School district consolidation: Scale economies and the optimal scale of education. Evidence from Flanders.

Kristof De Witte*#, Fritz Schiltz§

* *Katholieke Universiteit Leuven (KULeuven),*
Faculty of Business and Economics, Naamsestraat 69, 3000 Leuven, Belgium
 # Maastricht University, Top Institute for Evidence Based Education Research (TIER),
Kapoenstraat 2, MD 6200 Maastricht, The Netherlands
§ Katholieke Universiteit Leuven (KULeuven),
Faculty of Business and Economics, LEER department
Naamsestraat 69, 3000 Leuven, Belgium

Correspondence: fritz.schiltz@kuleuven.be

This paper investigates the relationship between school district size, cost per student and variables measuring the performance of school districts. Based on a comprehensive panel data set covering 1075 school districts (2009-2012), our findings indicate sizeable potential cost savings from consolidation of school districts, especially at the lower tail of the district-size distribution. In order to disentangle scale economies due to class, school, and district size, we apply our cost model to disaggregated cost data, controlling for a wide range of district socioeconomic characteristics. We show that assumptions on the functional form strongly affect the estimated scale economies and offer two possible extensions to allow more flexibility in the estimation method. Estimation of these extended models identifies school district structure and managerial practices as decisive determinants of possible cost savings through consolidation. Although our application is limited to compulsory education in Flanders, our methodology can be easily extended to other countries or non-profit sectors looking for reduced per unit costs.

Keywords: economies of scale; school district consolidation; costs; educational economics

We are grateful to participants of the 2nd Workshop on Economics of Education in Maastricht, organized by the Top Institute for Evidence Based Education Research (TIER), for many useful comments and remarks.

1 Introduction

In the educational economics literature, many research efforts have been dedicated to identifying drivers of student outcomes (in both primary and secondary schooling). In this paper, we shift attention towards cost efficiency of school districts. By identifying the cost-minimizing scale to organize education at the district level, we can check the consistency of findings in the literature mainly focusing on research in the US (Luyten, Hendriks, & Scheerens, 2014).

The available literature can be divided into three broad types of size effects in education. First, class size effects (pupil-teacher ratios) are thoroughly studied, leading to a general agreement on significant advantages of smaller classes, especially with respect to students characterised by a lower socio-economic background (e.g. Angrist & Lavy (1999)). In contrast to class size effects, the branch of the economics of education literature focusing on school-size effects finds possible economies of scale when increasing the number of students per school. Again, not all students equally benefit from these increases in school size. Students with low SES are argued to benefit most from an education in relatively small schools (Leithwood & Jantzi, 2009; Luyten et al., 2014). Therefore, a study by Bickel & Howley (2000) stressed that school size is contingent on student and neighbourhood characteristics. Hence, the authors are sceptical with respect to the "optimal" school level in education. A third branch of the literature studies scale effects at the school district level. This aspect of economies of scale in education has received much less attention compared to class and school size effects. However, school district organizational aspects are increasingly gaining attention in the literature and amongst policy-makers.

Reorganization and professionalization in the public sector is a hot topic, following a shift towards optimization suggested in theories coined 'New Public Management'. The result is a tendency to increase professionalism by enlarging the scale of operations in public sector entities (Alonso, Clifton, & Díaz-Fuentes, 2013). This observed trend is spreading towards education (Jarl, Fredriksson, & Persson, 2012). Bloom, Lemos, Sadun, & Van Reenen (2015) suggest management practices as an explanation of inter- and intra-country differences of educational outcomes. In their study, one of the main drivers of these management practices was the degree of accountability to an external governing body. This governing bodies corresponds to the school board in control of a set of schools, a 'school district'. Other studies also indicate the importance of school district characteristics on student and financial outcomes directly (Bidwell & Kasarda, 1975; Heinesen, 2005; Saatcioglu, Moore, Sargut, & Bajaj, 2011), or indirectly through (e.g.) teacher absenteeism (Theobald, 1990) and management practices (De Witte & Schiltz, 2015). Because of the importance of school board characteristics, we decided to perform our analysis at the district level.

