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Special Issue
Economies of Scale and Collaboration: Financial Sustainability in Local Government

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Special Issue Information

Dear Colleagues,

This special issue will present research papers that assess the efficiency and sustainability of local government with a focus on issues concerning mergers, outsourcing and various types of collaboration. Authors are encouraged to submit papers that examine local government policies regarding different forms of collaboration and upscaling, incorporating efficiency gains due to economies of scale. We are particularly interested in papers with a focus on sustainability of service delivery and finance. A strong quantative and empirical component is required, preferably including analyses based on methodologies such as Stochastic Frontier analysis and Data Envelopment Analysis. From a policy perspective the papers must contain clear policy recommendations. All types of local government services may be included.

Prof. Jos L.T. Blank
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Guest Editors

Keywords

- local government
- policy analysis
- mergers
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Article

Managing Size of Public Schools and School Boards: A Multi-Level Cost Approach Applied to Dutch Primary Education

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Abstract: In many countries, the provision of primary education is among the core responsibilities of local governments. One of the main questions local governments face concerns the optimal configuration of school boards and size of schools. In this paper we analyse the relation between cost and scale in school boards and in schools. The influence of both the governing layer (board) and the operational layer (school) on average cost are jointly modelled. Board cost is modelled as an aggregation of individual school cost functions so that individual school cost data are not required in order to estimate the model. The results indicate that small schools (<60) pupils are operating under sizable economies of scale. The optimum school size is estimated at roughly 450 pupils, but average cost remains roughly constant with regard to size. In contrast to school size, the effect of board size (in terms of the number of schools governed) on average cost is limited. The policy recommendation is that municipalities should create at least three schoolboards within their jurisdiction and take measures in case individual school size declines below 60 pupils.

Keywords: local government; cost model; economies of scale; multi scaling; schools; school boards

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1. Introduction

In many countries, providing (primary) education is a core task of local and/or state governments. In order to maintain sustainable government expenditure and foster the quality of education, governments are constantly seeking ways to deliver more value for their money, especially when faced with increasing enrolment. One of the main channels through which policy makers in amongst others the U.S. and Netherlands have sought to increase the efficiency of educational spending is through the consolidation of schools and/or school districts [1,2]. An important motivation of consolidation is the notion of economies of scale, i.e. that idea that bigger units have lower average (per-pupil) cost.

There is a large strand of literature on economies of scale in educational institutions and several review articles have emerged over the past decades [2,3]. While models, data and techniques vary, the vast body of these studies are concerned with estimating the relation between (average) cost and enrolment [4–7]. In general, while results differ across countries and methodologies, the smallest of schools and school districts are generally found to operate under economies of scale [2,3,8,9], although the tipping point (optimal size) varies. One issue with regards to economies of scale that has attracted less attention of empirical researchers is the distinction between the governing layer of school districts (U.S.) or boards (Netherlands) and the operational layer (schools). In the Netherlands, one board may govern up to thousands of pupils and tens of schools, while other boards govern only one school and

200 pupils. Similarly, some boards govern few large schools while other govern a larger number of smaller schools.

This paper departs from the observation that both layers matter for average (i.e. per-pupil) cost. From a policy perspective, this recognition has implications for policy makers and educational managers with regard to the size and number of school boards and schools. For example, given some level of enrolment, school boards (or districts) face the question of the optimal number of schools. The size and amount of school boards or districts is, in turn, a design choice influenced by national or local government. In other words, given the cost structure of schools and school boards, what is the optimal size of boards and schools in terms of enrolment and the number of schools governed by boards, and what does this imply for choices regarding consolidation or closure (when facing decreasing enrolment) of school (boards)?

Regarding the mechanisms that drive economies of scale at each level, school districts may e.g. benefit from scaling by requiring less overhead per governed school or pupil. At the school level, the potential effects of scale on cost include occupancy rates of school buildings, the spreading of fixed cost over a larger number of pupils or the specialization of teaching and managerial staff. Whereas the bundling of activities (joint purchases, integrated IT systems and manpower sharing) may be beneficial for all schools, the cost savings may be voided by increased managerial complexity, extra managerial layers, complex bureaucratic procedures, etc. In the study of economies of scale focusing on only one layer, bias may occur, for example, due to the fact that large school boards concentrated in densely-populated areas may also govern large schools. Possible observed (dis)economies of scale at the board layer may then be a result of the (dis)economies of scale of the associated schools instead of the board. In order to avoid any of these biases, the interdependency between the two layers should be integrated in the empirical model.

To see why the distinction is relevant especially in Dutch primary education, consider Figure 1. Each dot represents a single school board. The vertical axis corresponds to the enrolment at each board. The horizontal axis corresponds to the average school size of the schools governed by a board. Both size indicators are only correlated weakly. That is, there are both small boards (in terms of enrolment) governing relatively large schools and large boards governing many relatively small schools.

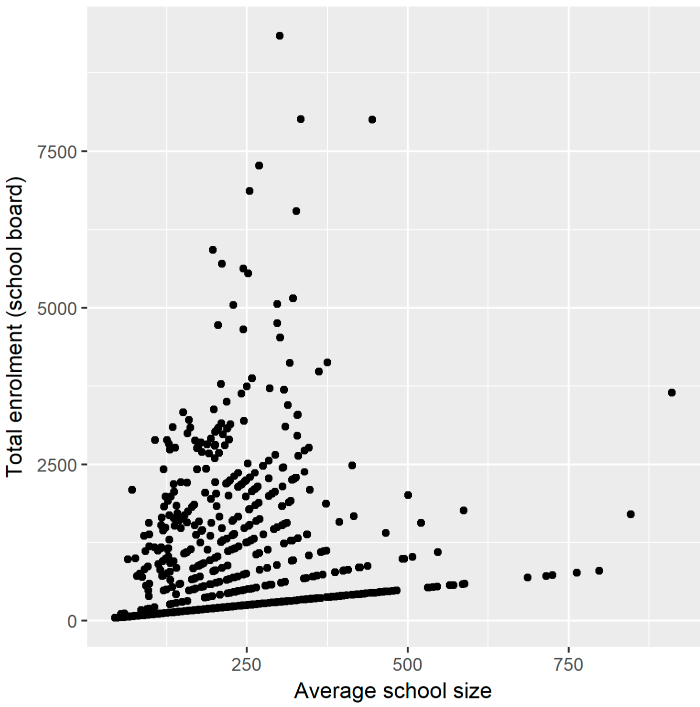

Figure 1. Relationship between average school size and total enrolment at the school board.

Despite the lack of empirical analyses, multiple studies have recognized the importance of both layers. For example, Bickel & Howley [10] perform a multi-level analysis to explore the relation between district and school scale and performance. In a more recent study, Schiltz & De Witte [9] estimate district-level cost functions for Flemish schools and also note the potential joint influence of scale effects at both the district and the school level. Related is the analysis by Duncombe et al. [7]. They model U.S. school district cost and include the median governed school size as an exploratory variable, shedding some light on the importance of school size and dynamics between the different layers. Most closely resembling this analysis is Wales [11] which develops an simple but somewhat comparable aggregation approach to what we will do in this paper. In most previous studies, however, the unit of analysis typically is either the school district (or board) or school as determined by data availability: "although the school is the appropriate unit of analysis for investigating school costs, district-level data are often used, largely because school-level data are unavailable" [8]. More generally, the observation that the administrative scale of public organizations may not correspond with the scale at which they produce or deliver services has been recognized in other domains as well, such as local governments. Blom-Hansen et al. [12] for example distinguish between the administrative size of municipalities and the "plant" level of production, where economies of scale actually arise. In the realm of local governments, it has also motivated research into e.g. the effect of intermunicipal cooperation, a reform through which local governments can import economies of scale [13–15].

To this end, this paper develops and estimate a model that allows for the simultaneous analysis of economies of scale at both the governing (districts or boards) and operational (school) level. This is done by modelling school board cost as an aggregation of school cost functions, so that individual school cost data is not required for estimation of the model.

Methodologically, solving this issue is a challenging task since it belongs to the class of aggregation problems. In case the structure of a micro unit (e.g., a school) is known, the question arises whether we are able to derive the structure of an aggregated unit. From the seminal work of Daal & Merkies [16], we know that "aggregation is nearly always impossible" and that the aggregated function can be derived only under very specific conditions. In this paper we do not claim to solve this issue, but we can bypass the impossibility clause by aggregating individual cost functions through computational means. The model does not require individual school cost data. The research question, therefore, is whether it is possible to design an empirical model that takes into account the production technology and economic behaviour at both the school and school district level—and whether these can be estimated, even in the case of missing financial data at the school level.

The remainder of this paper is outlined as follows. Section 2 outlines the methodology. Section 3 discusses the data used for estimating the model. Section 4 includes the results of the estimation. Section 5 offers some conclusions and suggestions for further research.

2. Methodology

2.1. Model Design

To establish an empirical relationship between (minimum) cost and production (scale), it is common to apply a so-called cost function. Cost functions are a mathematical representation of this relationship, which may also include resource prices and a number of control variables. Cost functions eminently are suitable for deriving all kinds of economic relations, such as economies of scale and scope. For an explanation of this approach see [17,18]. Formally, a cost function can be written as:

$$C = c(y, w) = \min_{x}\{w \times x | (y, x) \in T(x, y)\} \tag{1}$$

where:

C = (minimum) costs;
y = vector services produced;

w = vector of resource prices;
x = vector of resources;
$T(x, y)$ = set of feasible combinations of services produced and resources.

The parameters of cost functions are estimated on the basis of data on individual firms or other economic entities that can be indicated as Decision Making Units (DMUs). Other economic entities can refer to lower hierarchical functional entities (departments) or to higher entities (regions, boards, districts et cetera). The choice of DMU is a matter of perspective, depending on which policy or managerial issue is being addressed. In general, a pile of layers—each of them with specific responsibilities and discretionary power—can be distinguished. The relevant distinction here is between schools and boards. This distinction is in line with the distinction between the (primary) teaching process and the (secondary) general management process. The first directly refers to course content, education time and course schedules; whereas the latter refers to the administrative and financial tasks, labour contracts and building investment and maintenance. For obvious reasons these two different processes cannot be separated but may strongly interact.

Estimating cost functions that consider complex organisational structures still is a relatively unexplored area. As discussed in the introduction, there are conceptual similarities in many sectors, and several authors have dealt with analysing different scale layers (e.g., in health and local government). In the aforementioned study of Niaounakis & Blank [19] on the effects of collaboration in local tax levying, data on the contributions of each municipality to municipal cooperation are available. In the preceding case of education, we lack this type of data. In this paper, data on production (enrolment, test scores, etc.) and environment of individual schools are available, but costs and other input data are not. Thus, in developing a suitable cost model, not only do we have to account for the complex organisational structure, we also must deal with a number of unobserved variables. The solution to this problem, putting it simply, is to sum up all the underlying cost functions of the associated schools to an aggregate cost function and estimate the parameters of the aggregated model. We will formally derive the relationship between schools and school board. Suppose that the minimum cost of an individual school s connected to school board b can be displayed as:

$$C_{bs}^{\min} = c(Y_{bs}, W_{bs}, Z_{bs}) \tag{2}$$

where:

$C_{bs}^{\min}$ = minimum costs of school s of school board b;
Y_{bs} = vector of services of school s of school board b (e.g. number of pupils per type of training, education results);
W_{bs} = vector prices of resources used of school s of school board b (e.g. wage index, material price index);
Z_{bs} = vector environmental factors of school s of school board b (e.g. social background).

This also includes costs for student administration, the ICT department, accounting, human resources and management. In case these (secondary) costs are carried by a separate body (the board), it is assumed that they can be allocated to the associated schools. This can be regarded as a school outsourcing these managerial and auxiliary activities to a third party (the board). It is assumed that secondary costs are directly related to services delivery and the size and quality of the board providing these services. In fact, the latter refers to the efficiency component of the school. Therefore, we may add to the minimum cost an efficiency term that is strongly correlated with a number of attributes of the board, such as the number of associated schools or the total services provided by the associated schools.

$$Ineff_{bs} = \exp[g(Z_b)] \tag{3}$$

where:

Eff_{bs} = inefficiency of school s of school board b;
Z_b = attributes of board b;

The inefficiency term is a factor that inflates the minimum costs by a certain factor greater than one. This implies that the function g(.) must be so defined that it always produces outcomes greater than or equal to zero. Actual costs of school s of school board b then equal:

$$C_{bs} = c(Y_{bs}, W_{bs}, Z_{bs}) \times \exp[g(Z_b)] \tag{4}$$

The total cost of board b is then the summation of costs of all associated schools of board b:

$$C_b = \sum_s c(Y_{bs}, W_{bs}Z_{bs}) \times \exp[g(Z_b)] \tag{5}$$

Or in logarithms:

$$In(C_b) = In[\sum_s c(Y_{bs}, W_{bs}Z_{bs})] + [g(Z_b)] \tag{6}$$

The common procedure is that the (minimum) cost function $c(Y_{bs}, W_{bs}, Z_{bs})$ is reflected by a mathematical equation (the functional specification), whose parameters can be estimated by an econometric method (e.g., nonlinear least squares). From the estimated parameters an estimate of scale effects can be derived.

The above equation now only includes observable variables. The left-hand side includes the total cost for all member schools, including the costs for management of the school board. The problem is now reduced to a statistical problem, because on the right side we find—in case there are many schools associated with a school board—a large number of terms. There are two solutions. The first solution is specifying a simple representation of the cost function, so that different terms can analytically be aggregated. There remains a simple regression equation consisting of terms such as the total number of pupils belonging to a school board. The second solution is based on the ability to solve the problem entirely numerically. The search for economies of scale requires a flexible functional form that allows scale elasticities to vary with size. The suggested simple solution does not meet this requirement and is therefore further ignored. We therefore entirely focus on the numerical solution.

As the parameters of $c(Y_{bs}, W_{bs}, Z_{bs})$ and $g(Z_b)$ are empirically established, elasticities with respect to services produced by the school and with respect to the boards' attributes can be calculated.

2.2. Functional Specification

For an empirical application of the economic model, we use the well-known translog cost function [20]. The model includes first, second order and cross terms between outputs, and year dummies representing technical change. Because of the lack of accurate price indices for different resources, we ignore the possibility of price substitution. We divide actual cost by a general consumer price index to control for nominal developments. The translog cost function looks as follows:

$$\begin{aligned} &c(Y_{bs}, W_{bs}, Z_{bs}, T) = \exp\{a + \textstyle\sum_m b_m In(y_m) + \\ &\tfrac{1}{2}\textstyle\sum_m \sum_{m'} b_{mm'} In(y_m) In(y_{m'}) + \sum_p d_p In(z_p) + \sum_p \sum_{p'} In(z_{p'})\big\} + \sum_t h_t(yr = t) \end{aligned} \tag{7}$$

Here, a, b and h_t are the parameters to be estimated. The model that will be estimated is obtained after substitution of (7) in (6).

3. Data

Data were sourced from the Education Executive Agency (DUO) of the Dutch Ministry of Education, Culture and Science. The agency publicly reports available datasets, including the annual financial statements of boards and enrolment at schools. Recall that the key issue in this paper is that enrolment and other pupil-related indicators are registered at the level of individual schools, while financial statements are observed at the board level.

The data set is constructed as follows. Each observation corresponds to a single school board and contains information on its cost. For board b, let $y_{b,s}$ denote enrolment at school s. Furthermore, let N_b denote the number of schools governed by board b. Then $y_{b,s}$ equals zero for $n > N_b$. The largest number of schools governed by a single board in our sample equals 31.

In the actual data set, three enrolment variables are included. Dutch school boards are eligible for additional funding for enrolled pupils from a disadvantaged socio-economic background. To cater to their educational needs, schools with a large number of such pupils have smaller class sizes, implying higher cost. The three enrolment variables included correspond to the classification that is also used within the funding mechanism (SES-1, SES-2, SES-3).

Data are included for the years 2011–2015. Note that as the yearly (within-) variation of school boards - in terms of enrolment or cost - is limited in most cases, little additional information is gained from analysing multiple years. In 2015, there were 971 school boards governing schools providing elementary education. The final sample included for analysis contains 723 or roughly three quarters of these boards. In total, these boards govern 2601 different schools or 4.60 on average. Omissions are due to the fact that some boards in primary education may also govern one or more special needs education schools. Some boards even govern one or more vocational education schools. Their inclusion requires an extension of the cost function by additional output (enrolment) variables to account for the different pupils. While this offers the possibility to study economies of scope and a larger sample, the advantage of analysing a homogeneous group of boards outweighs the computational difficulties posed by including several poorly comparable school boards. In roughly thirty per cent of the schools, test scores were not available. For a board that governs both schools with test scores and without known test scores, the missing school scores a set equal to the average test scores of the other schools governed by the boards.

In addition to the cost and enrolment variables discussed, a number of additional indicators are included: i.e. the average test score at each school and the number of schools governed by each board. Table 1 provides a set of summary statistics on the included variables.

Table 1. Descriptive statistics, 2015.

VARIABLE	MEAN	STD. DEV.	MINIMUM	MAXIMUM
***BOARD LEVEL* (*N* = 723)**				
COST (IN MILLIONS OF EUROS)	5.20	6.46	0.37	52.41
ENROLMENT (TOTAL)	983.15	1214.64	45.00	9340.00
ENROLMENT (SES-1)	903.00	1199.27	44.00	8347.00
ENROLMENT (SES-2)	46.10	63.14	0.00	447.00
ENROLMENT (SES-3)	34.05	79.56	0.00	980.00
NUMBER OF SCHOOLS	4.60	5.53	1.00	31.00
***SCHOOL LEVEL* (*N* = 2601)**				
ENROLMENT (TOTAL)	213.30	128.25	12.00	1283.00
ENROLMENT (SES-1)	196.00	123.14	12.00	1246.00
ENROLMENT (SES-2)	10.11	12.30	0.00	174.00
ENROLMENT (SES-3)	7.19	16.72	0.00	205.00
AVERAGE TEST SCORE	535.26	3.92	514.70	546.20

4. Results

The main results are presented in Table 2. The results were obtained by estimating Equation (6) after substituting Equation (7) using nonlinear least squares.

Table 2. Model estimates (N = 3178).

VARIABLE	PARAMETER	ESTIMATE	STD ERROR	T-VALUE	T-VALUE CORREC-TED
CONSTANT	a	−0.984	0.006	−164.423	−85.096
ENROLMENT (SES-1)	b_1	0.634	0.006	110.568	57.224
ENROLMENT (SES-2)	b_2	0.058	0.003	20.363	10.539
ENROLMENT (SES-3)	b_3	0.128	0.002	62.498	32.345
SES-1 X SES-1	b_{11}	0.215	0.010	21.121	10.931
SES-1 X SES-2	b_{12}	−0.008	0.002	−3.522	−1.823
SES-1 X SES-3	b_{13}	−0.038	0.002	−19.127	−9.899
SES-2 X SES-2	b_{22}	0.023	0.001	15.694	8.123
SES-2 X SES-3	b_{23}	0.003	0.001	3.482	1.802
SES-3 X SES-3	b_{33}	0.045	0.001	44.595	23.080
NUMBER OF SCHOOLS	d_1	−0.017	0.006	−2.790	−1.444
NUMBER OF SCHOOLS X NUMBER OF SCHOOLS	d_{11}	0.016	0.005	3.574	1.850
TEST SCORE	d_2	0.100	0.026	3.883	2.010
TEST SCORE X TEST SCORE	d_{22}	1.742	0.190	9.181	4.752
YEAR = 2011	h_1	−0.019	0.006	−3.182	−3.182
YEAR = 2012	h_2	−0.035	0.006	−5.861	−5.861
YEAR = 2013	h_3	−0.025	0.006	−4.298	−4.298
YEAR = 2014	h_4	0.006	0.006	1.023	1.023
R2		0.99			

At first sight, the estimated model obviously appears to have a good fit ($R^2 = 0.99$). The first-order parameters have plausible positive signs and are estimated as significant at the 1% level. It should be noted that the standard errors have not been clustered. Due to the special aggregation structure and the high non-linearity of the model, it is cumbersome to exactly calculate the corrected standard errors. Therefore we apply a raw correction measure based on the intra correlation of the residuals only. The formula for this raw correction factor is:

$$\tau = \sqrt{1 + p_u(\overline{N} - 1)} \tag{8}$$

where:

τ = correction factor least squares standard errors of estimated parameters;
ρ_u = intra correlation of the residuals;
$\overline{N}$ = average number of replications in the panel;

Note that formula (8) does not include any correction for the intra correlation of the independent variables in the model, implying that this this correction factor is overestimated and so are the corrected standard errors. The reported T-values therefore are underestimated. Note that in case of time dummies no correction need to be made, since no intra correlation exists and the estimated parameters are not biased due to the panel data structure. Most of the parameters show extremely low standard errors. Even in the case of inflating these standard errors by the correction factor, these standard errors still are very low. The exceptions are the parameters corresponding to the number of associated schools and the average test score. The standard errors of the remaining parameters b_{12} and b_{23} may be affected in such a way that they are no longer significant at the 5% level, but they still are at the 10% level. The parameters of the number of associated schools and square of associated schools are not significant at the 5% level after correction (the square term still is at the 10% level). The hypothesis of no relationship between number of associated schools therefore cannot be rejected. The parameters estimate of the average test score and square average test score are significant at the 5% level, even after the correction, implying that the hypothesis that there is no relationship between cost and average test score must be rejected. The requirements concerning monotonicity with respect to outputs are met (positive parameters). Note that requirements regarding input prices are not relevant here, since costs are deflated by a price index number.

As an indicator of the plausibility of the estimates, we estimated the marginal costs, presented in Table 3, of the different enrolment categories. The marginal costs have been calculated for a fictional school. The fictional school is assigned 220 pupils (corresponding to an average school) with an average composition of pupils regarding SES (200, 12 and 8). Operating in the year 2011, this fictional school has an average score on educational quality and is associated with a board that consists of three schools. From the estimates of the year dummies' parameters (significantly negative) we can also conclude that in 2011, 2012 and 2013 the conditional mean of costs were lower than in 2015, implying a substantial negative productivity change.

Table 3. Marginal costs of enrolment per SES category at an average school, 2011.

OUTPUT CATEGORY	MARGINAL COST
SES-1	€4253
SES-2	€7830
SES-3	€20,411

From these results, we note that the marginal cost of a pupil with SES-1 is about 4300 euro, about 7800 euro for a SES-2 pupil, and about 20,000 euro for a SES-3 pupil. These numbers are plausible, although the latter may be regarded as somewhat high. It must be noted that pupils in category SES-3 are rather rare.

We now turn to the key result of the analysis regarding economies of scale. Figure 1 presents the estimated average cost curve at the school level. Figure 1 is based on the average composition of a school with respect to SES (respectively 90% SES-1, 6% SES-2 and 4% SES-3). The size of the average school is set to 1. Furthermore, the average costs are presented in an index where the average cost of a school with average size is set to 100.

