Care, Culture, and Parks Regressions

	<i>Elderly-Care Coverage</i>		<i>Cultural spending per capita</i>		<i>Parks spending per capita</i>	
	1980-85	1986-89	1980-85	1986-89	1980-85	1986-89
Log(PINC)	-0.026 (-0.59)	-0.015 (-0.29)	199.7 (1.70)	363.1 (3.58)	-9.34 (-0.32)	-4.21 (-0.17)
CH	-0.058 (-0.16)	-0.261 (-0.72)	-806.1 (-1.20)	-1466.0 (-1.04)	106.4 (0.47)	-67.3 (-0.32)
YO	0.571 (1.48)	-0.296 (-0.99)	-374.8 (-0.55)	420.6 (0.35)	445.3 (1.91)	411.4 (1.84)
EL	-0.870 (-1.70)	-0.471 (-1.00)	-775.9 (-0.65)	-3273.3 (-2.44)	107.9 (0.37)	-282.6 (-1.46)
Log(POP)	-0.173 (-2.32)	-0.123 (-1.69)	-575.8 (-2.57)	-707.2 (-2.94)	30.9 (0.72)	-116.4 (-2.62)
N	443	443	443	443	443	443

t-statistics in parentheses; note that, due to data limitations, the post-reform period for these services does not include 1990

Table 6: Migration

	<i>Average migration rates</i>		
	<i>In</i>	<i>Out</i>	$(In+Out)/2$
1980	0.048	0.044	0.046
1981	0.047	0.044	0.045
1982	0.044	0.043	0.044
1983	0.043	0.042	0.042
1984	0.040	0.042	0.041
1985	0.041	0.044	0.043
1986	0.042	0.046	0.044
1987	0.047	0.047	0.047
1988	0.047	0.048	0.047
1989	0.044	0.046	0.045
1990	0.042	0.045	0.044
1980-85	0.044	0.043	0.043
1986-90	0.044	0.046	0.045

Migration rates are averages across cities and are expressed as a share of the existing population.

Table 7: Dissimilarity index for share of children (CH), youths (YO), elderly (EL) and total for all three groups

<i>Year</i>	<i>CH</i>	<i>YO</i>	<i>EL</i>	<i>Total</i>
1980	0.059	0.052	0.115	0.075
1981	0.061	0.052	0.115	0.076
1982	0.062	0.052	0.114	0.076
1983	0.064	0.052	0.113	0.076
1984	0.064	0.052	0.112	0.077
1985	0.064	0.052	0.113	0.077
1986	0.061	0.053	0.113	0.077
1987	0.060	0.055	0.113	0.078
1988	0.057	0.056	0.112	0.078
1989	0.054	0.058	0.111	0.077
1990	0.052	0.059	0.109	0.077
1980-85	0.062	0.052	0.114	0.076
1986-90	0.057	0.056	0.112	0.077

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Footnotes

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¹For example, figures presented by Shah and Shah (2006) show that, in a sample of ten lower-income countries, local governments relied on intergovernmental transfers for 51% of their revenue, in contrast to a smaller transfer share of 34% for OECD countries. In a larger sample of developing countries analyzed by Shah (2004), 42% of subnational revenue (local and provincial) came from transfers.

²Although the Shah studies cited in footnote 1 do not present evidence on tax autonomy for the sample countries, a separate OECD study (1999) shows that, for one sample country (Mexico), subnational governments had effective control over only 14% of their tax revenue, with this limited control enjoyed only at the state rather than local level.

³This decoupling allows public-good provision to respond under partial decentralization to heterogeneity in the demands for z despite a common transfer level for all localities. The response is narrower, however, than under full decentralization.

⁴Sigman (2007) offers a test for the effects of decentralization that does not rely on a natural experiment. Her empirical results show that variation in environmental quality is higher within federalist countries than within non-federal states, evidently reflecting variation in the restrictiveness of local environmental policies within the former set of countries.

⁵With full decentralization, jurisdictions in his model choose both the investment level in individual public projects and the number of projects to implement, in a setting with inter-jurisdictional spillovers. The central government can improve the outcome by specifying the level of project investment while still allowing localities to choose the number of projects undertaken, a partial-decentralization outcome that shares the spirit of the current approach.

⁶It does so because spending is then fixed at the level of the central transfer regardless of whether the uncertain unit cost of the public good turns out to be high or low (rather than adjusting to reflect this cost). As a result, rent-seeking politicians who wish to masquerade as benevolent can more easily extract rents under partial decentralization without revealing

their type. While this conclusion affirms the superiority of full decentralization, Brueckner (2009) (in a variant of his basic model) offers a different result by showing that partial decentralization instead limits the options of rent-seekers, making it potentially superior to full decentralization.

⁷While local governments use nonredistributive and nondistortionary head taxes in a desire to avoid tax competition, a redistributive capital tax, which also distorts the economy by depressing capital supply, funds central provision of public goods. Facing a tradeoff between efficiency and redistribution in the choice of local versus central provision, voters choose the optimal share of public goods to be provided locally, thus determining the extent of partial fiscal decentralization. Panizza (1999) and Jametti and Joanis (2011) use similar models in empirically oriented papers.

⁸For example, Rodden, Eskeland and Litvack (2003) offer a set of country studies addressing various issues of fiscal discipline in centralized systems. In the Norwegian context, Borge and Rattsø (2002) and Rattsø (2004) analyze fiscal adjustment within that country's centralized fiscal structure. Barankay and Lockwood (2007) analyze the impact of decentralization on governmental productive efficiency, using data for Swiss cantons with different degrees of decentralization. Zhuravskaya (2000) studies private business formation across Russian cities with different degrees of fiscal discretion.

⁹With more than two types, the number of possible city types would increase, given that each consumer type is potentially in the majority in some city. However, the dispersion effect of partial decentralization continues to emerge. Letting θ_i denote the population share of consumer type i , the analog to (12) and (13) is

$$\widehat{x}_i < x^*, \quad \widehat{z}_i > z^* \quad \text{if} \quad \frac{\beta_i}{1 - \alpha_i} < \frac{\sum_{j \neq i} \theta_j \beta_j}{\sum_{j \neq i} \theta_j (1 - \alpha_j)},$$

with the first set of inequalities reversed if the third inequality is reversed. Therefore, depending on the relationships among the α 's and β 's for the consumer types, partial decentralization will lead to increases in z and decreases in x in some cities and reverse changes in other cities, creating the kind of changes seen in the two-type case. A further generalization that increases the number of public goods beyond two also leaves the main predictions of the theory unaffected.

¹⁰Note that $z_i = T^* + R_i - x_i = T^* + R_i - x^* - \widetilde{x}_i = z^* + R_i - \widetilde{x}_i$, with the z^i component fixed.

¹¹Although class size is equal to teachers per class divided by teachers per student at the level of individual observations, the same relationship does not hold for the mean values shown in the table.

¹²Note that a larger population reduces child-care coverage both before and after the reform.

¹³A significantly positive elderly-share effect, which is hard to interpret, exists in the pre-reform period for teachers per student, but it disappears following the reform. Similarly, a significantly positive population effect exists prior to the reform for teachers per class, disappearing after it. These changes, which unfortunately run counter to the predictions, contribute to the significance of the F statistics.

¹⁴Table 5 presents unweighted migration rates, where the rates are not weighted by city populations. While weighted rates do not replicate the apparent post-reform migration increase, the regression results, being based on individual city populations and including city fixed effects, give the clearest picture.

¹⁵The number of people needing to move is expressed relative to the number who would have to move to equalize age shares if the population were completely segregated by age.