This paper attempts to estimate the optimal district size to organize education using Flemish administrative data. Although district size reflects only one aspect of school district governance, the literature indicates a strong connection between district size and school board organizational characteristics (Sleegers, Bergen, & Giesbers, 1994). Hence, identifying the optimal scale of education could support further research linking efficient management practices of these 'optimal districts' to school board characteristics (De Witte & Schiltz, 2015). We analyse (operational) cost data to identify this optimum by exploiting the specific funding mechanism of education in Flanders and its broadly heterogeneous educational landscape. This funding scheme was introduced in 2008 and designed to target students with a low socioeconomic status (SES). Based on a weighted[1] sum of the number of students in a school, resources are awarded by the Flemish government to the corresponding district. Importantly, from then on, school districts receive full autonomy over the allocation of these resources across its schools, emphasizing the need to determine the school district as our unit of analysis.

We focus on the cost of education since more detailed data is available with respect to costs in contrast to student outcomes, due to the absence of standardized test scores in Flanders. As we will point out in our review of the literature, cost functions are methodologically more developed compared to the methods used to estimate production functions (Andrews, Duncombe, & Yinger, 2002). However, as we will also argue, more flexibility in specifying the functional form is still needed to obtain robust estimates of the optimal district scale and its decisive determinants.

Results in the literature are mixed and strongly connected to the educational context of the studies[2]. Therefore, Luyten et al. (2014) argues that more research outside the US is needed to strengthen policy recommendations with respect to school district consolidation and the optimal scale of education. The freedom of education in Flanders offers the possibility to perform a robustness check of earlier studies on optimal district scale in educational systems that are organized in a more top-down manner (e.g. US, Denmark). In Flanders, anyone can freely go to any school, founded by anyone (if this school is subject to a set of criteria). Also, school districts are not geographically based and only differ in their organizational characteristics.

This paper makes several contributions to the literature. First, we apply a wide variety of cost function specifications. Our models include quadratic and translog cost functions. To allow more flexibility, we extend these models by adding a Fourier parametric cost function, the most flexible parametric approach available. This paper is the first in analyzing the available data using a Fourier extension to identify the optimal scale of school districts. Fixed effects estimation of these functional forms allows us to identify the major determinants of economies of scale in education and, more importantly, the optimal school district size. Second, we apply these state-of-the-art techniques to (panel) data from schools and districts in Flanders. In doing so, we are able to strengthen findings in the international (mainly US) literature, and assess the importance of context-dependencies in estimating the optimal district size, as stressed in (Luyten et al., 2014).

The remainder of this paper proceeds as follows. The following section presents an overview of the literature. In doing so, we motivate the need for a more flexible approach to identify the most efficient scale of education at the district level, applied to 'non-US' data. The next two sections present the available data and introduce the different specifications used to estimate this

[1] The weights are called 'points' and are assigned corresponding to a set of socio-economic characteristics (mother tongue, parental employment status, immigrant status etc).

[2] Notably in production function studies. More consistency is observed in studies estimating cost functions, although context-dependency remains vital. We will present the general findings in *Literature review*.

optimum. Section 5 summarizes the obtained results both numerically and graphically. Section 6 concludes.

2 Literature review

This section presents the available literature with respect to scale effects in education (at the district level). First, we present the main findings in two important reviews of this literature (Andrews et al., 2002; Fox, 1981). We mainly focus on studies estimating scale economies using cost functions but we also briefly touch upon production function studies to describe the similarities and discrepancies in these two approaches. Finally we review some more recent studies (both cost- and production-oriented) to motivate the need for more research on district size.

As indicated in the introduction, studies on the optimal size of education are abundantly available, especially at the school level (e.g. Stiefel et al., 2000). A study by Lewis and Chakraborty (1996) estimated the relationship between scale variables and the cost per student. The authors concluded that "when both [school size and district size variables] are included in the regression equation, only school size is significant. Consolidation of schools, not districts, may be the key to achieving lower per unit costs.". Another study by Duncombe, Miner, & Ruggiero (1995) also included both school and school district size[3] and their results indicated sizeable potential cost savings by consolidating (especially small) school districts.

This conflict in results between both studies might be due to either the context-dependency of the conclusions, as indicated by (Leithwood & Jantzi, 2009; Luyten et al., 2014), or it might be due to differences in the chosen cost function specification[4]. Already in a review by Fox (1981) the significant variation in results was emphasized. Fox argued that methodological improvements could improve the consistency in findings with respect to returns to scale in education. A more recent review of the literature by (Andrews et al., 2002) concluded that more uniformity in results was observed in post-1980 studies. In general, the available research suggests sizeable cost savings in the smallest (around 500 students) school districts. Cost savings are the largest until the size of 2000-4000 students per district. Once a threshold of approximately 6000 students is reached, costs per student tend to stop declining and diseconomies of scale can be observed in the largest districts.