From Figure 2, we conclude that the average cost for small schools—for example a school with a size less than one quarter of the average school size—is 60% higher than for the average school. The estimated average cost curve indicates substantial economies of scale for small schools. Average cost increases for schools larger than twice the average school size, implying that diseconomies of scale prevail though the rise in average cost is modest. From the estimated parameters in Table 2, we can easily derive that, for a substantial number of (small) schools, scaling up is beneficial from a cost perspective.

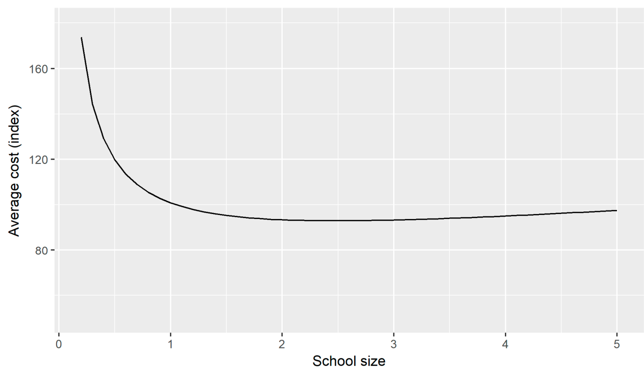

Figure 2. Average costs with respect to school size.

Figure 3 represents the average costs with respect to the number of associated schools in a school board. The reference category here is a school with an average number of pupils and with an average composition with respect to the SES-categories. The average cost is presented as an index and set to 100 in case the number of associated schools equals one.

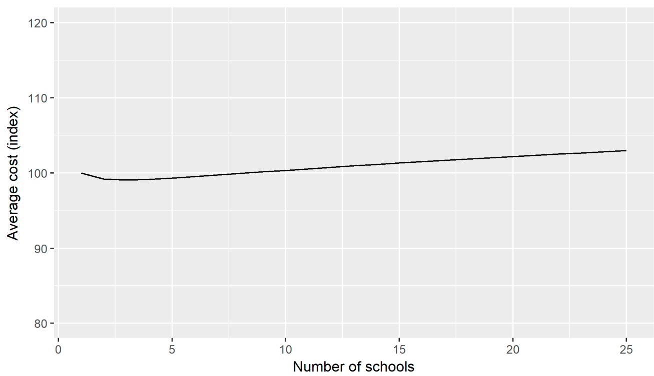

Figure 3. Average cost with respect to the number of schools in a school board.

From Figure 3, we conclude that expanding a one-school school board by adding two extra schools leads to a decline in average cost of about 2%. However, as the number of associated schools increases beyond that, average cost also increases. The cost of a board with 25 or more associated schools has an average cost 5% higher than a board with three associated schools. Note that these outcomes are controlled for the size of the associated schools and purely reflect the effect of the number of associated schools. Although we may regard these as interesting outcomes, we need to put them in perspective. From the parameters presented in Table 1, we can calculate the efficiency component due to the number of associated schools (and its statistical properties, such as standard errors and t-values). If we apply this to all observations, it shows that the efficiency of only 10% of the observations significantly differs (at 5% level) from the most efficient configuration (three schools in a board). In other words, the effect of board size is practically negligible. The policy implication that follows from this is that there is hardly any empirical evidence showing that board size matters for average cost.

5. Concluding Remarks

In many countries local governments face the question what the optimal configuration of school boards and schools is within their jurisdiction. From an economic perspective, the answers to these questions lays in the existence of (dis)economies of scale at the board level as well as the school level. However, these questions cannot be answered as easily as is suggested by many studies on economies of scale. Driven by data limitations, most studies only focus on the consequences of consolidation at the operational level (school) or at the governing level (school board). For obvious reasons these two levels are strongly intertwined, and their mutual dependency should be taken into account. In this paper we propose a model that connects both levels and meanwhile solves a data issue. The data issue concerns missing cost and input data at the school level which is addressed by estimated an aggregated cost function which only requires data at the board level.

The model is applied to a panel data set of primary schools in the Netherlands over the time (2011–2015). The results indicate that the cost structure of schools is characterized by substantial economies of scale at small sizes (say, fewer than 60 pupils). For schools with more than 60 pupils, average cost with respect to size flattens out. Optimal school size is estimated at 440 pupils. If school size increases further, then (modest) diseconomies of scale exist.

Regarding the size of school boards, a different picture arises. It shows that there might be some (board) economies of scale. Average cost declines in boards with the number of school managed up to three schools, but the effect is very modest. Boards with more than three associated schools show a modest increase of average cost. Only for the largest boards, with more than 25 schools, might we expect a significantly higher average cost than the optimal board (with three schools). Our results indicate that studies that find increasing economies of scale for small districts may in fact be driven by the (small) schools that these districts are governing. Given this possibility, it would be very useful to make a comparative analysis in the U.S. case, where district studies are common.

The optimal configuration indicated by the results is a board governing three schools of about 450 pupils each. From a cost point of view, schools smaller than 60 pupils should be avoided. In these cases, a merger could be considered. Mergers of schools greater than 200 pupils are not expected to exploit significant economies of scale. The number of schools per school board matters little for average cost, and other considerations may be more relevant here.

In the old days it was common to manage all public primary schools by one board (the municipality itself). Due to a change in legislation a municipality was allowed to form different schoolboards within their jurisdiction. However, many municipalities still operate from the original centralized perspective, but may consider to create at least three school boards with each of them their own discretionary authority. However, the cost savings from this strategy is limited. Far more important is the school size. Municipalities should monitor school size within their jurisdiction and in case pupil numbers shrink below 60 decide to encourage or force to merge or close down the school. However, due to considerations of proximity and respecting the spirit of the Freedom of Choice Act it is not very likely municipalities will be closing down or merge small schools. On the other hand, it is very interesting to know that these other public values come with a price.

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Article

An Empirical Analysis of Scale Economies in Administrative Intensity in the Paraná State Local Government System in Brazil

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Abstract: A substantial empirical study has investigated scale economies in local government functions, most notably in local transportation, water, and wastewater provision. By contrast, relatively little effort has been directed at the empirical analysis of economies of scale in municipal administration, including in Brazilian local government, despite its significance for public policy on structural reform in local government. In order to address this gap in the literature, we investigate administrative scale economies in the Paraná state local government system in Brazil over the period 2006 to 2018. We find that there was a 'U-shaped' scale effect between council size by population and administrative intensity after controlling for a range of economic and social variables. Various public policy implications are considered.

Keywords: administrative intensity; Brazil; economies of scale; local government; Paraná; optimal municipal size

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1. Introduction

Almost all local government systems comprise local authorities that vary significantly in terms of their environmental characteristics, such as population size, population density, geographic size, and topographical features. A substantial empirical study has examined the operational efficiency of local government, including the impact of scale economies at both the system-wide level and in specific municipal functions and services, especially in urban transportation, water, and wastewater [1–3]. The magnitude of scale economies in local government is significant in various respects, including in terms of public policy aimed at improving municipal performance through structural reform by means of municipal mergers, shared service programs, and other policy instruments [4,5].

Despite the voluminous empirical study on scale economies in local government, little effort has been directed at the empirical investigation of scale economies in municipal administration [6]. Given the emphasis frequently placed on minimizing administrative costs in real-world policy initiatives involving municipal mergers, this is surprising. However, some significant empirical work has been undertaken [6–10]. In the scholarly literature, administrative intensity is typically defined as the administrative costs of running an organization. Several methods have been used to proxy administrative intensity, such as the percentage of employees deployed in central administration and the proportion of total outlays expended on administration [11]. The degree of administrative intensity in any given public organization is affected by both its internal organizational characteristics [7,12–14] and its external environment [15,16].

Since a high proportion of 'back-office' costs to 'front-line' expenditure can lead to disproportionate overhead costs [12,17,18], and hence possibly diminish the operational efficiency of local government, it is unfortunate that the problem has not been thoroughly examined. Given the paucity of empirical analyses on scale economies in administrative intensity in local government, we seek to address this gap in the empirical literature on local government by empirically examining scale economies in administrative intensity in the Paraná state local government system in Brazil between 2006 and 2018. In particular, we seek to establish whether (i) administrative scale economies exist in the Paraná state local government system, and (ii) whether any significant differences in administrative intensity are evident between metropolitan and non-metropolitan councils.

Given the high and increasing proportion of very small population size municipalities in the Paraná state local government system, as well as the institutional imperatives for forming new small municipalities, commentators have expressed concern over its impact on municipal performance [19,20]. A debate has subsequently arisen around whether public policy measures, such as structural reform through municipal mergers, should be introduced to increase the size by population of Paraná local authorities [19,20]. By investigating the question of scale economies in municipal administration, this paper can contribute to this debate.

The paper is divided into five main parts. By way of institutional background, Section 2 briefly describes the Brazilian local government, including the Paraná state local government system. Section 3 summarizes the empirical literature on administrative scale economies in local government. Section 4 describes the data and empirical strategy employed, while Section 5 presents the results of the analysis. Section 6 provides a discussion of the results and the associated broader policy implications. The paper ends in Section 7 with some brief concluding remarks.

2. Brazilian Local Government

Under its Constitution of 1988, Brazil has a federal system of government comprising a national government and 26 state governments, each with its own local government system [21]. As of November 2018, Brazil had a total of 5570 municipalities, together with a single federal district, for a population of some 208.5 million people across a spatial area of about 8.5 million km^2 [22].

The political structure of the Brazilian local government is unusual [21]. In essence, local authorities in the different Brazilian state local government systems have statutorily empowered elected mayors (*prefeito*) and deputy mayors (*vice prefeito*), overseen by an elected legislative body (*câmara de vereadores*) [21]. Mayoral elections take place every four years and mayors are restricted to a maximum of two consecutive terms [21].

The population size of a given municipality determines the composition of its elected body in terms of the aggregate number of councillors. There must thus be at least nine elected representatives for local governments with a total population of up to 15,000 residents, and no more than 55 elected representatives for local authorities with more than 8 million residents [23]. Elected councillors and mayors alike serve four-year terms [24]. In addition to assuming responsibility for the provision of local services, most notably primary education, public health services and public transportation, in Brazilian local government mayors also assume authority over cultural, environmental and heritage questions [21].

Since 1950, the number of Brazilian municipalities has increased exponentially in line with rapid population growth. Table 1 provides a summary of the growth in the number of municipalities in Brazil and Paraná, as well as municipal size by population and population density. As we can see from Table 1, over the period 1950 to 2018, the total Brazilian population rose from 51,944,397 to 208,494,900 people, which is about a fourfold increase. Notwithstanding a demographic shift from rural areas to cities, the non-metropolitan population nonetheless increased [22]. As a result, the number of local authorities rose in Paraná. A contemporary political debate has arisen over the optimal number of local government areas in Paraná, with some commentators recommending municipal mergers of local authorities with less than 5000 residents [19,25].

Table 1. Number of municipalities in Brazil and Paraná, 1950–2018.

Panel A: Brazil				
Year	**Municipalities**	**Population**	**People Per Municipality**	**Density (Population/Km^2)**
1950	1889	51,944,398	27,498	6.1
1960	2766	70,324,103	25,424	8.34
1970	3952	93,134,846	23,567	11.1
1980	3991	119,011,052	29,820	14.23
1990	4491	146,825,475	32,693	17.26
2000	5507	169,799,170	30,833	19.92
2010	5565	190,747,731	34,276	22.43
2018	5570	208,494,900	37,431	26.69
Panel B: Paraná				
Year	**Municipalities**	**Population**	**People Per Municipality**	**Density (Population/Km^2)**
1950	80	2,115,547	26,444	10.62
1960	162	4,263,721	26,319	21.56
1970	288	6,929,821	24,062	35.11
1980	290	7,629,849	26,310	38.89
1990	323	8,448,713	26,157	42.37
2000	399	9,003,804	22,566	47.96
2010	399	10,444,526	26,177	52.40
2018	399	11,348,937	28,443	56.93

One reason for the increase in the number of 'small' municipalities in recent decades resides in the incentive structure and associated government transfers, which are primarily derived from the Municipal Participation Fund (MPF) [26]. Under the current arrangements, Brazilian municipalities with smaller populations receive, on average, a higher level of municipal participation funding on a per capita basis. This, in turn, has encouraged the proliferation of 'small' municipalities (<10,000 residents), which have become increasingly dependent on intra-governmental transfers [27]. Given the high proportion of small local authorities by population in the Paraná local government system, it provides a valuable real-world case to examine scale economies in terms of administrative intensity.

3. Economies of Scale in Municipal Administration

In the public administration literature, two conflicting hypotheses can be identified on the impact of administrative intensity in the public sector. In the first place, a public choice perspective holds that the costs associated with administration represent a "bureaucratic burden" that reduces the scarce resources available for public service provision [28]. By contrast, other scholars have argued that administrative intensity can improve organizational performance through enhanced decision-making, planning, and coordination [18,29,30]. Empirical research into administrative intensity has considered several aspects of the problem in public sector entities, ranging from relatively uncomplicated single-purpose local public entities, such as American school districts [18,31] to complex multi-purpose public organizations, such as universities [13]. However, apart from Andrews and Boyne [7] and a handful of other investigators [6,8,9,15,16,32–34], scant empirical research has examined administrative intensity in local government.

With respect to scale economies in municipal administrative intensity, Andrews and Boyne [7] found that municipal size by population is negatively related to administrative costs in English local government. Similarly, in their study of local government in the Netherlands, Bikker and van der Linde [9] (p. 460) established that scale economies in local administration exist "at 17% around the mean—higher for smaller and lower for larger municipalities". In contrast, in their study of administrative intensity in the Sabah state local government system in Malaysian Borneo, Ting, Dollery and Villano [8] found that for small and large local authorities, population size had no impact on administrative intensity. However, the number of employees had a non-linear (inverted 'U-shaped') effect on the proportion of administration costs. Along similar lines, in their study of the New South Wales local government system in Australia, Reddy Yarram, Tran and Dollery [6] found that municipal size by population revealed a 'U-shaped' relationship with regard to the administration costs of urban municipalities. However, they found no evidence of scale economies in administrative intensity in rural and regional local authorities. Given these mixed empirical findings, we investigate whether a statistically significant relationship exists between administrative intensity and municipal size by population in the Paraná state local government system.

4. Empirical Strategy

The data employed in this study were derived from multiple sources, which routinely collect and publish annual data on Brazilian local government areas. Expenditure data were sourced from FINBRA [35], which has published detailed information on municipal expenditure since 1986. This data collection, which is managed by IPARDES [36] and Sidra [37], includes information on population size, geographical area, population density, population growth, and the principal economic activity of the local government area (i.e., agricultural, industrial, or trade). The data collected by IBGE [38] yields information on the political dimension of municipal institutions. Finally, the data compiled by the RAIS [39] provides information on all formal workers in the state of Paraná. Moreover, data from IBGE [40] was used to classify each local government area as either metropolitan or non-metropolitan.

Data from these varied sources were used to construct a 13-year panel dataset over the period 2006 to 2018. When creating our panel dataset, we excluded a small number of missing observations (1.62%). Thus, our final sample comprised 5104 observations for 399 local government areas over 13 years. It is important to note that theoretical insights drawn from the literature on administrative intensity drove the selection of the dependent and independent variables and the specification of the subsequent econometric model. The dependent variables used in the econometric analysis were selected to measure administrative intensity, which is comprised of expenditure on planning, general administration, financial administration, internal control, territorial planning, human resource training, revenue management, outsourcing, and social communication. As a result, administrative expenditure represents a sound proxy for back-office costs in the context of Brazilian local government data. Several independent variables were also included in our econometric models to capture and control for the effects that municipal size and a variety of municipal characteristics may exert on administrative intensity.

4.1. Dependent Variables

In our subsequent statistical analysis, we employed the following measures of administrative intensity for the 399 local government areas in Paraná over the period 2006 to 2018: (i) the natural logarithm of administrative expenditure per capita; and (ii) the natural logarithm of administrative outlays as a percentage of total net expenditure.

Prior to logarithmic transformation, our dependent variables were converted in 2018 to Reais (BRL) using the Brazilian Extended National Consumer Price Index (IPCA) to remove any inflationary effects. Figure 1 illustrates the trend in our untransformed dependent variables between 2006 and 2018. Two important points are worth noting. In the first place, per capita administrative expenditure has grown from around BRL 400 in 2006 to BRL 560 in 2018 (an increase of 40%). Secondly, administrative expenditure (as a proportion of total expenditure) has steadily declined from 19.20% in 2006 to 15.50% in 2018. This indicates that while per capita administrative expenditure is increasing, it is growing at a rate less than the growth in total municipal expenditure.

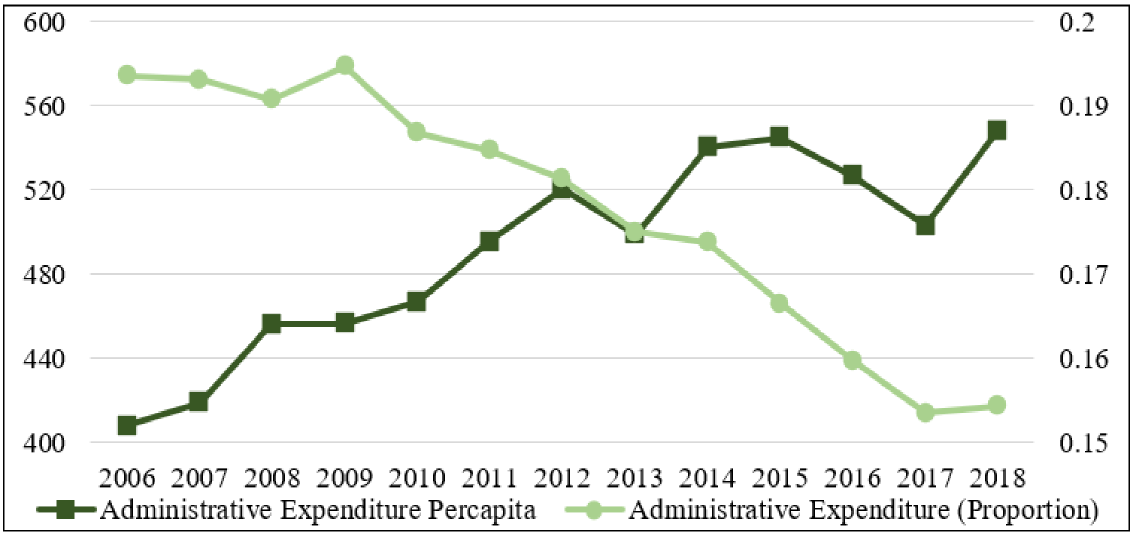

Figure 1. The administrative intensity in Paraná, 2006–2018.

We then transformed our dependent variables into a natural logarithmic scale to correct for skewness and to normalize our data. This type of transformation is commonplace, and it has been previously employed in similar studies that have empirically examined whether economies of scale are present in municipal expenditure [20,41–44].

4.2. Explanatory Variables

The explanatory variables employed in our subsequent empirical analysis were broadly classified as either population variables or control variables. For each municipal area, our population variables consisted of population size, the square of population size, and population density. In the context of local government, population size is a measure commonly used in debates on structural reform through municipal mergers, and it is often the variable that policymakers employ to propose changes in local authority boundaries [7]. Thus, our investigation is based on council size by population size in order to shed light on the current debate on municipal amalgamation in Brazilian local government. We also include population density—split into four categories—to control for municipalities with vastly different population density profiles [20,41,42].

Municipal differences in terms of socioeconomic factors were accounted for by the inclusion of the following control variables: (i) age diversity, (ii) ethnic diversity, (iii) political outlook (i.e., left-wing mayor), (iv) income level (municipalities in the bottom 25% of the income distribution), (v) whether the municipality was classified as metropolitan or non-metropolitan, and (vi) the municipality's principal economic activity (i.e., agricultural, industrial, or trade).

The diversity of the population, estimated as age diversity and ethnic diversity, is an essential control variable because a more varied local population may require more resources to identify and address its needs [7]. To measure these variables, we used data from RAIS [39], which provides data on all formal workers in Brazil. We constructed our demographic diversity variables following Andrews and Boyne [7]. More specifically, "the proportion of the sub-groups within each of these categories", within a municipal area, "were squared and then summed before being subtracted from 10,000", [7] (p. 749). The construction of the ethnic diversity variable is based on the following subgroups: White, Black, Asian, Mixed, and Indian. The construction of the age diversity variable is based on the following subgroups: 16–25; 26–35; 36–45; 46–55; 56–65. Thus, a higher score reflects a higher level of age and ethnic diversity, respectively.

Another important control variable is related to the economic activity of a local government area [10]. As such, we included a measure of the main economic activity for each local government area (i.e., agricultural, industrial, or trade). Furthermore, the nature of political disposition has also been routinely used in the empirical literature, given its putative impact on local public expenditure. Thus, we include a binary variable to denote if the elected mayor is affiliated with a left-wing political party. We classified the following political parties as being left of centre: PCdoB (Partido Comunista do Brasil), PDT (*Partido Democrático Trabalhista*), PMN (*Partido da Mobilização Nacional*), PPL (*Partido Pátria Livre*), PPS (*Partido Popular Socialista*), PSB (*Partido Socialista Brasileiro*), PSOL (*Partido Socialismo e Liberdade*), PT (*Partido dos Trabalhadores*), PV (*Partido Verde*) and REDE (*Rede Sustentabilidade*) [45]. However, it is critical to note that delineating between two ideological political platforms in Brazil (i.e., left and right of centre) is particularly challenging given the proliferation of political parties [21]. Finally, a wave indicator (year) was also included to account for period effects. The definitions and summary statistics of the variables employed in our econometric analysis are reported in Table 2.

Table 2. Definitions and summary statistics.

Variable	Description	Mean	SD	Min	Max
Administrative Intensity					
Administrative expenditure (proportion) *	The log of administrative expenditure as a percentage of net current expenditure	0.18	0.07	0.03	0.81
Administrative expenditure (per capita) *	The log of the per capita administrative expenditure	491.62	285.95	56.40	4375
Demographics					
Population	The number of people residing in each local government area divided by 10,000	2.74	10.39	0.13	191.72
Population squared	Population squared	115.46	1712.74	0.02	36,756
Density 1	Population density < 16.66; 0 = otherwise	0.25	0.43	0	1
Density 2	1 = Population density from 16.67 to 25.19; 0 = otherwise	0.24	0.43	0	1
Density 3	1 = Population density from 25.20 to 39.71; 0 = otherwise	0.25	0.43	0	1
Density 4	Population density from 39.72 to 4.408.71; 0 = otherwise	0.25	0.44	0	1
Controls					
Age diversity *	The log of the age diversity	7595.82	124.47	6834.43	7880.80
Ethnic diversity *	The log of the ethnic diversity	5137.36	2456.69	0	9945.92
Political positioning	1 = Left wing mayor; 0 otherwise	0.28	0.45	0	1
Income bottom 25%	1 = Municipality in the bottom 25% of the income distribution; 0=otherwise	0.25	0.43	0	1
Metropolitan	1 = metropolitan; 0 = otherwise	0.33	0.47	0	1
Agricultural	1 = agricultural is the main activity; 0 otherwise	0.50	0.50	0	1
Industry	1 = industry is the main activity; 0 otherwise	0.07	0.26	0	1
Trade	1 = trade is the main activity; 0 otherwise	0.42	0.49	0	1

* Note: Summary statistics before logarithmic transformation.