[3] The authors included the median school size within the evaluated district to capture the extent of district school centralization.

[4] For example, Duncombe et al. (1995) assume a parabolic function by including students per district squared as an additional variable while Lewis and Chakraborty (1996) estimate a log-log relationship.

In contrast to the production function literature, which is not at all consistent in its scale-related findings[5], major methodological improvements have been made with respect to cost function specifications. Most studies assume a quadratic function and include a measure of school size to disentangle district and school size effects. Others have estimated a translog cost function which adds flexibility by including a number of interaction terms. As indicated before, the specific 'costs and benefits' of consolidation are strongly related to socio-economic background of students (Friedkin & Necochea, 1988). However, studies estimating a translog function have not indicated a statistically significant role for interaction terms between SES, district size and costs per student (e.g. Callan & Santerre, 1990). To account for district-specific effects, panel data can be used (Downes & Pogue, 1994). Other approaches include adding an efficiency term (DEA) as a control variable (e.g. Duncombe, Ruggiero, & Yinger, 1995) or using stochastic frontier regression methods (SFA) (e.g. Johnes & Johnes, 2009). Applying these extensions resolves endogeneity issues due to the simultaneity between district size and quality (Driscoll, Halcoussis, & Svorny, 2003)[6]. Hence, when analyzing the results, we will apply SFA as an additional robustness check. A final advance in the literature has been a separation of the analyses for different types of costs. In doing so, a more flexible approach is followed by allowing different relationships between costs and size (e.g. distinguish between operational and total costs).

Despite improvements in the theoretical framework and methodology, Andrews et al. (2002) argue there is still room for progress in the available literature. More flexible functional forms are needed to minimize the assumptions made on the data. Additionally, studies using panel data are suggested to account for these district-specific effects. The majority of studies on economies of scale through school district consolidation have analyzed cross-sectional data. Some recent (production function) studies applied these suggestions (e.g. Driscoll et al., 2003; Heinesen, 2005; Jones, Toma, & Zimmer, 2008) while others tackled the issue of district size from a different angle using political economy models. Public choice theories point at diseconomies of scale through consolidation due to increasing bureaucracies (Gordon & Knight, 2008; Robertson, 2007) or indirectly through an increase in bargaining power of teachers' unions (Rose & Sonstelie, 2010). Public choice theory has been widespread in the economics of education literature (e.g. Moe, 1984; Strang, 1987) and can be seen as complementary to the explanations presented in this paper focusing on school district organizational structures.

[5] In most production functions, school or district size has been included as a secondary control variable. Only a small number of studies considered size as determinant. For simplicity, most papers specified a linear functional form, which stands in stark contrast with more flexible forms in cost function studies (Andrews et al., 2002). The discrepancy in results between two strands of the literature might be due to the differences in estimation methods. A more recent study by (Heinesen, 2005) released all functional form assumptions by including size-dummies resulting in scale economies similar to those observed in the cost function literature.

[6] We would like to thank Jill Johnes for this useful comment during the 2nd Workshop on Education Economics, Maastricht, March 2016.

3 Data

We use administrative data at the district level covering all[7] (1075) school district in Flanders during the 2009-2012 period. As noted in the introduction, school districts are not organized on a geographical basis but merely differ by the provider of education. This provider can be the local community government, an independent provider (e.g. Catholic education) or the Flemish government. All providers are free to organize schooling and are funded correspondingly, either direct (if organized by the Flemish government itself) or indirect, through subsidies. The available funding can depend on the type of provider and hence dummies are included in all regressions to capture these differences[8]. Students can freely choose between schools and districts resulting in rivalry among schools both within and between districts. This dual freedom of education creates a very heterogeneous educational landscape within a relatively homogenous and small area, Flanders. Figure 1 presents a histogram to illustrate the dispersion in district size. More than half of the districts are smaller than 500 students, while outliers also exist at the right tail of the distribution (17383 students in the largest district). More detailed descriptive statistics related to district size and other variables will be presented in Table 1.