4.3. Empirical Approach

The association between administrative intensity and population size was estimated using panel data. The simplest version of the analysis is the pooled model, which assumes that the model has constant coefficients, referring to both intercepts and slopes. The fixed-effects model allows unobserved individual effects to be captured in the model. However, we also estimated a random-effects model by including the differences between units as parametric shifts of the regression function. This technique is appropriate when sampled cross-sectional units are drawn from a large population. There are various well-known differences between pooled, fixed-effects, and random-effects models. We applied the Breusch–Pagan Lagrange multiplier (LM) test in order to verify which model produces more consistent results (i.e., pooled or random-effect model). We then used the Hausman test to compare the differences between the random-effects and the fixed-effects models.

More specifically, we applied a pooled OLS, random-effects, and fixed-effects model for each local government area i over period t:

$$AI_{it} = \alpha_{it} + \beta_1 P + \beta_2 X_{it} + \mu_{it} \quad (1)$$

The dependent variables in Equation (1)—*AI*—are the administrative intensity variables (i.e., the natural logarithm of per capita administrative expenditure and administrative expenditure as a percentage of total net expenditure), *P* is a vector of population variables (i.e., population size, population squared, and population density), *X* is a vector of control variables as described above, and μ is an error term. In our econometric analysis, the quadratic population term is of primary interest since it enables us to identify the existence of a 'U-shaped' association between administrative intensity and population size.

The empirical approach adopted in this study consists of two main parts. In our first econometric specification, we investigate the relationship between the natural log of per capita administrative expenditure and population with three different models (pooled, random-effects, and fixed-effects). Second, we extend our initial econometric specification to include a different proxy for administrative intensity, thereby estimating three-panel models with administrative expenditure as a percentage of total net expenditure as our dependent variable.

5. Results

Before reporting the results from our econometric analysis, in Table 3, we present annual per capita municipal administrative expenditure stratified according to population size. Annual per capita municipal administrative expenditure is stratified into eight population groups ranging from small (<2500 residents) to large (>90,000 residents). As we can see from Table 3, administrative per capita expenditure is markedly higher among local government areas with less than 2500 residents. For example, administrative per capita expenditure in local government areas with less than 2500 residents is BRL 1119, which gradually declines as the population increases. A similar pattern emerges from our other dependent variable—administrative expenditure in proportion of total current expenditure—which is 0.2135 among municipalities with less than 2500 inhabitants, and then falls in line with population size. For example, in municipalities with more than 90,000 residents, administrative expenditure represents 15.76%.

Table 3. The administrative intensity stratified by population, Paraná, 2006–2018.

	Population Category							
Expenditures	**Population (×10,000)**							
	<0.25	**0.25–0.4**	**0.4–0.6**	**0.6–1**	**1–2**	**2–4**	**4–9**	**>9**
Administrative expenditure (per capita)	1119	780	634	449	358	336	268	347
Administrative expenditure (proportion)	0.2135	0.2053	0.2035	0.1836	0.1594	0.1578	0.1367	0.1576
Observations	451	743	579	779	893	415	283	174
Number of councils	14	51	72	62	104	49	21	23

Note: Constant *Reais* (BRL) values (2018).

While these initial descriptive results display an obvious pattern, this initial result should not be viewed in isolation since we need to conduct a formal empirical test to verify whether there is a statistically significant quadratic relationship between population size and per capita municipal administrative expenditure, while simultaneously controlling for a variety of factors that may influence administrative expenditure. Accordingly, we now turn to the results from our econometric analysis, which was designed to account for these various factors.

In Table 4, we report the association between the log of per capita administrative expenditure and population size. As noted earlier, we estimated the model using three different specifications (pooled, random-effects, and fixed-effects). The models provide an adequate level of statistical explanation of the variation in the administrative intensity variable (Table 4). In order to assist in the interpretation of our results, we divided the population size by 10,000 so that the estimated regression coefficient represents the marginal effect of a 10,000-resident increase in the population. Moreover, it is important to stress that the population and population-squared coefficients are statistically significant ($p < 0.01$), indicating the presence of a 'U-shaped' curve.

Table 4. The administrative intensity in per capita expenditure, Paraná, 2006–2018.

	Pooled	**Random-Effects**	**Fixed-Effects**
Demographic			
Population	−0.0209 ***	−0.0284 ***	−0.0469 ***
	(0.002)	(0.005)	(0.011)
Population squared	0.0001 ***	0.0001 ***	0.0001 **
	(0.000)	(0.000)	(0.000)
Density 2	−0.0261	−0.1306 ***	−0.1242 ***
	(0.019)	(0.026)	(0.029)
Density 3	−0.0854 ***	−0.2243 ***	−0.2002 ***
	(0.020)	(0.030)	(0.036)
Density 4	−0.2770 ***	−0.2824 ***	−0.1926 ***
	(0.024)	(0.038)	(0.047)
Controls			
Age diversity	0.2947	−0.1609	−0.2302
	(0.473)	(0.371)	(0.377)
Ethnic diversity (log)	0.1597 ***	0.0246 ***	0.0180 **
	(0.013)	(0.008)	(0.008)
Political positioning (log)	−0.0430 ***	−0.0293 ***	−0.0266 ***
	(0.015)	(0.008)	(0.008)
Income bottom 25%	−0.0317	0.0020	0.0065
	(0.021)	(0.010)	(0.010)
Metropolitan	0.0592 ***	0.0453 ***	0.0417 ***
	(0.015)	(0.014)	(0.014)
Industry	−0.0292	0.0857 ***	0.0948 ***
	(0.028)	(0.021)	(0.022)
Trade	−0.2265 ***	−0.0159	−0.0028
	(0.017)	(0.012)	(0.012)
Wave control	Yes	Yes	Yes
Constant	2.2884	7.3105 **	7.9930 **
	(4.203)	(3.314)	(3.366)
R-squared	0.2622	0.2108	0.2151
Breusch–Pagan Lagrange test	18,959		
Hausman-test		115.94	
N. of cases	5104	5104	5104

Standard errors in parentheses. * p <0.1, ** p <0.05, *** p <0.01.

It should be noted that all models yield similar results, indicating that the findings are robust to alternative econometric models. However, according to the Breusch–Pagan LM test, the random-effect model generates superior results to the pooled model. We then conducted a Hausman test to verify the differences between the random-effects and fixed-effects models, and found that the fixed-effects model was the preferred econometric specification.

Considering both the population and the population squared coefficients, an increase from 10,000 to 20,000 residents in a given local government area will, on average, lead to a decline in per capita administrative expenditure from BRL 475.68 to BRL 453.92. This represents a reduction of 4.57% in administrative expenditure in the fixed-effect model.

Furthermore, we note that our population density variables have a strong negative influence on per capita municipal expenditure, which is in line with the existing urban sprawl literature [46,47]. For instance, compared to the low-density reference group (Density 1), administrative per capita expenditure for medium-density (Density 2) local government areas are, on average, 21% lower. The remaining density coefficients reported in Table 4 can be interpreted in a similar way. Intuitively, population density may influence expenditure in many respects. For example, a municipality with a small area can be administratively efficient, even with less than 10,000 residents, since the smaller the managed area, the lower the expenditure. Following this line of reasoning, we cannot compare a municipality with 10,000 inhabitants in the area of 1300 km^2 with a different municipality with 10,000 inhabitants in an area of 50 km^2.

Other interesting results emerge from an analysis of the economic, demographic and political variables. Demographic diversity does not appear to affect administrative intensity in the Paraná local government system. This finding is similar to other studies, such as Andrews and Boyne [7]. Moreover, it is important to note that we constructed this variable based on data on all formal sector workers in Brazil (i.e., more than 46 million people in 2018). However, while this is an extensive sample, it nonetheless represents only economically active persons, typically between the ages of 18 to 65. Despite this limitation, our large sample allows the generation of a very good sample for diversity in Brazil. Ethnic diversity, for example, yields striking results. The estimations of all three models reveal statistically significant coefficients ($p < 0.01$), indicating that ethnic diversity positively affects administrative expenditure.

Although the presumed partiality of left-wing mayors for higher levels of spending might lead to the expectation that administration costs would increase in left-wing controlled municipal areas, our results show a negative impact. We also included a variable to control for the level of municipal income, although this variable is not statistically significant. Finally, our results reveal that the administrative expenditure is higher for those municipalities located metropolitan areas compared to those municipalities located in non-metropolitan areas.

We also estimated administrative intensity as a percentage of total net expenditure. The results are presented in Table 5. In common with the previous estimations, we find the presence of a 'U-shaped' cost curve as the population and population-squared coefficients are statistically significant ($p < 0.01$). According to Breusch–Pagan LM and the Hausman, the fixed-effects model once again produces the most consistent results.

Table 5. The administrative intensity as a percentage of total net expenditure, Paraná, 2006–2018.

	Pooled	**Random-Effects**	**Fixed-Effects**
Demographic			
Population	−0.0114 ***	−0.0171 ***	−0.0413 ***
	(0.001)	(0.003)	(0.011)
Population squared	0.0000 ***	0.0001 ***	0.0001 **
	(0.000)	(0.000)	(0.000)
Density 2	0.0373 ***	−0.0106	−0.0089
	(0.014)	(0.022)	(0.028)
Density 3	−0.0198	−0.0554 **	−0.0363
	(0.014)	(0.025)	(0.034)
Density 4	−0.0446 ***	−0.0525 *	0.0080
	(0.017)	(0.031)	(0.045)
Controls			
Age diversity (log)	1.8397 ***	0.2377	−0.0140
	(0.339)	(0.345)	(0.360)
Ethnic diversity (log)	0.0859 ***	0.0389 ***	0.0328 ***
	(0.009)	(0.007)	(0.007)
Political positioning	0.0010	−0.0244 ***	−0.0248 ***
	(0.010)	(0.007)	(0.007)

Table 5. *Cont.*

	Pooled	Random-Effects	Fixed-Effects
Income bottom 25%	0.0186	−0.0083	−0.0063
	(0.015)	(0.010)	(0.010)
Metropolitan	0.0452 ***	0.0287 **	0.0231 *
	(0.011)	(0.013)	(0.014)
Industry	0.0069	0.0669 ***	0.0748 ***
	(0.020)	(0.020)	(0.021)
Trade	−0.0882 ***	−0.0060	0.0038
	(0.012)	(0.011)	(0.012)
Wave control	Yes	Yes	Yes
Constant	−18.7174 ***	−4.0367	−1.7100
	(3.009)	(3.080)	(3.218)
R-squared	0.1569	0.1991	0.2014
Breusch–Pagan Lagrange test	13,408		
Hausman test		79.21	
N. of cases	5,104	5,104	5,104

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Our results show that an increase from 10,000 to 20,000 residents in a given local government area will, on average, lead to a decline in administrative expenditure ratio from 18.30% to 17.56%. Moreover, we also observe the relationship between population density and the administrative expenditure ratio. In contrast to the previous model, we do not find statistically significant differences by density group in our fixed-effect model.

6. Discussion

In this paper, we investigated administrative scale economies in the Paraná state local government system in Brazil over the period 2006 to 2018. Our study contributes to the present debate in the international literature as to whether local government expenditure exhibits economies of scale. The results show that population size and population density have statistically significant effects on the administrative expenditure in the State of Paraná. More specifically, we identified a 'U-shaped' cost curve which indicates that an increasing population will initially reduce average costs. However, beyond some level of population, the average cost will begin to increase. This behavior is also observed in other international studies [42,44].

However, it is important to note that Brazilian local governments are numerous, and many of them are small and financially unsustainable [48]. More precisely, in 2018, about 75% of municipalities had less than 20,000 inhabitants in the Paraná local government system (Table 3), which indicates that a significant reduction in administrative expenditure would flow from an amalgamation of small local government areas. On this question, our results contribute to the current political debate on merging small municipalities in Brazil [25], and particularly to the discussion in Paraná [19], as well as other states, such as Santa Catarina [26]. In this sense, when considering municipal mergers, policymakers should consider the benefits of a reduction in administrative costs [7].

From a public policy perspective, our study suggests that the local government consolidation of small municipalities, at least in the context of the Paraná local government system, can improve efficiency in municipal administration. However, this does not imply that other reform options could not contribute to improving municipal performance in Paraná. For example, public policies that promote shared services in Paraná local government may lead to a reduction in administrative expenditure. However, the results of the impact of shared services on Brazilian local government expenditure are not conclusive [48]. As such, the Paraná government should investigate the role that shared services may play in potentially reducing costs and improving municipal efficiency [20]. Furthermore, the constitutional amendment proposed by the federal government, which recommends the amalgamation of municipalities with less than 5000 inhabitants and own revenue of less than ten per cent of their total revenue, should be further investigated since it could reduce administrative expenditure. In sum, our study contributes to the wider policy debate on the structural reform in local government in Brazil by providing empirical evidence of scale economies in administrative expenditure in the Paraná state local government system.

7. Conclusions

This paper has sought to address a gap in the empirical literature on Brazilian local government by investigating scale economies in administrative intensity in the Paraná state local government system. Drawing on a variety of data sources, we were able to contribute to the extant empirical literature by providing the first comprehensive analysis of municipal economies of scale in terms of administrative intensity for the 399 municipalities in the Paraná state local government system. The design of our study was informed by the international empirical literature on scale economies in municipal administration. As we have seen, we found empirical evidence for economies of scale in administrative expenditure in Paraná.

Our most important finding is that there is a 'U-shaped' scale effect on administrative intensity after controlling for a range of economic and demographic variables. This empirical result has two main public policy implications for the present policy debate in Brazil, which has focused on a large number of municipalities with less than 5000 residents and an own-source revenue of less than ten per cent of total revenue [25], in the context of ensuring the long-run sustainability of local governments. Firstly, the existence of scale economies in municipal administration provides empirical support for structural change through municipal mergers on the obvious grounds that larger local government entities expend a smaller proportion of their revenue on administration compared with their smaller counterparts. Secondly, at a more nuanced level, the presence of scale economies in administrative intensity provides empirical evidence in favor of shared services in municipal administration without the need for radical and expensive structural change that simply abolishes small municipalities and creates new larger local government bodies in their place. Detailed models of shared services in municipal administration have been advanced in the scholarly literature, such as the joint board model described by Dollery and Johnson [49]. These models, sometimes designated as "area integration models", focus on minimizing municipal expenditure by combining the administrative services of several small local councils into a single unit. In this way, existing small municipalities retain their political autonomy but reduce outlays on administration. However, public policymakers need to be cognizant of political barriers to both municipal mergers and shared services [50].

Future research in the area could potentially fruitfully investigate the relationship between administrative intensity and local government size by population by analyzing other Brazilian state local government systems. This would generate useful comparative data on the existence and extent of scale economies in municipal administration in Brazil, and thereby inform public debate.

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Economies of Scope and Local Government Expenditure: Evidence from Creation of Specially Authorized Cities in Japan

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Abstract: There is little evidence of either the existence or absence of economies of scope in public services provided by general-purpose local governments. This study uses difference-in-differences (DID) analysis and the event study method to estimate the impact on expenditure of the designation of cities as either core cities or special case cities, thereby giving them the authority to undertake a wider range of activities, and identify the magnitude of the economies of scope in local governments using panel data for Japanese municipalities during the period 1996–2015. The findings of this research are summarized as follows. First, in the provision of public services by general-local governments, economies of scope do not occur in the short term (2–3 years), but do appear in the mid to long term (more than 5 years for core city status). After the delegation of duties, per capita expenditure for core cities increases by 2.8% immediately after the designation, but then decreases by 0.6% annually. Second, the wider the range of extra activities delegated, the greater the economies of scope.

Keywords: core cities; economies of scope; expenditure; local government; special case cities

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1. Introduction

Since the pioneering studies by [1,2], the importance of economies of scope has been widely argued, in particular in the context of the industrial organization literature on assessing the costs of specialization. Economies of scope exist if the cost of providing a diversified set of products is less than the cost of specialized production of these products. Much attention has been paid to economies of scope in multiproduct manufacturing firms, as these firms have considerable opportunities to increase their productivity by broadening their range of activities, enabling them to fully exploit underused resources such as employee expertise, information from various divisions, and production facilities. This results in joint production in which costs are shared by the various activities and overall organizational outcomes are jointly generated.

There is also potential for economies of scope in public sector activities. A notable example of economies of scope in the provision of public services involves the *colocation of organizations* [3,4], which makes it possible to not only share facilities, thereby saving on overheads such as electricity, security, and cleaning, but also reduce users' travel costs by providing one-stop access to a range of different services. In addition, different sections can approach the same users more easily at lower cost.

Moreover, the need for *professional staff* who have expertise in various specific public services is related to the prevalence of economies of scope in the public sector. When economies of scope arise from intangible resources, such as managerial ability, dominant logic, routines and repertoires, and technologies, they can result in a sustainable competitive advantage [5]. For example, third sector organizations operating residential care homes tend to be more diversified than private sector providers, providing both residential and other forms of care, and thus are able to benefit from economies of scope [6]. Related to administrative expertise, *relationship-oriented activities* are another source of economies of scope. Local governments have an advantage in this regard because they can access information about their residents and acquire more trust from their residents than other organizations.

Overall, there is considerable potential for economies of scope in local government activities because they provide a range of services. A strand of relevant literature has been accumulated. For example, in the case of local public transport, the long-term costs of urban transit companies in the US during the period from the late 1970s through the 1980s were investigated [7–9]. There were potential economies of scope, dependent on the post-consolidation wage level [7], whereas it was found that there was potential for cost complementarity depending on the combination of transit modes [9]. The cost structure of Swiss urban transport was studied in [10] and the study found evidence of economies of scope, supporting the view that multimode transportation companies may benefit in comparison to unbundled franchise monopolies. The cost structures of municipal solid waste (MSW) services have also been studied, albeit to a limited degree, given the rising levels of waste generation in society. The multiproduct nature of MSW services was modeled in [11] and they found that offering joint disposal and recycling services reduced costs by approximately 5% as a result of economies of scope. Third sector organizations have drawn attention to the presence of economies of scope, as much of their work is undertaken by professionals and they have closer access to and more significant relationships with service users than other providers [3]. It was found in [3] that the benefits obtained by third sector organizations from economies of scale, for example through their consolidation, were overemphasized, while economies of scope and learning should be given more weight from a policy-making viewpoint. However, to date, little evidence of economies of scope in third sector organizations has been reported, while some studies of UK fundraising charities [12] and US charities [13] have found evidence of economies of scale.

Nevertheless, there is little evidence of either the existence or absence of economies of scope in public services provided by general-purpose local governments. A pioneering study on efficiency in the provision of local public services through economies of scope was conducted by [14], which proposed a framework for modeling municipal costs as a means of measuring economies of scope. It was found that potential economies of scope exist in the provision of municipal services. An influential study involving cost function analysis of local government service provision was also conducted with a focus on firefighting services using data on municipal fire departments in New York [15], and the study found evidence of economies of scale in the quality, economies of scope, and constant returns to population scale. It is suggested in [16] that the finding that administrative overheads are higher for councils in the lower tier of their two-tier system indicates the presence of diseconomies of scope associated with administrative duplication in these units. Overall, it seems that economies of scope are present in the supply of local services provided by general local governments, as these local governments are naturally more multiproduct and multifunctional entities than specialized public service providers, and employ professional staff whose knowledge enables them to achieve greater efficacy across a range of services. In this vein, the assessment of economies of scale has been crucial in this field of study, although little evidence has been accumulated to date. Thus, the research question in this study involves accurately assessing the size of economies of scope in the activities of general local governments.

The objective of this study is to estimate the impact on expenditure of the designation of cities as either core cities or special case cities, thereby giving them the authority to undertake a wider range of activities. I use difference-in-differences (DID) analysis and the event study method to identify the magnitude of the economies of scope in local governments using panel data for Japanese municipalities during the period 1996–2015. As mentioned above, previous empirical studies on economies of scope in the provision of public services have measured the size of scope economies by estimating the cost function of the public organization concerned and calculating fitted values of the cost function in the case of specialized production by extrapolating the value zeros into the amounts of outcomes out of interest (e.g., [10,11]). However, previous studies have raised concerns about the validity of the extrapolations and the specifications regarding the cost functions (e.g., [17]). The novel contribution of this study is the analysis of economies of scope by building on the program evaluation framework using the DID and event study approaches to avoid problems associated with the cost function approach. To the best of my knowledge, no previous empirical studies have used the program evaluation methodology to detect the presence of economies of scope in general public service provision.

A key to the identification of the impact of designation is the system of specially authorized cities, that is, core cities and special case cities in Japan. The central government launched the core city designation in 1996 and the special case city designation in 2000 to delegate some of the activities the prefectures normally handled and give the designated cities the authority to handle a wider range of activities than ordinary cities. To ensure their fiscal capacity to handle a wider range of responsibilities, population requirements were set for both designations, and cities that met the population requirements were able to apply for specially authorized city status. As the population requirement was higher for core city status, a wider range of duties was delegated to core cities. Figure 1 shows the numbers of core and special case cities that have been designated since 1996 and 2000, respectively. It can be seen that the number of core cities has steadily increased since the introduction of the core city designation, while the number of special case cities peaked in 2010, and has been falling since then. Additionally, the designation of cities as specially authorized cities has occurred every year since the scheme commenced. These authorized cities are used as the treatment group in this study, and the variations in the timing of designation are used to identify the impact on expenditure of changes in the scope of activities as a result of a transition to special city status, that is, the size of the economies of scope that were generated.

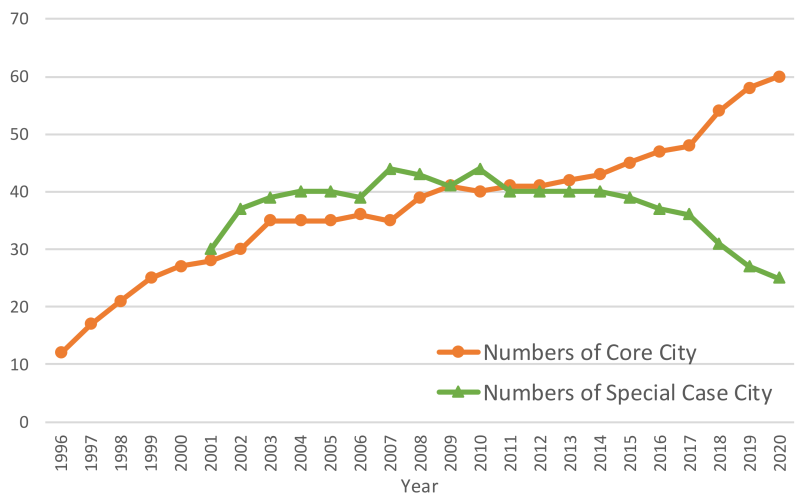

Figure 1. Numbers of core and special case cities, 1996–2020. As of 1 April 2020. The numbers of core and special case cities are as of April 1 each year. Core and special case cities were launched, respectively, in 1996 and in 2000.

The remainder of this paper is organized as follows. Section 2 presents the institutional background, specifically the Japanese local government system and the designations to core cities and special case cities. Sections 3 and 4 discuss econometric specification and data, respectively. The main and extended results are presented and discussed in Section 5. Section 6 is the conclusion.

2. Institutional Background

2.1. Local Government System in JAPAN

Japan is a unitary state and has a two-tier system of local governments: 47 prefectures and about 1700 municipalities as of 2020. Prefectures constitute regional governments spread across wider areas; municipalities are composed of cities, towns, and villages, and are subordinate governments of prefectures. The responsibilities of prefectures comprise police force, the operation of high schools, prefectural hospitals, prefectural roads, regional urban planning, and duties delegated from the central government such as the maintenance of national roads. Municipalities handle basic concerns associated with the daily lives of residents, such as registration of present and permanent addresses, the operation of elementary and junior high schools, social welfare for infants and senior citizens, city planning, the operation of water and sewerage systems, collection and disposal of garbage, and fire protection. In 2018, public welfare expenditure accounted for the largest share, around 26%, while expenditure on education, debt repayments, and civil engineering works each accounted for more than 10% of total expenditure. The responsibilities of local governments in Japan are similar to those in many developed countries

Total public spending in Japan was about 25% of GDP in 2018, while the central and local governments accounted for 4.1% and 11%, respectively [18]. Prefectures and municipalities accounted for approximately 46% and 54% of the local government budget, respectively. Fiscal autonomy of the municipalities is small, relying on funds from the central government. Intergovernmental transfers occupied about 29% of their budget in 2018, and 13.3% comes from general grants (Local Allocation Tax) and 15.3% comes from conditional grants (National Treasury Disbursements). Among the remaining municipal revenues, local taxes and bonds take up, respectively, 34% and 8.5%. Municipal taxes mainly comprise income tax (47% of total tax revenues) and property tax (40.5%), and specifically, municipal income taxes comprise individual income tax (36.1%) and corporate tax (10.8%).

2.2. Specially Authorized Cities in Japan: Designated Cities, Core Cities, and Special Case Cities

Japan has long had two tiers of cities, authorized (ordinary) cities, and government ordinance designated cities (or designated cities) (see, for example, [19,20] for further explanation for the city system in Japan). Designated cities were officially authorized as a second tier of cities in April 1956 by the central government, as it was recognized that very large cities, that is, those with a population of more than 1 million, should be provided with a wide range of authorizations beyond those that applied to ordinary cities. To be designated, officially a city had to have a population of at least 500,000 and a density of more than 2000 people per km^2, but eventually, the central government had long viewed a population of at least 1 million as a requirement for designation. Designated cities have been delegated many tasks, most of which are normally undertaken by the prefectures, including almost all functions related to city planning and urban transport, and their territories have been divided into wards, which undertake basic functions such as resident registration, trash pickup, and local tax collection. Figure 2 depicts the relationship between all categories of cities and the numbers of extra duties delegated to specially authorized cities. As shown the figure, the number of extra duties delegated to designated cities is about 1300. Initially, there were five designated cities, but by April 2020 there were 20 designated cities.

Core cities are included in a specially authorized tier of cities in the Japanese municipal hierarchy that was introduced in 1996. Initially, to be considered as a core city, a city had to have a population of at least 300,000 and an area of more than 100 km^2, and a daytime/nighttime population ratio of 1 or more in the case of a city with a population of 500,000 or less. A candidate city applied for designation following approval by its city council and prefectural assembly. The qualification terms were eased with the abolition of the daytime/nighttime population ratio requirement in 1999, further eased by limiting the area requirement to cities with a population of 500,000 or less in 2002, and then simplified to just the population requirement in 2006. In 2014, the category of special case cities was abolished, and the population requirement was amended to a population of at least 200,000. Core cities are delegated a wider range of administrative and service authorities than ordinary cities, but provide a smaller range of services than designated cities. As shown in Table 1 and Figure 2, the number of extra duties for core cities is around 2200, and the extra costs in the first year of the designation are on average around JPY 1280 million (approximately USD 12.8 million). The contents of extra duties are listed in Table A1 in Appendix A. Initially, there were 12 core cities, but this number had increased to 60 by 2020, as shown in Figure 1.

Table 1. Extra duties and costs for core cities.

Cities	No. of Extra Duties	Extra Costs in the First Year, JPY 1000	Population	Per Capita Extra Costs, JPY	Designation Date
Hachinohe	2003	924,000	238,000	3882	1 January 2017
Morioka	1900	1,310,000	300,746	4356	1 April 2008
Yamagata	2426	1,352,476	253,832	5328	1 April 2019
Fukushima	2000	934,988	294,378	3176	1 April 2018
Mito	2640	2,070,000	270,783	7644	1 April 2020
Takasaki	2386	2,413,829	364,919	6615	1 April 2011
Koshigaya	2024	1,241,090	326,313	3803	1 April 2015
Kofu	2398	998,460	193,123	5170	1 April 2019
Yao	2000	1,098,000	268,562	4088	1 April 2018
Suita	2491	1,188,911	374,526	3174	1 April 2020
Akashi	1856	926,599	293,509	3157	1 April 2018
Tottori	2211	930,000	193,766	4800	1 April 2018
Matsue	1980	1,264,044	206,407	6124	1 April 2018
Average	2178	1,280,954	275,297	4653	-

Notes: The author sampled the core cities that open on their homepages their extra duties and costs borne to be core cities; the extra duties and costs come from their open resources such as the leaflets. Population is collected from the latest Census as of the designation date. The average of per capita extra costs is calculated as a population-weighted average.

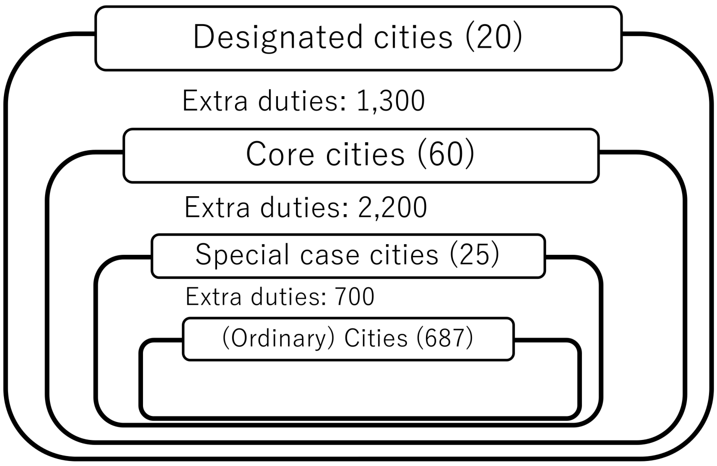

Figure 2. Relationship between cities and numbers of extra duties delegated to specially authorized cities. As of 1 April 2020. Parentheses indicate the numbers of cities in each category. The average of extra duties for designated cities is calculated from the estimated duties of four designated cities—Shizuoka's estimate of 1560, Sakai's estimate of 1043, Hamamatsu's estimate of 1394, and Niigata's estimate of 1157—reported in [21]. The average extra duty for core cities is from Table 1. The number of extra duties for special case cities is that of Matsue, because the source of the estimated extra duties delegated to special case cities is limited to Matsue.

In July 1999, the Omnibus Law for Decentralization (*Chiho Bunken Ikkatsu Ho*) was enacted, and one of the most important items it contained related to the introduction of special case cities as a fourth tier of specialized cities. The requirement to be considered a special case city was a population of at least 200,000, and the process for designation was similar to that for core cities. As the financial capacity to accept new responsibilities was crucial, not all of the cities meeting the population requirement applied for designation as a special case city. Functions devolved to special case cities are much more limited than those devolved to core cities. The number of delegated duties is about 700, as shown in Figure 2, and a list of delegated functions is presented in Table A1 in Appendix A. Following the easing of the population qualification for core city status in 2014, special case city was abolished and was designated as "special case cities for the enforcement period," which retain the same administrative responsibilities as before. Another reason for the abolition of special case cities is that, while many of the duties operated by prefectures were recently being delegated to ordinary cities, the duties handled by special case cities were similar those for ordinary cities. The number of special case cities had risen to 44 by 2010, but declined to 25 following the changes in 2014, as illustrated in Figure 1.

3. Empirical Strategy

3.1. Econometric Specification

In this study, I used two-way fixed-effects regressions to estimate difference-in-differences (DID) treatment and event study effects. The data used in this study are yearly panel for Japanese municipalities from 1996 to 2015. To assess the impacts of designation as either a core city or a special case city on expenditure, I used the following empirical equation:

$$y_{it} = \delta^{core} D^{core}_{it} + \delta^{spec} D^{spec}_{it} + X_{it}\beta + c_i + time_t + \epsilon_{it}, \tag{1}$$

where y_{it} represents the log of per capita total expenditure (in the baseline estimation) and i and t represent the municipality and year, respectively. D^{core}_{it} is a dummy variable that takes a value of 1 for cities that are designated as a core city, and 0 otherwise, and D^{spec}_{it} is a dummy variable that takes a value of 1 for cities designated as a special case city, and 0 otherwise. Therefore, δ^{core} and δ^{spec} are DID treatment estimators for core city status and special case city status, respectively. If δ^{core} takes a negative value, this means that the city reduces its total expenditure after transition to core city status, indicating that economies of scale emerge when duties are delegated from the prefectures. X_{it} represents a vector of control variables and β represents its coefficient vector. c_i represents municipality time-invariant dummies and $time_t$ represents yearly time dummies. ϵ_{it} represents the error term.

Control variables are selected based on those used to explain various types of expenditure in the literature on local government mergers (e.g., [22–25]) (the empirical specification builds on the theoretical and empirical model developed by [26,27] to estimate the demand function for publicly provided goods. In the empirical equation, local expenditure is represented by the median income to reflect the median voter's preference, and by socioeconomic and demographic variables to capture the diverse preferences of the constituency). Controls include the log of population size to represent government expenditure, log of population density to capture geographical characteristics, and log of per capita taxable income to represent wealth, the shares of population aged 14 or under and 65 or over to represent demographic composition, the share of foreigners to represent the degree of ethnic heterogeneity, the unemployment rate to reflect economic conditions, and a merger dummy and trend, or the elapsed years from the merger, to represent the dynamic impacts of mergers on expenditure. See Table A2 in Appendix B for detailed explanation of the controls.

Empirical research on municipal mergers has demonstrated definite group-specific trends over time in local expenditure (e.g., [22–25]). In this study, I also took into account specific linear time trends, TR^{core}_{it} and TR^{spec}_{it}, which represent the number of years that have elapsed since the transition to a core city and special case city, respectively. For instance, if a city transitioned to a core city in 2002, its core city time trend takes a value of 1 in 2003, 2 in 2004, 3 in 2005, and so on. Then, the DID trend estimator for the time trends is τ^{core} for a core city and τ^{spec} for a special case city. The econometric specification is as follows:

$$y_{it} = \delta^{core} D^{core}_{it} + \tau^{core} TR^{core}_{it} + \delta^{spec} D^{spec}_{it} + \tau^{spec} TR^{spec}_{it} + X_{it}\beta + c_i + time_t + \epsilon_{it}. \tag{2}$$

Regarding core city status, if δ^{core} and τ^{core} are positive (negative), the city's expenditure increases (decreases) discontinuously immediately after designation as a core city and gradually thereafter. If δ^{core} is positive (negative) but τ^{core} is negative (positive), the city's expenditure increases (decreases) sharply immediately after designation but then decreases (increases) gradually thereafter. This argument also holds for special city status.

Given that time trends specific to the number of years elapsed since designation explain a significant proportion of the variation in expenditure over time following designation, it is anticipated that the sizes of treatment effects vary more flexibly over time. If so, an event study approach might be more appropriate because generally, this approach presumes different treatment timings and various treatment effects. Thus, in this study, I adopted an event study framework wherein the treatment effects are allowed to differ in treatment timing, in years relative to the treatment, and in size following the treatment. Here, as explained in detail later, for the formal parallel trend test, the pre-event, or pre-designation, year dummies are also incorporated in the regression equations. The econometric specification is as follows:

$$y_{it} = \sum_{h=1}^{24} \eta_{-h}^{core} EV_{-hit}^{core} + \sum_{h=1}^{19} \eta_{-h}^{spec} EV_{-hit}^{spec} + \sum_{k=1}^{19} \eta_{k}^{core} EV_{kit}^{core} + \sum_{k=1}^{15} \eta_{k}^{spec} EV_{kit}^{spec} + X_{it}\beta + c_i + time_t + \epsilon_{it}, \quad (3)$$

where k represents the number of years since designation. EV_{kit}^{core} and EV_{kit}^{spec} are dummies that take a value of 1 k years after a city's designation as a core city and special case city, respectively. η_k^{core} and η_k^{spec} represent event study estimates of EV_{kit}^{core} and EV_{kit}^{spec}, respectively. If η_k^{core} (η_k^{spec}) is negative, the expenditure of the core city (special case city) decreases k years after designation. If most of the η_k^{core} estimates are negative, it can be said that economies of scale exist in government expenditure because, even after the responsibilities increase following the transition to core city status, total expenditure declines over the long term (the same argument holds in relation to special case cities). The event study approach generates large numbers of estimates, and by convention, these are presented graphically by displaying the number of years prior to and following the event on the horizontal axis and the magnitudes of the coefficients on the vertical axis.

3.2. Identification Strategy

To identify DID treatment estimators, the parallel trend assumption, namely, that during the pretreatment period, the treated and control have the same time trend, should be satisfied (e.g., [28,29]). Recent empirical studies applying the DID approach have tested the validity of the DID estimation approach applying graphical illustrations of the outcomes and more formal statistical tests of the existence/nonexistence of pretreatment trends. Following the conventional approach to testing the identification assumption, in this study, first I graphically compared between the evolutions of the average per capita expenditure for the "never designated" municipalities, that is, the municipalities that have never been designated as either a core city or a special case city during the sample period, and those for the designated cities in the predesignation periods. Normally, the parallel trend assumption is tested by comparing the graphs of outcomes averaged at each period between the treated and control groups in the pretreatment period. However, as the designation timing differs among cities, the predesignation window is not consistent over all units, and thus the standard testing strategy cannot be applied. Therefore, as a compromise, the graphs for the never designated municipalities and the designated cities in the pretreatment periods are presented to enable us to check the assumption.

As can be seen from Figure 3, average per capita expenditure among the core cities in the predesignation periods evolved in a similar manner to that of the never designated municipalities, suggesting that the parallel trend assumption appears valid. However, the average of the former is much lower than that of the latter. The difference seems to be because to become a core city, cities had to have a population of at least 300,000, which is much larger than the municipal average of 67,000 as of 2010, and hence the candidate cities' average per capita expenditure was lower given their economies of population size. Figure 3 also displays the same graph for the special case cities in the predelegation periods. As can be seen in the figure, there was a discontinuous jump in 2004 in per capita expenditure by the special case cities in the pretreatment periods and there have been greater variations since 2007. The jump in expenditure can be explained by the large-scale municipal merger, which reduced the number of municipalities from 3132 in 2003 to 1821 in 2005 and then increased the sizes of merged municipalities. The fluctuations seem to arise from the reduction in the number of newly designated special case cities since 2008, which is only four. However, those trends for the special case cities in the predesignation periods are almost in parallel with those for the never delegated municipalities except 2004. As the expenditure impacts of municipal mergers are controlled in the regressions, the trends for the never designated municipalities and for the special case cities in the predesignation periods can been viewed to some extent parallel. Thus, the parallel trend assumption seems valid, and the differences in the levels of per capita expenditure between the never designated municipalities and the core cities and special case cities are validated with reference to the fact that they arise from population differentials.

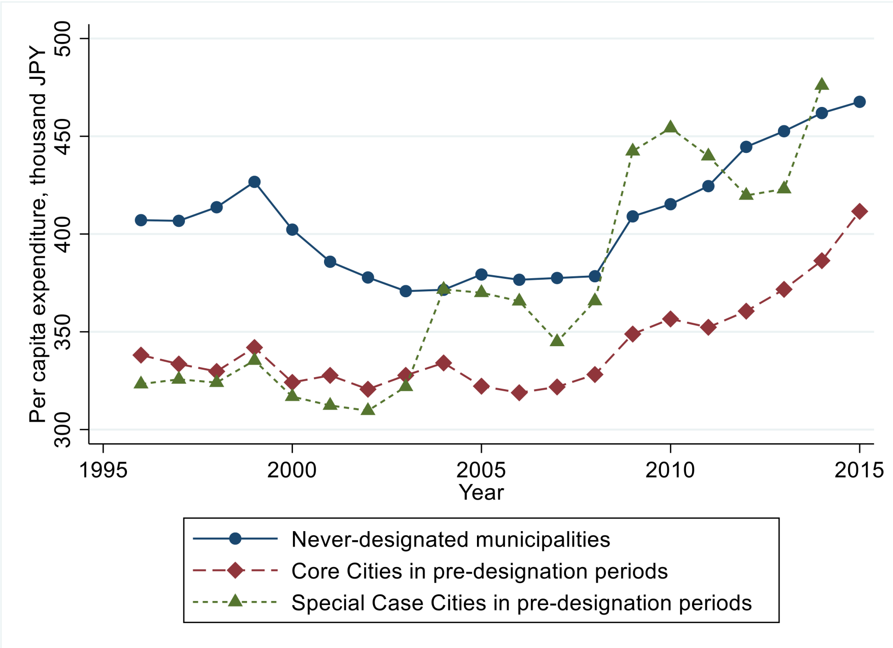

Figure 3. Average per capita expenditures for the never designated municipalities and for core and special case cities in the predesignation periods. The sample is the same as that of the baseline regression.

The parallel trend assumption is more formally tested by statistical methods such as a falsification test and regressions including time dummies. Recent empirical studies have tended to rely on regression-based tests wherein the interaction terms of the treatment variable with time dummies for the entire sample period are included instead of the treatment effect dummy in the standard DID framework to determine whether nonparallel trends between the treated group and the control group exist prior to treatment by checking the coefficients of the interactions during the pretreatment periods (e.g., [23,30,31]). This approach is valid if the time frame comprises the pre- and post-treatment window, or the treatment timing is unique, even if the sizes of the treatment effects change over time. However, in the present study, the treatment timing differs among units as cities were designated as core cities or special case cities in different years. Hence, it is difficult to define the unique pre- and post-treatment window. As noted earlier, the changes in city status have the nature of an event study, and thus regression-based parallel trend testing can be applied because it is analogous to the framework used in event study estimation, as in Equation (3). Then, analogous to the interaction terms of the treatment dummy and pretreatment year dummies in the standard parallel trend test, the year dummies representing the years prior to the year of designation are incorporated into Equation (3) to check whether there is a difference in the expenditure trend between the never designated municipalities and the designated cities in the predesignation periods.

In Equation (3), EV_{-hit}^{core} (EV_{-hit}^{spec}), where h represents an index for the years prior to the designation, represents a pre-event year dummy that takes a value of 1 for core (special case) cities in k years prior to the designation to core (special case) city status in year t. η_{-h}^{core} (η_{-h}^{spec}) represents the coefficient of EV_{-hit}^{core} (EV_{-hit}^{spec}), and thus is a predesignation event study estimate. If the majority of η_{-h}^{core} (η_{-h}^{spec}) are statistically insignificant, the trends for the core (special case) cities in the predesignation periods and for the never designated municipalities are the same, thereby validating the parallel trend assumption.

Figure 4 shows a plot of the event study estimates for the designation to core city status in the pre- and post-designation periods, along with the corresponding 95% confidence intervals. As can be seen from Figure 4, none of the event study estimates in the pre-event periods are significant at the 5% level, indicating no designation year-specific trends and suggesting the validity of the parallel trend assumption regarding core city status. Figure 5 shows the corresponding graph for the designation to special case city. As shown in the figure, with wider confidence intervals there is a larger variation in the point estimates, and the predesignation estimates for 12–14 years prior to the year of designation are positively significant. However, the predesignation event study estimates are not significant in the years of less than 10 relative to the designation year, and thus it seems that the parallel trend assumption remains valid. Overall, the graphical illustration of expenditure by the never designated municipalities and the designated cities in the pre- and post-treatment periods and the results of the event study analyses suggest that the parallel trend assumption seems valid for both core cities and special case cities.

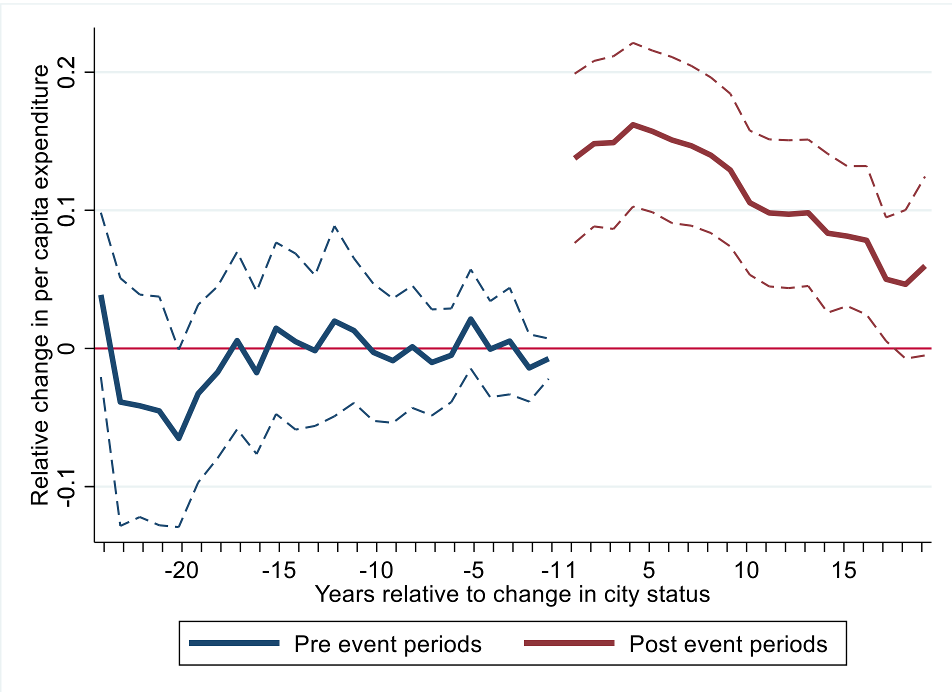

Figure 4. Event study estimates of the effects of designation to core city on expenditure. The figure plots event-study estimates from the two-way fixed effects regression equation, or Equation (3). The equation includes all the controls, individual fixed effects, and year dummies. The (red) solid flat line indicates the y axis of zero. The dashed lines represent the 95% confidence intervals for each point estimate. Standard errors are robust to municipal clusters.

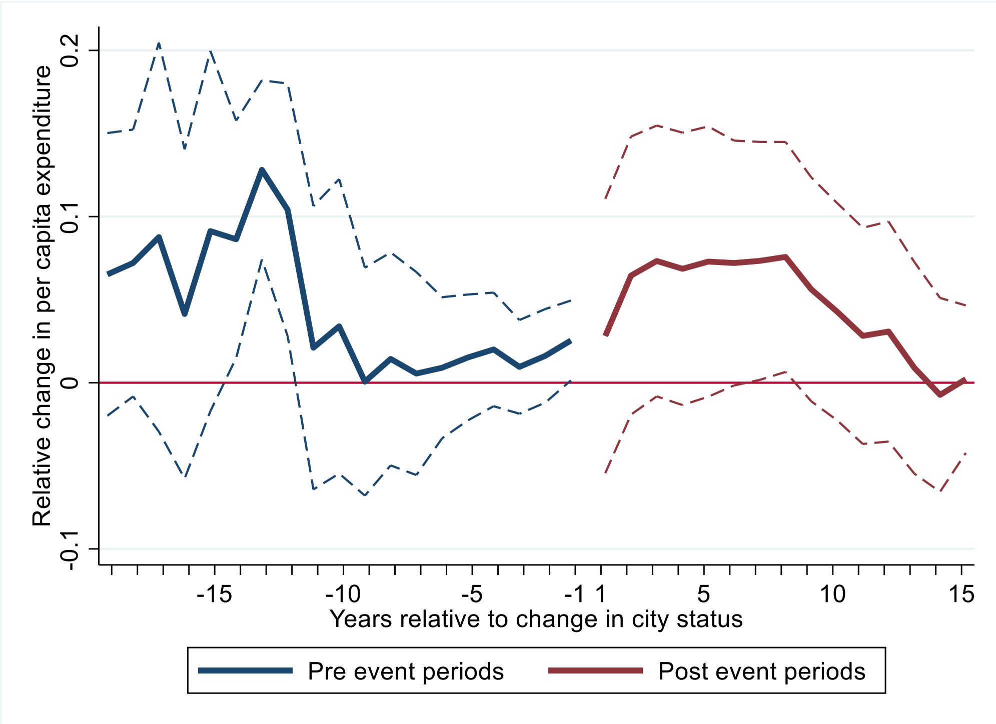

Figure 5. Event study estimates of the effects of designation to special case city on expenditure. The figure plots event-study estimates from the two-way fixed effects regression equation, or Equation (3). The equation includes all the controls, individual fixed effects, and year dummies. The (red) solid flat line indicates the y axis of zero. The dashed lines represent the 95% confidence intervals for each point estimate. Standard errors are robust to municipal clusters.

4. Data

In this study, I used panel data for Japanese municipalities during the period 1996–2015. A large number of mergers in the early 2000s saw some municipalities disappear and other new municipalities emerge, and thus the panel is unbalanced. As a result of these mergers, the number of municipalities fell from around 3200 in 1999 to around 1700 in 2015. Most of the variables employed in this study are collected annually, although data on the population aged 14 or under, the population aged 65 or over, foreigners, unemployment, and the labor force are collected every 5 years during the Census, and thus the gaps are filled using linear interpolation between the survey years. Designated cities are excluded from the sample because they are granted great authority different from the other cities. See Table A2 in Appendix B for definitions of the variables and data sources.

Table 2 shows summary statistics and units for all of the variables used in the estimations, classified by city and designation status. Per capita expenditure is clearly greater for ordinary cities, followed by core and special case cities. The average for the core cities declines over time, but that for special case cities increases, thereby reversing their relative expenditure positions in the post-designation period. As for the other fiscal items, per capita amounts are greatest for ordinary cities, but the relative levels of the core and special cities are ambiguous. Population is lowest in ordinary cities, followed by special case cities and core cities, and this order remains the same both before and after the designation. This seems appropriate because the population level required to be designated a core city is higher than that required to be designated a special case city, and both of these levels are much higher than the average city population over the entire country.

Table 2. Descriptive statistics.

	A. Core cities			
	Predesignation Periods		**Postdesignation Periods**	
	Mean	**SD**	**Mean**	**SD**
Per capita expenditure (JPY 1000)	325.59	62.72	355.70	51.60
Per capita current expenditure (JPY 1000)	288.72	56.39	312.88	45.72
Per capita investment cost (JPY 1000)	1.22	5.85	0.63	2.41
Per capita fiscal transfers (JPY 1000)	61.39	42.50	65.69	27.22
Core city dummy	0	0	1	0
Core city-specific trend	0	0	7.62	5.15
Special case city dummy	0	0	0	0
Special case city-specific trend	0	0	0	0
Population, unit	378,587	98,864	441,739	111,084
Population density (unit/km^2)	1378.41	1663.73	1008.51	964.66
Income per taxpayer (JPY 1000)	3554.7	983.3	2672.3	1418.7
Share of population aged 14 or under (%)	15.01	1.44	14.35	1.37
Share of population aged 65 or over (%)	15.90	3.64	20.08	3.78
Share of foreigners (%)	0.99	0.77	0.98	0.77
Unemployment rate (%)	5.44	1.59	5.43	1.22
Merged municipality dummy	0.13	0.33	0.41	0.49
Merged municipality-specific trend	0.51	1.76	2.05	3.28
Per capita cumulative debt (JPY 1000)	338.93	113.78	386.98	113.94
Observations	198		586	
	B. Special case cities			
	Predesignation periods		Postdesignation periods	
	Mean	SD	Mean	SD
Per capita expenditure (JPY 1000)	332.42	66.52	327.17	61.56
Per capita current expenditure (JPY 1000)	295.30	56.43	291.20	53.36
Per capita investment cost (JPY 1000)	1.21	5.54	0.33	1.14
Per capita fiscal transfers (JPY 1000)	49.13	19.07	60.97	19.33
Core city dummy	0	0	0	0
Core city-specific trend	0	0	0	0
Special case city dummy	0	0	1	0
Special case city-specific trend	0	0	6.10	4.21
Population, unit	232,220	70,263	270,435	69,593
Population density (unit/km^2)	1216.11	1589.68	1325.15	1811.962
Income per taxpayer (JPY 1000)	3662.8	597.3	2565.3	1560
Share of population aged 14 or under (%)	15.42	1.21	13.99	1.085882
Share of population aged 65 or over (%)	15.49	3.97	20.69	3.79
Share of foreigners (%)	1.09	0.81	1.27	0.76
Unemployment rate (%)	4.88	0.92	5.68	1.15
Merged municipality dummy	0.15	0.36	0.36	0.48
Merged municipality-specific trend	0.44	1.47	1.93	3.29
Per capita cumulative debt (JPY 1000)	327.77	109.54	442.19	112.21
Observations	339		575	
	C. Ordinary cities			
	Mean	SD		
Per capita expenditure (JPY 1000)	408.23	203.47		
Per capita current expenditure (JPY 1000)	330.15	140.70		
Per capita investment cost (JPY 1000)	30.67	78.20		
Per capita fiscal transfers (JPY 1000)	71.61	87.63		
Core city dummy	0	0		

Table 2. *Cont.*

	A. Core cities			
	Predesignation Periods		**Postdesignation Periods**	
	Mean	**SD**	**Mean**	**SD**
Core city-specific trend	0	0		
Special case city dummy	0	0		
Special case city-specific trend	0	0		
Population, unit	30,827	42,519		
Population density (unit/km^2)	201.12	547.42		
Income per taxpayer (JPY 1000)	2617.5	1424.1		
Share of population aged 14 or under (%)	14.13	2.15		
Share of population aged 65 or over (%)	21.83	6.35		
Share of foreigners (%)	0.89	0.84		
Unemployment rate (%)	5.12	1.65		
Merged municipality dummy	0.14	0.35		
Merged municipality-specific trend	0.77	2.26		
Per capita cumulative debt (JPY 1000)	412.95	246.49		
Observations	41,033 [40,907]			

Notes: The sample is the same as that used for the baseline regression. Per capita statistics are a weighted average of population. Definition and sources of the variables are listed in Table A2. The bracket refers to the number of observations of per capita investment cost and per capita fiscal transfers.

5. Results

5.1. Baseline Results

Table 3 shows DID estimates of the impacts of the designation to core and special case cities during the period 1996–2015. As can be seen from column (1), which presents the regression results using Equation (1), the impact of the designation as a core city is not significant, but that of the designation as a special case city is significantly positive, meaning that, given that the designation impacts are constant over time, designation as a special case city increases costs, possibly reflecting diseconomies of scope. However, as shown in column (2), which presents the regression results using Equation (2), when group-specific trends after the event are included, the constant and trend effects of designation as either a core city or a special case city are significantly positive and significantly negative, respectively. This indicates that if a city transitions to core city status, its per capita total expenditure increases sharply by 2.8% immediately after designation, but then decreases by 0.6% annually, and in the case of transitioning to special case city status, per capita expenditure increases by 4.9% immediately after designation, but then decreases by 0.45% year-by-year. Thus, it can be seen that the transition to core city or special case city status does not facilitate economies of scope in the short run but does so in the long run. Turning to the control variables, population, population density, share of the population aged 14 or under, and the unemployment rate are all negatively correlated with expenditure, indicating that large, urbanized, and young municipalities experiencing challenging economic conditions are likely to exhibit a lower level of expenditure per capita. In addition, merged municipalities tend to temporarily increase their expenditure immediately following the merger, but then reduce it annually. Column (3) presents the estimation results from the same regression presented in column (2) using cities as a sample, and provides evidence supporting the existence of economies of scope in the long run, with almost the same point estimates for the trend impacts, that is, 0.64% and 0.42% annual decreases for core cities and special case cities, respectively.

Table 3. Difference-in-differences estimates of designation to core city and special case city.

Dependent Variables	**Log of Per Capita Expenditure**			**Log of Per Capita Current Expenditure**		
	(1)	**(2), Baseline**	**(3)**	**(4)**	**(5)**	**(6)**
Core city dummy	−0.0016	0.0281 *	0.0092	−0.0635 ***	−0.0123	0.0128
	(0.0161)	(0.0162)	(0.0141)	(0.0154)	(0.0161)	(0.0150)
Core city-specific trend		−0.0060 ***	−0.0064 ***		−0.0104 ***	−0.00674 ***
		(0.0019)	(0.0019)		(0.0019)	(0.00198)
Special case city dummy	0.0260 ***	0.0491 ***	0.0149	−0.0292 ***	0.0067	0.0209 *
	(0.0097)	(0.0108)	(0.0109)	(0.0112)	(0.0121)	(0.0124)
Special case city-specific trend		−0.0045 ***	−0.0042 ***		−0.0071 ***	−0.00424 **
		(0.0015)	(0.0015)		(0.0016)	(0.00167)
Log of population	−0.1294 ***	−0.1337 ***	−0.0262	−0.2435 ***	−0.2508 ***	−0.0368
	(0.0349)	(0.0350)	(0.0384)	(0.0318)	(0.0317)	(0.0399)
Log of population density	−0.1507 ***	−0.1481 ***	−0.1054 ***	−0.1385 ***	−0.1341 ***	−0.0913 ***
	(0.0186)	(0.0184)	(0.0164)	(0.0193)	(0.0190)	(0.0166)
Log of income per taxpayer	0.0249 *	0.0255 *	0.0150	0.0295 **	0.0305 **	0.0163
	(0.0132)	(0.0134)	(0.0092)	(0.0141)	(0.0144)	(0.0100)
Share of population aged 14 or under	−0.0110 ***	−0.0106 ***	−0.0203 ***	−0.0149 ***	−0.0143 ***	−0.0194 ***
	(0.0026)	(0.0026)	(0.0043)	(0.0025)	(0.0025)	(0.00457)
Share of population aged 65 or over	0.0004	0.0004	0.0077 ***	−0.0048 ***	−0.0048 ***	0.00771 ***
	(0.0014)	(0.0015)	(0.0020)	(0.0015)	(0.0015)	(0.00215)
Share of foreigners	0.0004	0.0002	0.0130 *	0.0001	−0.0002	0.0153 *
	(0.0040)	(0.0040)	(0.0079)	(0.0030)	(0.0030)	(0.00901)
Unemployment rate	−0.0134 ***	−0.0138 ***	−0.0196 ***	−0.0090 ***	−0.0097 ***	−0.0202 ***
	(0.0028)	(0.0028)	(0.0049)	(0.0025)	(0.0025)	(0.00522)
Merged municipality dummy	0.1120 ***	0.1173 ***	0.0425 ***	0.0530 ***	0.0620 ***	0.0466 ***
	(0.0131)	(0.0131)	(0.0133)	(0.0139)	(0.0140)	(0.0140)
Merged municipality-specific trend	−0.0062 ***	−0.0060 ***	0.0015	−0.0065 ***	−0.0062 ***	−5.03e−05
	(0.0014)	(0.0014)	(0.0020)	(0.0014)	(0.0014)	(0.00212)
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Sample	All	All	Cities	All	All	Cities
Adjusted R squared	0.265	0.266	0.351	0.399	0.401	0.351
Observations	42,802	42,802	14,323	42,676	42,676	14,197

Notes: In "Sample," "All" indicates all municipalities; "Cities" is all cities. Standard errors cluster robust with regard to municipality are in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%. Constants are abbreviated.

Columns (4)–(6) present the estimates of the effects of core city and special case city designation on current expenditure per capita. It can be seen that the cost-reduction effects of delegations are greater on per capita current expenditure than on per capita expenditure. As can be seen from column (4), the constant impacts are all significantly negative. Further, as in column (5), the group-specific trend impacts are all significantly negative, with greater point estimates in absolute value than the corresponding estimates presented in column (2), and there are no temporary cost increases for either status. It can be inferred from these results that in terms of cost reduction, economies of scope are more effective in current expenditure than in overall expenditure. The trend estimates presented in column (6) are similar to those presented in column (3), once again supporting the existence of long-term economies of scope.

The above regressions assume constant or linear treatment impacts of the designations, but the treatment effects may vary over time. Next, assume the econometric specification that allows flexible event study effects over time relative to the designation, as shown in Equation (3). Event study impacts of the designation to either core city or special case city are plotted, along with the corresponding 95% confidence intervals, in Figures 4 and 5, respectively. As can be seen in Figure 4, the event study impacts of the designation to core city status are significantly positive until 17 years after the delegation but have a negative trend 4 years after the designation. In line with the results of the analysis of the constant and trend effects on expenditure presented in column (2) in Table 3, a gradual decrease in expenditure subsequent to an instantaneous increase is observed by the event study approach. Regarding special case city status, as can be seen in Figure 5, there is an immediate increase in expenditure followed by a gradual decrease about 8 years after designation, but in most of the event years, the estimates are not significant. Consequently, the event study approach also provides evidence that designation to core city or special case city status has an immediate positive impact on expenditure, followed by a gradual negative impact in the long run.

5.2. Robustness Checks and Extensions

The abovementioned regression analyses ignore the extra costs that would be incurred if the additional functions that core or special case cities were required to undertake were handled separately by specialized governments. This is explained as follows. As noted in the literature (e.g., [1,14]), economies of scope exist if

$$C(Y,\ Y_{extra})\ \ C(Y,\ 0) + C(0,\ Y_{extra}),$$

where $C(\cdot)$ represents costs, Y represents a vector of the public services an ordinary city provides, and Y_{extra} represents a vector of the extra services a specialized city (either a core city or a special case city) provides. In the present analysis, $C(Y,\ Y_{extra})$ represents expenditure by delegated cities and $C(Y,\ 0)$ represents expenditure by ordinary cities, holding population constant. $C(0,\ Y_{extra})$ represents the extra expenditure that is incurred when a city is designated as a specially authorized city. In principle, $C(Y,\ Y_{extra})$ should be compared with $C(Y,\ 0) + C(0,\ Y_{extra})$ to determine whether there are economies of scope in the local governments' activities. However, because in many cases the extra costs associated with the designation are probably not calculated formally by the delegated city, I compared $C(Y,\ Y_{extra})$ with $C(Y,\ 0)$ in the abovementioned regression analyses.

Thus, as a robustness check, I performed a DID regression in which expenditure by specially authorized cities in the years prior to designation is replaced with the sum of expenditure by ordinary cities, $C(Y,\ 0)$, and the extra costs associated with the designation, $C(0,\ Y_{extra})$. As a result of limited data availability, I employed the average per capita extra cost in Table 2, JPY 4653, as the extra cost for core cities. The regression results are presented in column (1) in Table 4. It can be seen that in contrast to the 2.8% increase in expenditure immediately following designation, as shown in column (2) in Table 3, expenditure by the core cities remained unchanged immediately following designation and then decreased by 5.8% year-by-year. Conversely, the constant and trend effects of designation as a special case city were almost the same as those in column (2) in Table 3.

The impact on expenditure of municipal mergers is controlled for by including a dummy for merged municipalities and an event trend term that covers several years after the merger, but thus far, potential endogeneity, that is, reverse causality whereby the level of expenditure leads to a decision to merge, has not been taken into account in the regressions. To address possible endogeneity, I used the instrumental variable (IV) estimation approach as a robustness check. Following [24], who proposed the use of the IV approach in assessing the cost-reduction effects of mergers, dummy variables regarding population thresholds—specifically a dummy for municipalities with a population of less than 1000 after 2002, a dummy for municipalities with a population of 1000–3999 after 2002, and a dummy for municipalities with a population of 4000–7999 after 2002—were used as instruments because after the national government tightened its general-purpose fiscal transfers to municipalities with a population of less than 8000 in 2002, small municipalities were urged to merge to retain their fiscal autonomy by satisfying the new population requirement (e.g., [32]). The estimation results are presented in column (2) in Table 4. It can be seen that the impact of the specific designation trend is an annual 10.1% decrease in expenditure following designation as a core city, although the other constant and trend impacts are not significant. The IV estimation casts doubt on the effect of a reduction in expenditure following designation as a special case city, but supports evidence of the long-term economies of scale for core cities status. Additionally, because the cumulative debts of local governments are generally viewed as reflecting their future fiscal health or sustainability, and their past fiscal deficits, a regression with cumulative debts included as a control was run as an extended estimation. Furthermore, to ensure robustness, the control variables from the census were excluded and the sample period used in the regression was extended. As can be seen from columns (3) and (4) in Table 4, decreasing trends in expenditure for core and special case cities and a temporary increase for special case cities were still observed (as residents' preferences for living environment might influence local government's policy making, a regression that included as controls related to environmental sustainability per capita park area, per capita garbage, and the share of recycled garbage was performed. The constant and trend impacts of designation as core cities are significantly positive (2.9%) and negative (−0.67%), respectively, hence supporting evidence of the presence of long-term economies of scope for core cities. Furthermore, in case there was some form of structural break in governmental expenditure, structural break tests were conducted based on the assumption that a break might occur each year. Although a structural break can be seen each year, negative trends in expenditure for core and special case cities and a positive constant effect for special case cities still appeared in every case).

Table 4. Estimates of designation to core city and special case city, robustness checks and extensions.

Models	**Impacts on Extra Cost-Adjusted Expenditure**	**IV Estimation for Municipal Mergers**	**Including Per Capita Cumulative Debt**	**Excluding Controls from Census**	**Impacts on Per Capita Investment Expenses**	**Impacts on Per Capita Fiscal Transfers**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Core city dummy	0.0141	−0.1479	0.0314 **	0.0243	0.0535	0.0692 **
	(0.0159)	(0.2168)	(0.0143)	(0.0160)	(0.6536)	(0.0288)
Core city-specific trend	−0.0058 ***	−0.1013 **	−0.0043 **	−0.0063 ***	0.0529	0.0085 ***
	(0.0019)	(0.0464)	(0.0019)	(0.0019)	(0.0598)	(0.0033)
Special case city dummy	0.0488 ***	−0.0760	0.0570 ***	0.0443 ***	−0.2078	0.1681 ***
	(0.0107)	(0.1556)	(0.0099)	(0.0107)	(0.5574)	(0.0223)
Special case city-specific trend	−0.0045 ***	−0.0475	−0.0042 ***	−0.0047 ***	0.0401	0.0010
	(0.0015)	(0.0361)	(0.0015)	(0.0015)	(0.0733)	(0.0028)
Log of population	−0.1339 ***	−3.4261 *	−0.1392 ***	−0.1500 ***	3.3899 ***	0.3053 ***
	(0.0348)	(1.8100)	(0.0311)	(0.0317)	(0.5241)	(0.0862)
Log of population density	−0.1469 ***	1.8427 *	−0.1181 ***	−0.1595 ***	−1.8070 ***	−0.0487
	(0.0183)	(1.0559)	(0.0157)	(0.0181)	(0.3642)	(0.0350)
Log of income per taxpayer	0.0253 *	−0.0643	0.0266 **	0.0363 **	−0.1063	0.0424 **
	(0.0133)	(0.0408)	(0.0134)	(0.0171)	(0.1343)	(0.0204)
Share of population aged 14 or under	−0.0105 ***	0.0063	−0.0085 ***		0.0038	−0.0070
	(0.0026)	(0.0281)	(0.0025)		(0.0279)	(0.0058)
Share of population aged 65 or over	0.0003	−0.0285 **	−0.0018		0.0616 ***	0.0099 ***
	(0.0014)	(0.0125)	(0.0014)		(0.0148)	(0.0034)
Share of foreigners	0.0002	0.0398 *	0.0010		0.0290	−0.0028
	(0.0040)	(0.0231)	(0.0033)		(0.0531)	(0.0086)
Unemployment rate	−0.0137 ***	−0.0470 ***	−0.0126 ***		−0.0111	−0.0263 ***
	(0.0028)	(0.0149)	(0.0026)		(0.0289)	(0.0063)
Merged municipality dummy	0.1164 ***	1.1904	0.0998 ***	0.1339 ***	−0.3553	0.1233 ***
	(0.0130)	(1.4894)	(0.0116)	(0.0132)	(0.3187)	(0.0294)
Merged municipality-specific trend	−0.0059 ***	0.3705 **	−0.0077 ***	−0.0071 ***	−0.0214	−0.0254 ***
	(0.0014)	(0.1477)	(0.0014)	(0.0013)	(0.0244)	(0.0027)
Cumulative debt per capita			0.1818 ***			
			(0.0176)			
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Hausman test		3124				
Hausman test: p-value		0.000				
Adjusted R squared	0.261	–	0.304	0.269	0.045	0.379
Observations	42,802	42,802	42,802	48,581	42,676	42,676

Notes: The samples are panels for all municipalities. Standard errors cluster robust with regard to municipality are in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%. Constants are abbreviated.

By way of a further examination of the impact on expenditure of the designation to specially authorized cities, the DID approach with group-specific trends was used to analyze the influence on investment expenses and intergovernmental fiscal transfers per capita. As can be seen from columns (5) and (6) in Table 4, transition to core cities and special case cities had no effect on investment expenses but a temporary positive effect on intergovernmental fiscal transfers. In the case of core cities, intergovernmental fiscal transfers increased by around 1% annually. It follows that specially authorized city status does not seem to affect investment expenses and intergovernmental fiscal transfers, contrary to the effects on total expenditure and current expenditure.

To validate the finding that the reduction in expenditure is attributed to efficiency gains through economies of scope and not to cuts in services, the level of public service quality should remain stable following designation as a core or special case city. This can be confirmed by checking whether a proxy of public service drops following designation as a specially authorized city. To this end, I regressed some public service variables, specifically primary school teachers per 1000 students, nursing homes per 1000 people aged 65 or over, community centers per 1000 people, and the share of the population who used trash pickup services, on the same explanatory variables as those used for the regressions regarding the effects of designation on local expenditure, including the designation treatment and trend variables, to detect whether there were changes in service levels following designation. As can be seen from Table 5, no proxy for public service levels except the trash pickup variable changed following designation as either a core or special case city, and the share of population who used trash pickup services rose after designation, indicating that designation as a specially authorized city did not reduce the level of public services.

Table 5. Effects on public services of designation as core city and special case city.

Dependent Variables	Primary School Teacher per 1000 Students	Nursing Home Per 1000 People Aged 65 or Over	Community Center per 1000 People	Share of Population Who Can Utilize Trash Pickup Service
	(1)	(2)	(3)	(4)
Core city dummy	0.8200	0.0084	−0.0041	−0.1919
	(1.8537)	(0.0074)	(0.0082)	(0.1809)
Core city-specific trend	−0.2675 *	−0.0013	−0.0003	−0.0346
	(0.1615)	(0.0009)	(0.0010)	(0.0236)
Special case city dummy	1.2751	0.0133 *	0.0104	−0.3998 **
	(1.4556)	(0.0072)	(0.0104)	(0.1663)
Special case city-specific trend	−0.0732	0.0006	−0.0005	0.0021
	(0.2147)	(0.0010)	(0.0010)	(0.0228)
Control variables	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Adjusted R squared	0.128	0.039	0.00689	0.0322
Observations	42,669	20,993	15,129	31,460

Notes: The samples are panels for all municipalities. Standard errors cluster robust with regard to municipality are in paren-theses. * significant at 10%; ** significant at 5%. Constants and controls are abbreviated.

5.3. Size of Economies of Scope

Looking at the results of the regression analyses, it can be questioned how much a designation as either a core city or a special case city either reduces or increases expenditure over the long term. As is the case in the regressions used in this study, if the trend impact of special city status on expenditure is negative, even if the constant treatment impact is positive, a long-term reduction in expenditure through economies of scope would be expected. Then, based on the DID constant and trend estimates of the impacts of core city and special case city status presented in column (2) in Table 3, the long-term changes in expenditure since the delegation are calculated. As in Table 6, a designation of core city status results in an immediate increase in expenditure of 2.8%, but expenditure is reduced by 3.1% relative to initial expenditure 10 years after designation as a core city and by 9.1% 20 years after designation. Regarding special case cities, expenditure increases by 4.9% immediately following designation, but is reduced by 4.1% 20 years after designation. Thus, it is evident that while both core cities and special case cities enjoy economies of scope in terms of total expenditure, the effect is more than twice as great for core cities than for special case cities in the long term.

Table 6. Sizes of economies of scope.

Years after the Designation	Per Capita Expenditure for Core Cities, %	Per Capita Expenditure for Special Case Cities, %
0	2.81%	4.91%
1	2.21%	4.46%
2	1.62%	4.01%
3	1.02%	3.55%
4	0.43%	3.10%
5	−0.17%	2.65%
6	−0.76%	2.19%
7	−1.36%	1.74%
8	−1.95%	1.29%
9	−2.55%	0.84%
10	−3.14%	0.38%
11	−3.74%	−0.07%
12	−4.33%	−0.52%
13	−4.93%	−0.97%
14	−5.52%	−1.43%
15	−6.12%	−1.88%
16	−6.71%	−2.33%
17	−7.31%	−2.79%
18	−7.90%	−3.24%
19	−8.50%	−3.69%
20	−9.09%	−4.14%

Notes: The figures are estimated from the coefficients of the treatment and trend impacts of designation to core city and special case city, in column (2) in Table 3.

5.4. Discussion

It is useful to compare the size of the economies of scope obtained in this study with those obtained in previous studies. The most relevant previous study is [14], which analyzed potential economies of scope in public service provision at the county level using Farrell-type efficiency measures to compare the costs experienced by individual municipalities with a cost frontier. It is suggested in [14] that in terms of total and variable costs, economies of scope are present in most cities, and thus inferred that economies of scope existed as a result of the ability to share fixed costs. Table 2 in [14] shows that the average efficiency measure is 0.726 and that, as one minus efficiency measure is a potential percentage reduction in cost that would realize if the municipality performed according to the best practice in the sample, the potential cost saving is 0.274 (27.4%) on average. Their finding of the existence of economies of scope in the provision of municipal services is consistent with the finding of the present study. However, the sizes of the potential cost savings through economies of scope differ between [14] and this study. Specifically, in this study, savings of 9.1% 20 years after designation to core city status were identified compared with 27.4% in [14], but given the declining trend of 0.6% in expenditure for core cities following designation, the long-term potential cost savings are expected to be closer between them. It follows that, although previous empirical studies on economies of scope associated with the provision of services by local governments are scarce, not only in relation to the potential for economies of scale but also their size, the present study is comparable to [14].

6. Conclusions

The aim of this study was to determine the existence/nonexistence of the economies of scope in general government expenditure using panel data for Japanese municipalities during the period 1996–2015. I used two-way fixed-effects regressions to estimate the

DID treatment and trend impacts and event study effects on per capita expenditure of designation as a core city or special case city. Core and special case cities were authorized to undertake a broader range of activities than ordinary cities, and cities that met the population requirements were able to apply for designation at any time. Designations to these city statuses, which are labeled treatment events in this study, have occurred annually since their introduction, enabling a comparison of levels of expenditure between ordinary cities and these specially authorized cities.

A key requirement for the identification of the DID treatment and event study impacts is the parallel trend assumption. In this framework, per capita expenditure in the "never designated" municipalities, which comprises municipalities that have never transitioned to core cities or special case cities, should have the same trend as the specially authorized cities in the predesignation period. Graphical illustrations and formal regression-based tests confirm that the parallel trend assumption holds for both core cities and special case cities. Two-way fixed-effects regressions were used to estimate the impact of designation as a core city or special case city on expenditure trends. The results show that first, in the provision of public services by general-local governments, economies of scope do not occur in the short term (2–3 years), but do appear in the mid to long term (more than 5 years for core city status). After the delegation of duties, per capita expenditure for core cities increases by 2.8% immediately after the designation, but then decreases by 0.6% annually. Special case cities see an immediate increase of 4.9% in expenditure per capita followed by a 0.45% decrease annually. The results show that for core cities, economies of scope appear 5 years after designation and reach a peak of 9.1% 20 years after the transition, while for special case cities economies of scope are first seen 11 years after designation and reach a peak of 4.1% 20 years after the transition. However, note that the results for special case cities are not robust to empirical specifications. Second, the wider the range of extra activities delegated, the greater the economies of scope. This is inferred from the first result, as a greater variety of activities is delegated to core cities than to special case cities. Thus, economies of scope are observed in public services provided by general local governments, and these findings are robust to changes in econometric specifications and the sample used. The empirical analysis undertaken in this study is limited to the Japanese case of the creation of specially authorized cities, but the results regarding long-term cost savings through economies of scale can contribute to policy debates over fiscal decentralization and local government autonomy in other countries.

These findings have several implications in terms of policy making. First, this study provides robust empirical evidence of potential economies of scale in public services provided by general local governments. It has been argued that the public sector, including general local governments, has a great opportunity to benefit from economies of scope in the provision of public services through organizational reforms such as colocation of various divisions, application of professional knowledge to services provided by other sectors, and utilization of their competitive advantage in terms of relationship-oriented activities [3]. In practice, the public sector may be able to reduce its total and variable costs by colocating several divisions in the same building, facilitating interactions between skilled personnel in different sectors, such as primary and secondary school teachers, and sharing division-specific information such as that provided by the police department to enable search and rescue operations to be conducted in a timely manner. However, little evidence has been accumulated in previous studies, except for that of [14], as to what potential economies of scale are available in the provision of municipal services. Empirical studies have focused on determining whether economies of scope exist in the provision of specific public services such as MSW services [11], care services [6], and public transportation [7–10]. In this study, I not only presented empirical evidence of economies of scale for general government activities, building on the program evaluation framework using DID and event study approaches, but also demonstrated how economies of scope in terms of government expenditure emerge over time. This provides practitioners and public administrators with useful information on practical ways to achieve cost reductions in the public sector.

Second, from a local government sustainability perspective, the findings of this study suggest potential new policy strategies aimed at reducing general-purpose local government expenditure. In many countries, particularly developed countries, both urban and rural governments are facing fiscal challenges related to aging and declining populations, placing pressure on social security budgets and leading to reductions in healthcare and other public services [33] (p. 117). Given these pessimistic predictions regarding local government finances, cost savings are urgently required if local governments are to retain their fiscal autonomy [34]. Borrowing to finance local public investment facilitates a better allocation of financial resources. However, in principle, local governments should finance current expenditure using tax revenues, and long-term debt financing should only be used for capital projects (e.g., [35–37]). Thus, constituencies should keep a close eye on potentially excessive future debt service payments due to aging and declining population [38–41]. The findings of this study indicate that economies of scope, for example, through joint provision of multiple public services, can be a key driver of ongoing cost reductions in public service provision, resulting in improved sustainability of local governments.

Third, fiscal decentralization through the delegation of services that are currently provided by higher levels of government is clearly beneficial. Oates's [37] Decentralization Theorem states that in the absence of economies of scale in the provision of public goods and of interjurisdictional externalities, the level of welfare is higher under decentralization than under centralization [42,43]. By contrast, if economies of scale exist in public goods provision, spillovers are observed, and there is a low level of heterogeneity among jurisdictions in preferences for public goods, the level of welfare is likely to be higher under centralization than under decentralization (e.g., [44–46]). In reality, given the potential economies of scale, municipal consolidation is favored by practitioners as a means of reducing administrative costs and increasing efficiency in the provision of public services [47]. In many cases, economies of scope have not been considered in determining whether municipal consolidation is worthwhile (e.g., [14]), but creation of a large-sized local government by a merger that can have fiscal capacity to operate a wider range of functions also could be an advantage of municipal consolidation. In this regard, this study makes a significant contribution to the fiscal federalism literature, with a focus on economies of scope in public services as a new channel for cost reduction, and to the policy debate regarding the validity of municipal consolidations from a cost-saving viewpoint.

There is, however, a caveat in this research. The economies of scope literature has built on the cost function analysis and a calculation of production costs predicted if each product were produced separately, to measure the degrees of scope economies. Yet, the present study employs the program evaluation framework, where the cost impacts of a wider range of responsibilities assigned to specially authorized cities are more directly assessed by comparing expenditure between the designated cities and nondesignated municipalities. Indeed, comparison between the sizes of scope economies estimated from the cost function approach and those from the program evaluation methodology may yield further insight into the literature. This issue is left for future research.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. List of Duties Handled by Core and Special Case Cities

Table A1. List of extra duties handled by core cities and special case cities.

Extra duties handled by core cities
Duties pertaining to welfare administration
· Issue of physically handicapped person's handbook
· Authorization for the foundation of nursing homes for the aged and supervision of them
· Loan of welfare loan funds for mothers, children and widows
Duties pertaining to public health (duties handled by cities authorized to establish public health centers)
· Implementation of projects for the preservation and improvement of the health of local residents
· Permission of restaurant businesses
· Notification of septic tank installation
· Permission for use of hot springs
Duties pertaining to environmental protection
· Notification of installation of soot and smoke emitting facilities
· Measure order for industrial waste collectors and transporters, and industrial waste disposal operators
Duties pertaining to town planning, etc.
· Restrictions on outdoor advertisements in accordance with bylaws
Duties relating to education
· Training of teaching staffs paid by the prefectural government
Extra duties handled by special case cities (for the enforcement period)
Duties pertaining to environmental protection
· Acceptance of the application for installation of general particulate discharging facilities
· Acceptance of the application for installation of facilities emitting pollutants or waste liquid
· Permission for contaminated solid processing licensees
Duties pertaining to town planning, etc.
· Permission for the foundation of Land Readjustment Associations
· Permission for housing estate development projects within restrictive areas for housing land development
· Permission for development activities within urbanization areas or urbanization-controlled areas
Other duties
· Recommendations on the Measurement Act and regular inspections

Note: As of 1 November 2020. Sources: Ohsugi, S. (2001) "The Large City System of Japan" (http://www3.grips.ac.jp/~coslog/activity/01/04/file/Bunyabetsu-20_en.pdf) and MIC (https://www.soumu.go.jp/cyukaku/ accessed on 1 November 2020)

Appendix B. Variable Definition, Sources, and Units

Table A2. Variable definition and sources.

Variable	Definition	Sources
Per capita expenditure	Total expenditure divided by population	1, 2
Per capita current expenditure	Current expenditure divided by population	1, 2
Per capita investment cost	Construction Work Expenses divided by population	1, 2
Per capita fiscal transfers	General grants (*Local Allocation Tax*) plus conditional grants (*National treasury Disbursements*) divided by population	1, 2
Population	Population	2
Population density	Geographical area divided by population	1, 2
Income per taxpayer	Taxable income of local income tax per taxpayer	3
Share of population aged 14 or under	Share of population aged 14 or under to total population	4
Share of population aged 65 or over (%)	Share of population aged 65 or over to total population	4
Share of foreigners (%)	Share of foreigners (non-Japanese) to total population	4
Unemployment rate (%)	Percentage of unemployed people to labor force, 2010	4
Merged municipality dummy	Dummy that takes one for merged municipalities during the Heisei great merger by 2010	5
Merged municipality-specific trend	Trend that takes the years after the merger	5
Per capita cumulative debt	Cumulative debt divided by population	1, 2

Notes: 1 = Ministry of Internal Affairs and Communications (MIC) (1996–2015) *Survey on Municipal Financial Settlement* (https://www+A1.soumu.go.jp/iken/kessan_jokyo_2.html); 2 = MIC (1996–2015) *Basic Resident Register* (https://www.e-stat.go.jp/stat-search/files?page=1&toukei=00200241&tstat=000001039591); 3 = MIC (1996–2015) *Survey on Municipal Taxation* (https://www.soumu.go.jp/main_sosiki/jichi_zeisei/czaisei/czaisei_seido/ichiran09.html); 4 = MIC, Statistics Bureau (1995, 2000, 2005, 2010, 2015) *Census* (https://www.e-stat.go.jp/stat-search/files?page=1&toukei=00200521&tstat=000001039448); 5 = MIC (https://www.soumu.go.jp/gapei/gapei.html). All the Web pages were retrieved on 5 November 2020.

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Sustainable Provision of School Buildings in The Netherlands: An Empirical Productivity Analysis of Local Government School Building Operations

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Abstract: Building operations and construction are responsible for a large part of global energy use and carbon dioxide emissions. In this paper, we present an analysis of the efficiency and productivity of the provision of school buildings by Dutch municipalities. A cost function is estimated for the years 2005–2016 using stochastic frontier methods based on data of Dutch municipalities. The results indicate that inefficiency and unproductiveness are substantial. The provision of school buildings on a more appropriate scale, detailed performance benchmarking and including more incentives for innovative behaviour may result in a more sustainable provision of school buildings and less energy use and emission of carbon dioxide.

Keywords: sustainability; efficiency; school buildings; productivity; local government; performance benchmarking; carbon dioxide

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1. Introduction

Building operations and construction are responsible for 36% of global energy use and 39% of energy-related carbon dioxide emissions annually [1]. Emissions related to buildings come from two sources. The first source is the energy used during normal operations, such as lightning and heating, the so-called operational carbon emissions. The second source is the amount of carbon produced during construction, manufacturing building supplies and the transportation of materials to construction sites. The second source accounts for about 25% of a building's carbon emissions during its lifespan. Globally, the embodied carbon of buildings account for about 11% of emissions [1].

Obviously, buildings' carbon emissions are directly related to the construction process of the building, to the use of carbon-free or recyclable materials and to the extent to which the building is energy-efficient. However, another option is to promote the efficient usage of space in general. One of the most effective ways to reduce emissions is by diminishing the wastage of building capacity. Note that aside from all other technical and ecological improvements, measures to downsize overcapacity are free. One issue that is particular related to the capacity usage is the scale on which the firm or institution governing the buildings operates. A small firm has less flexibility in allocating building spaces and is less able to respond to changes in building capacity than a large firm. On the other hand, large firms may face bureaucratic issues and are less able to respond to changing capacities. One may think of information lacks and lengthy administrative procedures. In general, the scale issue may apply to all the infrastructural projects governments are dealing with, such as hospital, school, office and recreational buildings, but also to roads, canals, ports, etc. An interesting issue to address is which government layer should govern the provision of that specific infrastructure in order to downsize emissions.

In The Netherlands, more than 1.5 million primary education pupils are taught each day in 8500 school buildings. The school buildings cover an area exceeding 10 million square metres (Court of Audit, 2016). In 2014, an estimated EUR 1.45 billion was spent on primary school buildings.

As a result of decentralisation, municipalities have been largely responsible for school buildings in both primary and secondary education since 1997. Until 1997, the central government was responsible for providing school buildings. The central idea behind the decentralisation was that local government would have a better insight into the needs and availability of school buildings. A more productive usage of existing capacities could be expected. Since primary and secondary schools are of a limited size, transferring responsibilities to school boards would have been a bridge too far. Aside from the capacity usage, some other economic issues may prevail as well. School board management probably lacks the specialised knowledge and insights in operating in the market of construction and real estate. It also is to be expected that their bargaining power is smaller than of local government. Furthermore, the financial risks and uncertainties for each separate school board would be too high. Therefore, the economic rationale behind the decentralisation was that economies of scale would prevail at the level of local government. In 2016, school building capacity was provided by about 400 municipalities, varying in population between 5000 and 820,000 inhabitants. Local government in The Netherlands has a large discretion power in how to spend their money. As long as they face no long-term budget deficits, central government cannot interfere with local policies. Political control is conducted by the inhabitants, who can vote for the local government board every four years. Whereas political power varies strongly amongst municipalities, substantial differences in local policies exist. This implies that municipality data are eminently suitable for research.

It is, therefore, an interesting question whether economies of scale, cost efficiencies and technical change prevail in the provision of school buildings by municipalities. Due to the fact that the size of local government varies so much amongst municipalities in The Netherlands, interesting data are available to test this hypothesis. The central research questions therefore are as follows:

1. Do economies of scale exist in the provision of school buildings and is there an optimal scale?
2. To what extent can each local government increase its cost efficiency?
3. To what extent have local governments succeeded in improving school building productivity by innovative behaviour?

In this paper, we relate to these research questions by conducting an analysis of economies of scale, technical efficiency and technical change of providing school buildings by local government within the Dutch primary education system between 2005 and 2016.

In the next section, a cost model is estimated using stochastic frontier methods, using data over the period 2005–2016. The estimated frontier identifies the minimum cost (or volume) of school buildings given some level of output and contextual variables faced by the municipalities. From the results of the estimated cost function, economies of scale can be derived as well as (cost) efficiencies and technical change. In order to connect the methodology to the research questions, two issues must be emphasised. First, although we speak about cost function, we actually use a measure for the physical (building) input as the dependent variable. This measure is derived from cost by controlling for price effects (construction prices, interest rates and depreciation). Secondly, we measure services produced by the number of pupils actual using the buildings instead of the potential capacity (square or cubic meters, number of classrooms). This perspective allows us to derive conclusions from the outcomes in terms of productive usage of buildings or occupation rates.

For obvious reasons, the occupation rate is not the sole determinant of economies of scale or efficiency. Contracts on service and maintenance and administrative procedures may well affect these outcomes. Since we are lacking this type of information, we are not able to take these determinants into account and, therefore, some omitted variables bias may occur. However, we may assume that the impact of these determinants is relatively small compared to the impact of the occupation rate.

The remainder of this paper is organised as follows. The following section discusses the relevant literature. Section 3 outlines the methodology. Section 4 discusses the data, and Section 5 presents the estimation results. Section 6 concludes this paper.

2. Literature Review

In the literature, there is a strong focus on the efficiency of building operations, such as heating and lightning. These studies researched the effects of various determinants on building energy consumptions and described the relationship between environmental and managerial factors on energy use empirically [2]. Environmental factors are, for example, the outdoor temperature and building vintage [3,4]. Examples of managerial factors are indoor temperatures [5], the applications of artificial intelligent systems based on thermostats and sensors, collective holidays and additional isolation measures. In a number of studies, some measure of occupancy rate is also being included [5–7].

There is an extensive strand of the literature on the measurement and analysis of local government efficiency. Most of these studies focus on a specific service, such as waste collection [8–11], public health [12], policing [13–15], public administration [16,17], and public transport [18]. These studies also cover an extensive list of all kinds of themes, varying from scale issues, technical change to ways of tendering.

In a recent study, Niaounakis [19] particularly focuses on different issues regarding economies of scale in public services provided by local government. He analyses economies of scale in education, local infrastructures and tax offices from different perspectives. In his work, he stresses the relevance of the different scale concepts, relating to the size of the municipalities, to the size of the services, different governing layers and the public/private relationships. From this research two relevant conclusions emerge. First, the optimal size of public provision depends on the service. There is no such thing as one size fits all. Secondly, municipalities can benefit from scale economies by collaborating. Municipalities may vary the size of the collaborations over various services. Municipalities may optimally benefit from scale economies by letting the size of a collaboration depend on the service.

In spite of the numerous papers on municipality scale economies and efficiency, no research focusing on efficiency, scale economies or technical in the provision of school buildings has been produced. The only services that come close to it is the provision of rental family houses by corporations. They provide similar services, since they have to plan, design, construct, demolish, maintain and control properties. Interesting research concerns Dutch housing corporations [20,21]. He shows that the range for the optimal scale varies between 501 and 1000 dwellings. Corporations with more than 2500 dwellings strong diseconomies of scale exist. This implies that about 70% of the dwellings face diseconomies of scale. Unfortunately, it is to be expected that economies of scale in this context relate to the organisational structure of the corporation and has less to do with the occupancy rate of the housing stock.

Wolters and Verhage [22] note that the estimation of efficiency of housing corporations is being hindered by heterogeneity, for example, because of differences in their working area or the composition of the housing stock.

Another closely related research line is about energy use in buildings. This type of research relates to the link between types of buildings, energy use and emissions. An interesting example can be found in Khoshbakht et al. [23]. They performed an analysis of higher education buildings of 80 university campus buildings in Australia. Energy use, energy use intensity, related space types and occupancy conditions were analysed using stochastic frontier analysis (SFA).

3. Methodology

We analyse the cost structure, scale economies and relative efficiency of Dutch municipality school buildings by applying stochastic frontier analysis (SFA) to a cost model with a panel data technique. The stochastic frontier approach goes back to the seminal work of Aigner, Lovell and Schmidt [24,25] and Meeusen and Van den Broeck [26], who proposed a method that measures the distance of a specific firm to the firm that is operating at full-production maximisation or cost minimisation. The essence of this method is that this distance is a positive number that can be represented by a stochastic variable with a one-sided distribution. Since then, a pile of research emerged on this subject. For interesting oversights, see for example [27,28]. In this paper, we apply a cost model. A cost model relates minimum cost (c) to services delivery ($\boldsymbol{y}$), input prices ($\boldsymbol{w}$) and contextual variables ($\boldsymbol{z}$). The basic model can be represented as follows:

$$\ln(c) = g(\ln(\boldsymbol{y}), \ln(\boldsymbol{w}), \ln(\boldsymbol{z}), \boldsymbol{t}) + v + u \tag{1}$$

where $g(\cdot)$ is a parametric specification of a cost function, v reflects random errors and u is a one-sided distributed efficiency component. Since both v and u are not observable, we use the panel data structure to disentangle efficiency from random errors. Several panel data estimation techniques can be applied [29,30]. Since we have a set of cross sections at our disposals, each containing a substantial number of observations, a random effects approach seems to be most appropriate. Due to the incidental parameter problem, a fixed effects approach would be less appropriate.

For the functional specification of $g(\cdot)$, we apply a translog function, which is a second-order Taylor approximation of a general function and is popular in empirical work due to being relatively flexible [31], as follows:

$$\ln(c) = a_0 + \sum_m b_m \ln(y_m) + \frac{1}{2}\sum_m \sum_{m'} b_{mm'} \ln(y_m)\ln(y_{m'}) + \sum_k d_k \ln(z_k) + \sum_k \sum_{k'} d_{kk'} \ln(z_k)\ln(z_{k'}) + h_1 t + h_{11} t^2 + \sum_m g_m \ln(y_m) t + \epsilon \tag{2}$$

where
c = nominal cost deflated by a capital price index,
y_m = production of services m,
z_k = contextual variable k,
t = trend,
ϵ = random error,
$a_0,\ b_m, b_{mm'},\ d_k,\ d_{kk'},\ h_1,\ h_{11},\ g_m$ parameters to be estimated.

The cost function includes a time trend and a time squared variable allowing technical change to vary over time to a certain extent. Since we are analysing data on a time span of twelve years, this makes sense to do so. Furthermore, we assume an output biased technical change, i.e., that scale economies may change as a result of technological shifts. The data section will elaborate upon the choice of variables.

Further, we know that the cost of buildings, in particular the cost components related to construction, depend on, for instance, soil conditions and the easiness of access to the building site. These contextual variables are reflected by the z-variables.

From the estimated parameters of the cost function, we may derive several interesting economic outcomes.

3.1. Efficiency Scores

Efficiency estimates are obtained using the estimated errors, thereby shifting the errors by the maximum error in each specific year.

$$u_{it} = \epsilon_{it} - \min_i \epsilon_{it} \tag{3}$$

The efficiency score then equals the following:

$$Eff_{it} = \exp(-u_{it}) \tag{4}$$

3.2. Economies of Scale

Economies of scale are defined by the curvature of the estimated cost frontier with respect to y. Under (dis)economies of scale, an expanding output decreases (increases) the average cost. The cost elasticity of output along a ray from the expansion path is equal to the following:

$$\eta = \sum_m \frac{\partial \ln(c)}{\partial \ln(y_m)} \tag{5}$$

By definition, it then holds that (dis)economies of scale exist for $\eta < 1$ ($\eta > 1$).

3.3. Technical Change

Technical change is defined as the relative change in costs in the course of time, wherein time here is seen as a reflection of the state of technology. This yields the following:

$$tc = \frac{\partial \ln(c)}{\partial t} \tag{6}$$

Equations (5) and (6) can be evaluated at different points in the output space and context space.

4. Choice of Variables and Data

In our cost model we distinguish the following three types of variables: cost, outputs, input prices and context variables. Costs are represented by capital cost, including depreciation, interest and some additional control cost. To derive the actual volume of capital input capital cost is deflated by a price index based on the depreciation rate, the interest rate and a price index for investment in fixed assets. Some measurement errors may occur due to quality differences in buildings. Unfortunately, we do not have any data at our disposal to control for these quality differences. Since the primary goal of school buildings is to provide shelter to the pupils of a school, the number of pupils obviously is a good candidate for an output measure. Contextual variables are variables that are out of the control of the municipalities but may affect the cost substantially. In the case of construction, population density and soil factor are important contextual factors. It is well-known that the construction of buildings in urban areas is more complex than in rural areas. In large parts of The Netherlands, construction work has to deal with soft soil requiring the use of piles and complex foundations.

The data come from the municipal accounts (Iv3), as collected and published by Statistics Netherlands. The municipal accounts include information on the school buildings costs of municipalities over the time period 2005–2016. These data are extensively checked and corrected. The municipalities with remarkably high fluctuations and unrealistic costs have been systematically removed from the analysis. This indicates that some municipalities are using a different accounting method for dealing with capital cost, the so-called investment a fonds perdu method, instead of the common method of annual depreciation. The final analysis includes 4929 observations. Since some of the observations had to be removed, the panel is unbalanced. Table 1 summarises the included variables and their descriptives. In order to obtain an impression of the number and size of Dutch municipalities, we also included a frequency table of the size of the municipalities measured by the number of inhabitants in 2016.

From Table 1 we notice that there is a substantial variation in variables between the almost 5000 observations. Capital costs vary between €27,000 and €86 million. The smallest municipality only has to take care of 58 pupils, whereas the biggest municipality has to shelter more than 66,000 pupils. There is also a large variation in population density. This large variation in outputs and costs once more underlines the importance the central issue of this paper regarding economies of scale. If scale economies prevail, then large savings by exploiting these scale economies may be expected.

From the frequency tabulation in Table 1, we notice that there are about 400 municipalities. About 6% of these municipalities could be qualified as small (<10,000 inhabitants), 50% as moderate–small (10,000–30,000 inhabitants), one third as moderate–big (30,000–100,000 inhabitants) and 8% as big (>100,000 inhabitants).

Table 1. Descriptive variables.

Variable	N	Mean	Std. Dev.	Min	Max
2005–2016					
Capital cost	4929	1909.7	4456.7	27.4	86,203.3
Price of capital	4929	1.135	0.173	0.845	1.495
Number of pupils	4929	3800	5686	58	66,579
Population density	4929	978	724	111	6094
Soil factor	4929	1.094	0.149	1.000	1.860
2016					
Size	Freq.	Percent	Cum.		
<10,000	23	5.96	5.96		
10,000–30,000	202	52.33	58.29		
30,000–100,000	131	33.94	92.23		
>100,000	30	7.77	100		

5. Results

This section presents the results obtained from estimating the cost function (Equation (2)). The model estimates are presented in Table 2. The explanatory variables are standardised on the mean and taken in logarithms.

Table 2. Estimates based on random effects method.

	Coef.	Std. Err.	Z-Score	Sign.
Number of pupils	1.069	0.020	52.360	0.000
Number of pupils × number of pupils	0.121	0.021	5.770	0.000
Soil density	0.517	0.197	2.630	0.009
Soil density × soil density	−3.517	1.418	−2.480	0.013
Number of pupils × soil density	0.096	0.133	0.730	0.468
Time	0.060	0.006	10.820	0.000
Time × time	−0.003	0.000	−6.670	0.000
Time × number of pupils	−0.003	0.002	−1.790	0.074
Time × soil density	−0.018	0.013	−1.400	0.162
Constant	−0.527	0.024	−22.070	0.000
Explained variance	0.884			

From Table 2, we determine that the estimates make sense. Almost all the estimated parameters are significant at the 5% level. The only variable that does not contribute to the explanation of cost from a statistical point is population density and is, therefore, left out in the final model. The estimated model shows a good fit. When we include the random effects, the explained variance of the estimated cost equals 0.88. We now further evaluate the estimates by inspecting the various economic indicators that can be derived from them.

5.1. Economies of Scale

To analyse the influence of scale on building input, individual cost elasticities are derived according to Equation (4) and applied to all the municipalities in 2016. The outcomes are illustrated in Figure 1.

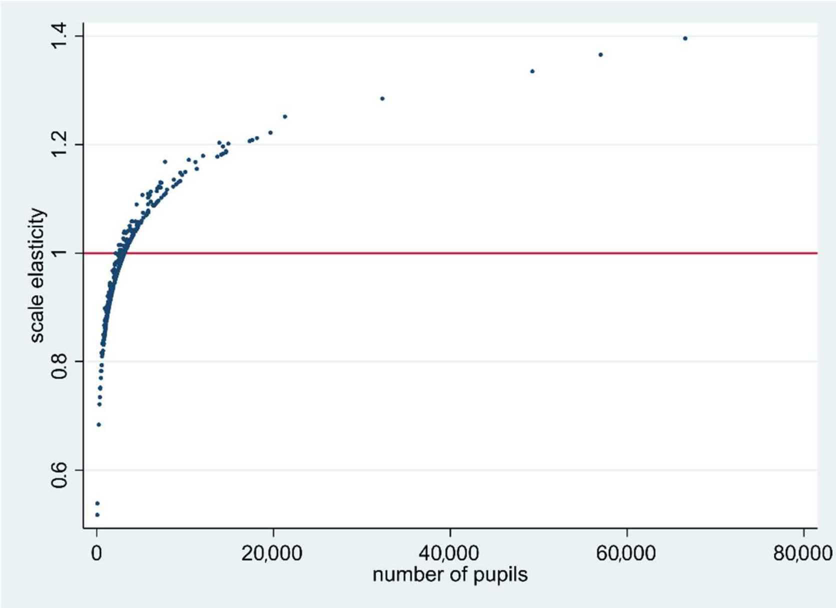

Figure 1. Elasticity of scale by number of pupils, 2016.

In Figure 1, it is demonstrated that a large part of predicted cost elasticities of scale equal about one, indicating that many municipalities face constant economies of scale. Applying a 95% two-sided statistical test, it is shown that about 41% of the municipalities face economies of scale, 39% constant economies of scale and 20% diseconomies of scale. According to Table 1, this implies that most of the municipalities with less than 30,000 inhabitants face economies of scale and at least all the municipalities greater than 100,000 inhabitants face diseconomies of scale. This implies that about 60% of the municipalities face some kind of scale inefficiencies. Therefore, there is room for improvement.

The existence of economies of scale in school buildings for small municipalities is due to the obligation to exploit small school buildings. Obviously, there is a direct correlation between small municipalities and low numbers of pupils. In The Netherlands, there is a strong preference for the proximity of schools in order to bring your children to school "just around the corner of the street" as well an unfamiliarity with the concept of school busses. Schools are also regarded as a part of the social coherence in small communities. In small school buildings, a relatively large "overhead" in space (hall, corridors, offices, utility rooms, etc.) exists. A low number of pupils per school also implies a low number of pupils per classroom and an inefficient usage of space. Another important explanation for the established scale effects is presumably the occupancy rate. Smaller municipalities or school boards have more difficulty absorbing fluctuations in the demand for school buildings.

5.2. Efficiency Scores

Figure 2 reflects the distribution of the estimated efficiency scores in 2016 by kernel density.

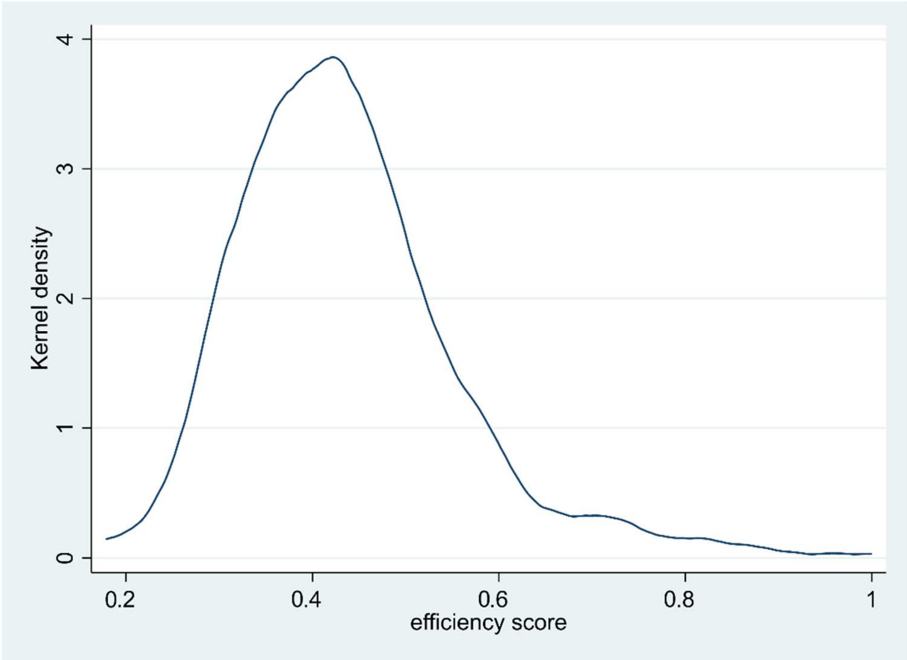

Figure 2. Kernel density of efficiency scores, 2016.

From Figure 2, it can be seen that the median efficiency score is a little above 0.4, indicating that large inefficiencies exist, and substantial improvements can be realised. In general, inefficiencies in capital utilisation are not very uncommon, since capital goods are fixed for a long time and cannot easily be adapted to changing needs. In particular, school buildings cannot easily be sold or utilised for purposes other than education due to their specific architecture. A substantial part of the inefficiencies is also the result of the fact that each classroom has a fixed capacity and will seldom be used to its full capacity due to the varying number of pupils in each class. Classrooms are constructed to shelter about a maximum of 30 pupils, but in practice will frequently be used only by 20 pupils or even less. Only in coincidental cases will the space in a school be used to its full potential. The long, small tail at the right side of Figure 2 reveals this aspect. Another explanation may be due to some special characteristics of the Dutch education system. Due to constitutional rights, parents can found new schools as they wish (and fulfil some requirements with respect to the number of pupils, etc.) based on religious or educational grounds. The government is obliged to fund these new schools and municipalities are responsible for providing school buildings. Although school boards cannot claim to have a school building of their own, it is quite common to have some physical separation in school buildings for different schools. This leads to extra inefficiencies.

5.3. Technical Change

Productivity also changes due to technical change. Figure 3 shows the relationship between productivity and time, reflecting productivity change due to technical change. The outcomes are calculated for schools reflecting an average size and average soil density.

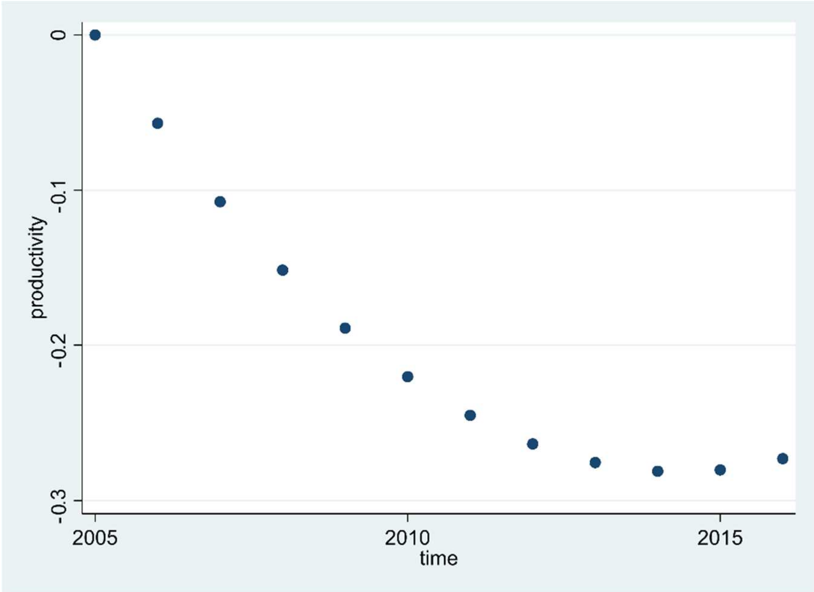

Figure 3. Productivity due to technical change, 2005–2016.

From Figure 3, we note that technical change is negative, indicating that over time more and more space has not been used efficiently. It also shows that this negative trend slows down over time and came to an end in 2015. Between 2005 and 2015, a loss of 28% in the productivity of school building productivity occurs. From this, we may conclude that incentives for productive building planning and management have been lacking.

6. Discussion and Conclusions

In this paper, we analysed the sustainability of local governments in providing school building capacity by applying a cost function model and the use of municipality data on the costs of school buildings and school enrolment.

From the results, we may conclude that school building planning and management in The Netherlands is far from productive. Small municipalities with low volumes of school building capacity and very large municipalities with high volumes show substantial scale inefficiencies. It is, therefore, recommended for small municipalities to collaborate on school building provision. From research regarding other public services, we know that collaboration may be very profitable [19,32,33]. In these cases, scale economies are materialised by collaboration instead of merging.

Even worse outcomes are related to technical inefficiencies. These inefficiencies amount to about 60%, indicating that substantial gains can be achieved. It must be noted that these outcomes may partly come from the special features of the educational process. Classrooms may not be used to their full extent due to varying class sizes. The number of classes may substantially vary over different school years and the use of the buildings is only limited to teaching hours during the day. Nevertheless, it must be emphasised that some municipalities do perform much better than other municipalities. These municipalities may be regarded as role models and other municipalities may learn from these role models.

Striking is the result that, in the period 2005–2015, municipalities experienced a decreasing performance each year. Finally, in 2015, we notice that productivity stabilised. There is obviously a lack of incentives for innovative behaviour regarding building planning and management. The fact that the negative trend is flatting out over the research period may be due to Bowen's Law. A free interpretation of Bowen's Law is that productivity change is inversely related with the available funding. In 2015, major reforms took place in the funding of local government associated with large budget cuts. These budget cuts were already announced at a very early stage. Probably, the municipalities anticipated these budgets cuts in the years before 2015.

Note that aside from the abundant use of materials during construction, the unproductive provision of building capacities also implies an abundant energy consumption and maintenance during its operational lifetime. From a sustainability perspective, a substantial reduction in raw materials and the emission of carbon dioxide during the construction process and period of operation can be achieved. In this paper, we only focused on school buildings, but we may expect similar results in the provision of government buildings, police buildings, prisons and courts. These would be fruitful avenues for future research.

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Economies of Scale and Sustainability in Local Government: A Complex Issue

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Abstract: Local governments may seek efficient public service delivery through scaling up production, and the quest for the optimal local government size has attracted extensive attention of scholars and policy makers. Indeed, if scale matters for local government efficiency, increasing size may be a key factor in achieving more value for money for citizens. As such, getting scale right may contribute significantly to achieving the Sustainable Development Goals (SDGs) as set out in the 2030 Agenda. Nonetheless, there is considerable uncertainty with regard to how scale shapes the average cost of local government service delivery. These uncertainties may have contributed to policy makers and public organizations disregarding the often inconclusive and sometimes contradictory empirical evidence in stimulating and allowing mergers and consolidation in many Western countries. This Special Issue is concerned with economies of scale in local government. Interesting issues to be addressed relate to the existence of general and service specific economies of scale and the implications of both for local government policy regarding various types of scaling (amalgamation, cooperation, and outsourcing). Based on a brief literature review, we inventory a number of issues which warrant further research. One of the conclusions is that the relationship between scale and sustainability is a complex issue with many aspects. Examples include the relation between economies of scale and outsourcing and cooperation, issues concerned with multi-level aspects of scale, and the trade-off that may exist between achieving economies of scale and cost efficiency (e.g., transition cost of mergers). Another conclusion is that no such thing as "one size fits all" exists. Different perspectives may play a role and should be born in mind when suggesting solutions and providing recommendations to achieve sustainable goals.

Keywords: local government; cost model; financial sustainability; environmental sustainability; economies of scale; economies of scope; collaboration; mergers; outsourcing; multi-level

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1. Introduction

One of the presumed key drivers of productivity growth that has significantly impacted public policy is the notion of economies of scale, the idea that public organizations, as is the case with firms and factories, can reduce the cost of public service delivery through size. Hence, getting scale right may contribute significantly to achieving the Sustainable Development Goals (SDGs) as set out in the 2030 Agenda [1]. Relevant goals set out by the SDG's are, for example, improving good quality of education, improving quality of health and well-being, and improving good sanitation.

The premise of economies of scale in public service production has given rise to consolidation waves across the entire breadth of the public sector in, amongst other countries, The Netherlands, including local governments, police departments, courts, education, and health care [2]. Increasingly, public organizations are also seeking economies of scale through less drastic measures such as outsourcing, jointly or otherwise, or combining back-office functions in IT and procurement. In recent years, the continued scaling of public service production has come under increased scrutiny, with many questioning if, and to what extent, the promise of "big is beautiful" has held up. This Special Issue is concerned with economies of scale in local government and seeks to contribute to the large and long-standing literature in this area. Attention will be given to how various mechanisms through which local governments seek economies of scale—e.g., amalgamation, cooperation, and outsourcing—are effective for cost reduction and financial sustainability in the long-term.

Particularly, key to this Special Issue is the recognition of "scale" as a multi-level concept. Multi-level here relates to the recognition that there are more levels of scale beyond the administrative boundaries of local government that matter for economies of scale. For example, many organizations are organized into smaller sub-organizations, such as locations, teams, or plants. It may well be that economies of scale are achieved at these lower levels within the organizations. A second example relates to the multi-product or multi-service nature of many organizations. For example, local governments provide a heterogenous set of services ranging from capital-intensive services such as waste collection to more labor-intensive services such as health services. Different products or services may be characterized by different cost structures and vary with regard to economies of scale. Aside from this there might also be a variation in the diversity of services delivered which in turn may also affect the cost. In turn, this implies that the effect of organizational consolidation between local governments on cost varies across services and size.

In this Special Issue, we focus on financial sustainability, but it should be stressed that it is not only about the money. As was mentioned earlier, financial sanity also implies good health care and education. Since local governments also spend a lot of money on infrastructures, such as housing, school buildings, public libraries, museums, theatres, and roads, efficient behavior may also lead to the achievement of climate goals in reducing fossil energy and the emissions of greenhouse gasses.

The outline of this contribution is as follows. In Section 2 we discuss the concept of economies of scale and scope. Section 3 provides a brief overview of the role of economies of scale in the literature on productivity and efficiency in local government. In Section 4 we identify different gaps in the literature on scale economies in local government, which some of them are addressed in this Special Issue. We briefly discuss the contributions to the Special Issue.

2. Theory: Economies of Scale and Scope in the Public Sector

Economies of scale are a well-documented concept rooted in traditional production economics. Economies of scale exist when the average cost of producing a good or service fall when output is expanded. Economies of scale may exist due to, for example, indivisibilities of capital, fixed cost, increased utilization rates of fixed assets, labor specialization, or discounts in bulk-purchases. Increasing scale may also invoke upwards pressure on average cost as firm hierarchy and complexity arises and concerns over bureaucracy increase [3]. When negative effects offset the positive returns to scale, diseconomies of scale persist. Schumacher [4] also pointed out this turning point eloquently in his famous work "Small is beautiful": "*In contrast, most of the sociologists and psychologists insistently warn us of its inherent dangers—dangers to the integrity of the individual when he feels as nothing more than a small cog in a vast machine and when the human relationships of his daily working life become increasingly dehumanised; dangers also to efficiency and productivity, stemming from ever-growing Parkinsonian bureaucracies.*" It is therefore commonly assumed that average cost is "U"-shaped, which indicates that, from an average cost perspective, there exists an optimal scale of production [5]. Figure 1 contains an example of a U-shaped average cost curve.

The tipping point, shape, and slope of the average cost function of production, however, depends on the characteristics of the product, service, and organization in question. In the public sector specifically, two main mechanisms for driving economies of scale have been put forward most prominently [6,7]: labor specialization and fixed cost of certain assets. Diseconomies of scale are typically ascribed to bureaucratic congestion as the required coordination and complexity increases as output volumes grow.

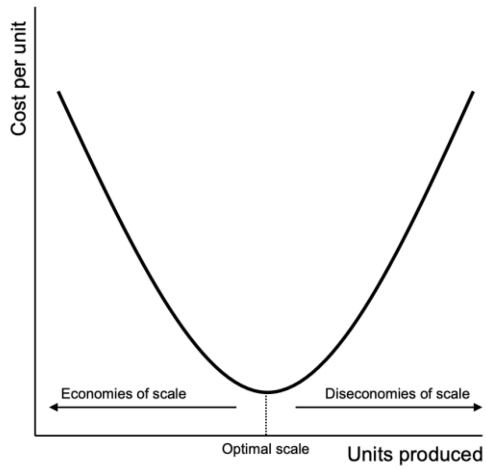

Figure 1. U-shaped average cost curve (Source: own elaboration).

Public organizations can seek economies of scale by altering the scale of production. Roughly four scaling mechanisms can be distinguished: (1) consolidation through merger or amalgamation, (2) joint production (cooperation), (3) outsourcing, and (4) organic growth [8].

(1) First and foremost, there is the "big stick" approach of merger, in which two or more previously independent organizations are merged into one new, bigger organization. In addition to affecting cost through scale, mergers may also impact short-term and long-term cost efficiency as a result of transition costs. In theory, these effects need not be negative, as mergers may also allow for eliminating inefficiencies, for example by adapting the best governing practice of the merging organizations. Consolidation can also take place between sub-units of organizations. An interesting case emerges when mergers also lead to the provision of a more diversified set of services. In that case, economies of scope may also occur, where economies of scope are defined as the benefits coming from dividing fixed costs over more different services instead of providing more services. This may arise when the merger affects the type of services provided by a local government.

(2) The second mechanism is cooperation. Two or more organizations can choose to embrace in the joint production of public service delivery. In theory, this allows them to achieve economies of scale in those areas where they may be most prominent, e.g., in capital-intensive or highly standardized services. However, potential downsides include the monitoring cost of governing the cooperation agreements, the cost of aligning processes, and free-rider behavior.

(3) Third, for the same reasons as under 2), local government may choose to outsource services to larger scale private parties, since they are not able to benefit from scale economies themselves. Examples are public transport, road construction and maintenance, and waste collection. Local governments can collaborate in a joint tender to private parties to enforce their market power to absorb a part of the scale economies of the private party.

(4) Fourth, organization size may change due to organic growth. While such trends are often insignificant in the short term, they may have significant effects in the long run. Local governments may increase population at the cost of another, or the (average) population may be affected, changing the overall national population.

3. Local Government Scale: A Brief Literature Review

In seeking efficiency gains in the delivery of local public services, many countries have pursued a long-term policy of local government amalgamation. As a result, the number of municipalities in the Netherlands, for example, has steadily decreased from 1015 in 1950 up to 355 in 2019. The policy backgrounds of Dutch local government amalgamation is well-documented [9–11]. Economies of scale are considered the main underlying assumption driving local government amalgamation. A more recent trend is that of local governments also seeking economies of scale in specific services through joint production via inter-municipal cooperation. The popularity of inter-municipal cooperation is on the rise in European countries and saving cost is often a key motivation [12].

The quest to determine the "optimal" scale of local government jurisdiction has attracted considerable attention of researchers across many disciplines. Essentially, the trade-off between small and big is debated over arguments that favor accessible, approachable local governments and involved citizens on the one hand, versus big, cost-efficient governments on the other hand. Indeed, economies of scale seem to be the dominant argument in favor of increasing local government size [6,13].

There is a large literature that empirically analyses economies of scale in local government. Essentially, these studies revolve around regressing measures of cost on measures of (output) size to fit cost functions. Applications started emerging over sixty years ago [14]. A distinction can be made between studies that focus on the overall, local government level and those that focus on the analysis of specific services [15], such as waste collection, road maintenance, or administration. In the analysis at the local government level, by far the most common measure of output size is population count, despite being considered a poor measure over local government output [16]. Service-specific studies have seen far more detailed and accurate output measures used than population count, such as kilograms of waste collected, the length of the road network maintained, or the number of taxes invoiced. Often, economies of scale are reported as a by-product of the more general analysis of local government efficiency (see [17,18] for extensive, recent overviews of the local government efficiency literature), which use so-called frontier techniques such as Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) to estimate cost functions. Regarding economies of scale and efficiency, Dutch local governments are relatively understudied; although, some studies have emerged recently [19–21].

By now, several articles have surveyed (parts of) the empirical literature on economies of scale in the provision of local government services [6,16,22–25]. Foremost, despite its size, the literature is described as inconclusive and in cases, contradictory [23–25]. In review of the existing evidence, Blom-Hansen et al. [6] noted that the "the empirical literature on the effects of municipal mergers has failed to identify systematic patterns that hold across time and space". On the basis of an extensive, international comparison of empirical studies Holzer [24] concluded that municipalities with populations less than 25,000 may still increase efficiency, although, dependent on context, and mostly restricted to specialized, capital-intensive services. Over 250,000 inhabitants, there is more consistent evidence suggesting that diseconomies of scale persist [24]. Local governments provide a heterogeneous set of services and it is indeed recognized that some services are more subject to economies of scale than others. In particular, economies of scale are more likely in capital-intensive services due to the associated fixed cost [6,14,16,24,26–31] and in highly specialized, seldomly used services where there is room for labor specialization [6,24]. Surprisingly, mechanisms underlying potential diseconomies of scale in local government services have been discussed to a lesser extent. As mentioned before, diseconomies of scale are typically discussed over bureaucracy concerns [3,26,32]. Diseconomies of scale due to bureaucratic congestion occur when the required inputs for coordination increase disproportionally as output volumes increase. Arguably, high-complexity services may be subject to more pronounced diseconomies of scale, but there is little literature on the moderating factors driving bureaucratic congestion in local government, and thus, why some may be more subject to bureaucratic congestion than others. In summary, the three key mechanisms underlying economies of scale are: (1) fixed cost, (2) specialization, and (3) bureaucratic congestion.

A more recent strand of literature exploits within-municipal variation resulting from amalgamation reforms implemented in several countries, including the Netherlands, Denmark, and Israel. These studies allow for a more causal identification of the relation between scale and cost as they observe actual changes that occur after amalgamation, as opposed to the cross-sectional and correlation analysis of economies of scale prevalent in the literature discussed before. The picture arising from these studies is that amalgamation has not led to a systematic decrease in spending in the Netherlands [33] and Denmark [6]; although, evidence for positive merger effects were found in Israel [25]. Regarding Denmark, indeed, cost savings in some services (roads and administration) were offset by cost increases in other areas (labor market services and culture), although most services remained unaffected [6]. Regarding inter-municipal cooperation, a relatively recent phenomenon, researchers are increasingly investigating whether cooperation is an effective reform for reducing cost. Emerging literature on the matter indicates that cooperation can be effective in decreasing cost, but there are some contradictory results (for an extensive and recent overview, see [34]). Recent applications in the Netherlands suggest that inter-municipal cooperation has been effective in decreasing cost in tax collection, but not in other service areas [21,35]. Again, these results highlight the relevance of local government service heterogeneity with regard to economies of scale. In particular, economies of scale through cooperation seems more achievable in capital-intensive services that pose little risk for bureaucratic congestion as output volumes grow. Regarding local governments engaging in outsourcing and privatisation, there is a considerable literature which has indeed suggested economies of scale as one of the key underlying mechanisms [36].

4. Research Challenges

As outlined above, many public organizations are seeking the efficient delivery of public services through scaling up production, and the quest for the "optimal" size of public organizations has attracted extensive attention of scholars and policy makers. Nonetheless, there still is considerable uncertainty surrounding the relation between scale and cost in local government and the determinants that drive this relation. Two important factors that bedevil the analysis of economies of scale are the fact that the output of public organizations is often hard to measure, and the multi-level nature of scale, with no single measure of scale doing justice to the (often complex) nature of public organizations. In studying the relation between scale and cost, researchers commonly measure scale at the firm size, e.g., the administrative unit of a local government. Blom-Hansen et al. [6] explicitly discussed this with relation to local government and distinguish the "firm" (local government) and "plant" size in, e.g., child care centers, libraries, and residential homes for the elderly, and argued that scale effects actually arise mostly at the lower (plant) level of the organization. In order to get an impression about the complexity of the organizational structure of services supply we present a number of diagrams of organizational structures that are common practice on local government services supply.

Figure 2 shows the most elementary form of service supply. Departments within the municipality are responsible for services supply. Examples are, for instance, the provision of official documents (passports and licenses) and the provision of social allowances. Figure 3 represents a form of decentralized service provision. The local government subsidizes private institutions represented by boards, such as school boards Figure 4 represents a form of super-centralized service supply. Services are supplied by a supra-local body, such as the biggest municipality in the cooperation or by a third party contracted by the cooperation.

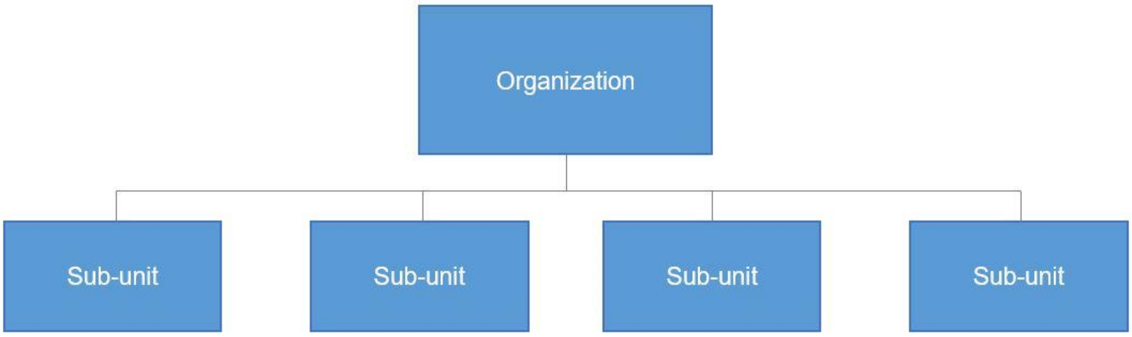

Figure 2. Centralized government service supply (Source: own elaboration).

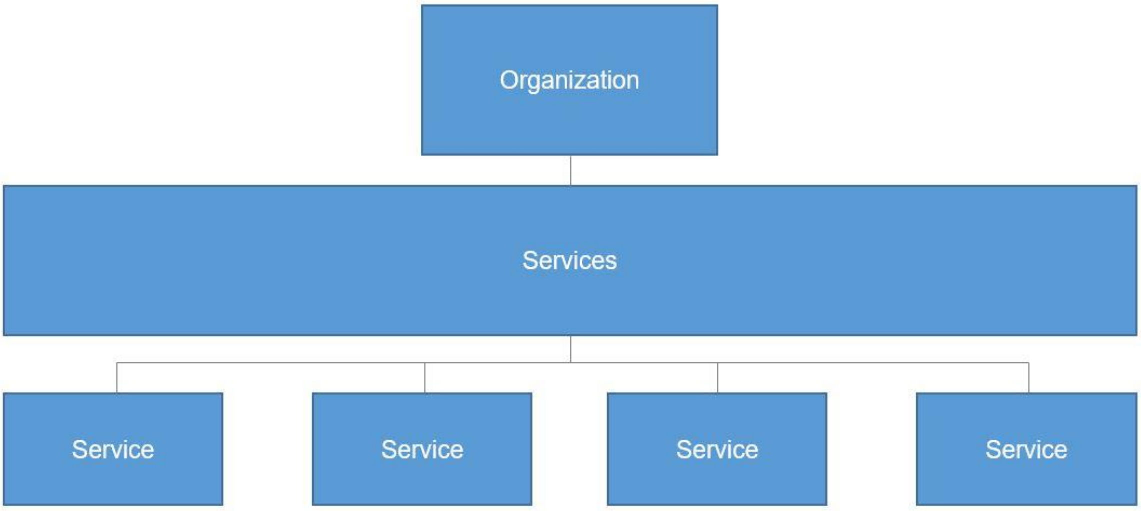

Figure 3. Decentralized government service supply (Source: own elaboration).

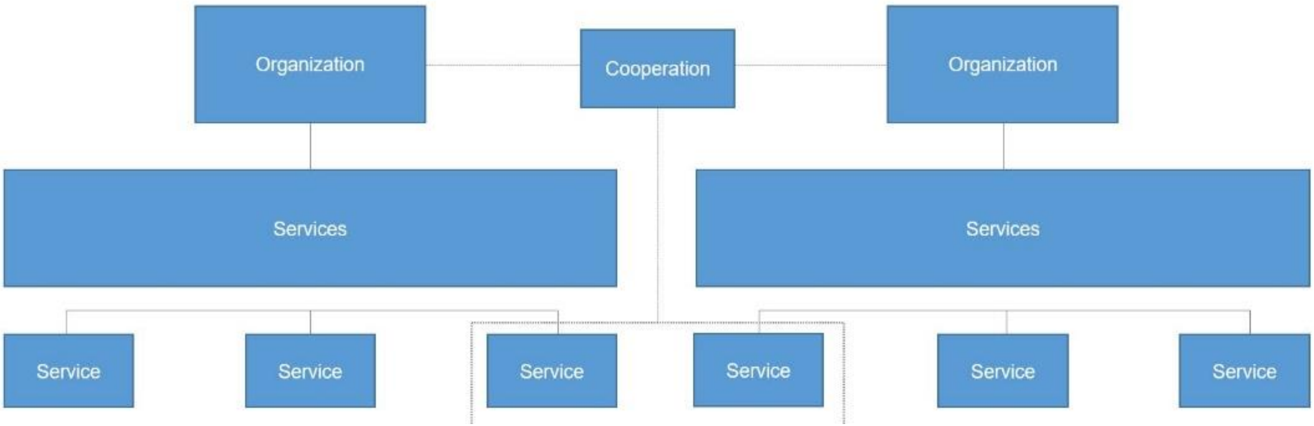

Figure 4. Government service supply by cooperation (Source: own elaboration).

Aside from the multi-level issue itself—which level are we analyzing—another complex issue arises when different levels are interacting. To illustrate this point we refer to study of Blank et al. [37] that analyzed whether concentrating emergency departments of hospitals is beneficial. They showed that economies of scale at this level indeed exist but are offset by diseconomies of scale at the hospital level resulting from their taking on more patients. Another interesting case regarding different scale levels can be found in the provision of education, which revolves around the distinction between *school* and *school board* size. Arguably, economies of scale may arise at both levels. Generally, driven by data limitations, existing empirical applications investigate scale effects only with regard to either school, or school board (or district) size. The challenge in both aforementioned studies is to incorporate multiple scale measures in one single model, instead of analyzing at one specific level. These conceptual difficulties may well have contributed to policy makers and public organizations disregarding the often inconclusive and sometimes contradictory empirical evidence in stimulating and allowing mergers and consolidation. The aim of this Special Issue is to narrow this research gap by addressing the relation between economies of scale and consolidation in local government. Some of the relevant research questions are:

- Are local government services subject to economies of scale, and is there heterogeneity across services?
- What is the relationship between local government amalgamation, economies of scale and cost?
- What is the relationship between inter-municipal cooperation, economies of scale and cost?

In the context of cooperations, municipalities may import economies of scale, thus benefitting from the larger scale of the cooperation. This implies that the scale at which a municipality produces differs from the scale of output of the cooperation. A proper modelling of this relation contributes to identifying to what extent scale effects can be imported and whether cooperation is associated with transaction costs, i.e., costs that arise due to increased bureaucracy and required alignment. The corresponding research question is:

- To what extent can local governments achieve service-specific economies of scale through inter-municipal cooperation or outsourcing, for instance to private enterprises?

An aforementioned interesting case refers to the distinction between *operational and board* size. More generally, regarding the multi-level aspect of scale, the most convincing analysis of economies of scale is one that incorporates the size indicators of all relevant operational units in the production process. For example, an analysis of economies of scale in the provision of education by local governments ideally incorporates measures of class size, school size, and the administrative size of the local government. The relevant question here is:

- How can we distinguish between the scale effects of different organizational or administrative levels and integrate them into a framework to assess the efficient size range configuration of each level?

An interesting issue also arises from the cost effects of implementing scale policy measures, in terms for instance in transaction and transition costs. These types of cost may affect cost efficiency for quite some time. Merger may take some time to be fully implemented and may come with substantial extra costs. The analysis should therefore account for these cost efficiency effects as well. The corresponding research question is:

- To what extent do scale policy measures, such as amalgamation and cooperation, affect cost efficiency (other than through scale itself), both in the short- and long-term?

5. Contributions to This Special Issue

Takeshi Miyazaki [38] conducted research on the effects on expenditure of the designation of cities (core or special case cities), thereby giving more freedom to be active in a wider range of services. The author stressed the fact that a larger municipality not only benefits from economies of scale, but also from economies scope or diversification. However, he showed that there is hardly any proof of (dis)economies of scope in public services provided by local governments. In the provision of public services by general local governments, economies of scope could not be established in the short term (2–3 years), but did appear in the mid- to long-term. After the delegation of duties, per capita expenditure for core cities increases by 2.8% immediately after the designation, but then decreases by 0.6% annually.

One of the issues addressed in Section 4 and in a recent study of Niaounakis [8] concerns the large variety in economies of scale between the different municipality functions. An interesting example of substantial economies of scale is presented in this Special Issue by Bernadelli et al. [39]. The authors analyzed economies of scale in municipal administration in the Paraná state local government system in Brazil over the period 2006 to 2018. They found that there is a U-shaped scale effect between council size by population and administrative intensity after controlling for a range of economic and social variables. Economies of scale in municipal administration provide empirical evidence for municipal mergers, since small municipalities expend a larger share on administration than large municipalities. The presence of scale economies in administrative services also favors creating shared services in municipal administration without the need for expensive merger transitions and the abolishment of small municipalities.

In their contribution to the Special Issue, Blank and Niaounakis [40] addressed the issue of economies of scale and the multi-layer aspect of services. One of the main questions for local governments concerns the optimal configuration of administrative layers. In particular, they focused on the optimal size of school boards and optimal size of schools. They analyzed the relation between cost and scale in school boards and in schools simultaneously. The influence of both the governing layer (board) and the operational layer (school) on average cost are jointly modelled. They applied their model to Dutch primary schools. The results indicate that small schools (<60) pupils are operating under sizable economies of scale. The optimum school size is estimated at roughly 450 pupils, but average cost remains roughly constant with regard to size. In contrast to school size, the effect of board size (in terms of the number of schools governed) on average cost is limited. The policy recommendation is that municipalities should create schoolboards with at least three schools within their jurisdiction and take measures in case individual school size declines below 60 pupils.

Blank [41] presented an analysis of the efficiency and productivity of the provision of school buildings by Dutch municipalities. A cost function is estimated for the years 2005–2016 using stochastic frontier methods based on data of Dutch municipalities. In his contribution Blank made an explicit connection between financial and environmental sustainability. Building operations and construction are responsible for a large part of global energy use and carbon dioxide emissions. This implies that more efficient provision of school buildings may serve financial as well as climate goals. The results indicate that inefficiency and non-productiveness are substantial among Dutch municipalities. Provision of school buildings on a more appropriate scale (mostly larger scale), detailed performance benchmarking, and including more incentives for innovative behavior may result in a more sustainable provision of school buildings and less energy use and emission of carbon dioxide.

6. Discussion

Although there is an extensive literature on economies of scale in local government, the literature has been described as inconclusive. As such, it has proven hard to provide policy makers and public managers with consistent recommendations regarding the efficient size of public service delivery in local government. This Special Issue aims to contribute to the literature on local government economies of scale and pays particular attention to the conceptual complexity regarding scale. The focus of this Special Issue is strongly directed towards financial sustainability, but in many cases, this goes hand in hand with environmental sustainability, as was pointed out in one of the contributions. Many of the services produced by local government are directly related to infrastructural works, such as school buildings, public libraries, roads, public transportation, and so on. Efficiency improvement in these services may also lead to lower energy consumption and emissions of carbon dioxide. It must therefore be stressed that in many cases efficiency and sustainability do not conflict. In case they do, efficiency and sustainability can easily be aligned by merely including sustainable outcomes, such as low emissions, into the efficiency framework.

In a number of contributions, the Special Issue recognized that economies of scale vary between the heterogeneous services local governments provide (multi-service) and between different vertical hierarchical levels within local governments (multi-level). Aside from the number of services produced per type of services another issue related to scale has a relevant impact. Differences in size may also imply a difference in function of the municipality. Cities have a strong appeal on people and business coming from outside the municipality and may therefore affect the types of services delivered. In these cases, the scope of services provided correlates with scale. This, in turn, may have important methodological implications for the analysis of economies of scale and the implications drawn for the optimal scale policy of local governments.

Instead of searching for the holy grail of an optimal organizational scale we would like to raise the awareness amongst researchers, policy makers, and politicians about the complexity of the scale issue in the context of local government performance. There is obviously no such thing as one size fits all. Different perspectives may play a role and should be borne in mind when suggesting solutions and providing recommendations to achieve sustainable goals. Although some of the questions raised will be foreseen with clear cut answers in this Special Issue, others, however, will still be unresolved and requires further research. The research agenda may follow the different perspectives aligned with the conceptual framework presented in this paper and fill in the knowledge gaps accordingly.

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