Funding is allocated by the Flemish government to each district, reflecting the number of students in a district, weighted by their socio-economic characteristics. In our analysis, the

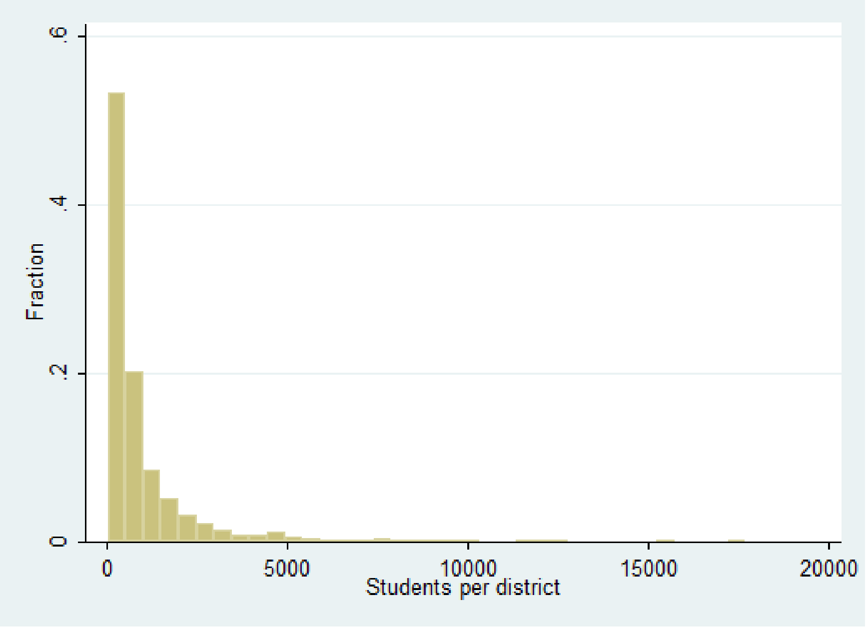

Figure 1: Students per district as a percentage of the population of school districts in Flanders.

[7] In total, there were 1099 school districts in Flanders in 2014. However, some districts were established after 2012 and others were eliminated from the data due to errors in the data. We also dropped some districts due to their very high degree of centralization and different organizational entity structure ("AGB Antwerpen"). All subsequent analyses were replicated including these observations and remain valid. However, including these districts would strongly alter summary statistics.

[8] When estimating a fixed effects regression, these dummies are omitted and district-specific characteristics (including the type of provider) are captured by the constant term.

dependent variable is chosen to be operational costs per student, aggregated at the district level. The natural logarithm of this variables is taken in order to mitigate the effect of possible outliers. Independent variables are selected based on the literature and include both control variables and possible determinants of costs per student in a district.

First and foremost, we include size variables measuring the number of students per district, per school, and per class[9], all expressed in logarithms.

Second, we control for school district structural characteristics influencing the cost of education. Dummies indicate whether a school district offers only education at the high school level (=1) or also other levels (=0) like primary schooling. If schools within a district also offer some sort of VET schooling, the VET dummy equals 1 and 0 otherwise. A third measure of district structure is captured by Herfindahl and Gini indices applied to school districts with schools being the 'market players' and the number of students reflecting the 'market share'[10].

Third, we include variables with respect to the environment to account for differences in student compositions. A measure of population density is constructed using data related to postal codes of schools belonging to the same district. This measure is included to take the sizeable differences in the cost of schooling between urban and rural areas into account (Kenny, 1982). A second environmental variable indicates the percentage of students whose mothers' education is at most a high school degree. A third variable indicates the percentage of students receiving additional support ("GON students").

Our final set of variables consists of school district personnel characteristics. We include variables measuring the percentage of teachers younger than 35 years old, the percentage of teachers holding a master's degree and the percentage of teachers being absent during a given year. Teacher absenteeism can serve as a proxy for school district management (De Witte & Schiltz, 2015), which in turn affects student outcomes (Bidwell & Kasarda, 1975)[11]. By including this variable we are able to account for quality differences between districts, and hence avoid the endogeneity issues mentioned by Driscoll et al. (2003). As a robustness check of our results, we will also apply SFA methods in the next section. Other (time-invariant) unobservable district-specific characteristics are captured in the fixed effects term as a result of estimation using panel data. Year dummies are included to control for general funding changes over time.

---

[9] School and class size variables were obtained by taking the averages across all schools and classes within these schools belonging to the same school district.

[10] These indices have also been applied in order studies to capture the degree of competition (e.g. Hoxby, 2000). We only calculated these measures within every district so it cannot be interpreted as a measure of overall competition.

[11] A study by Ehrenberg, Ehrenberg, Rees, & Ehrenberg (1991) directly links student achievement to teacher absenteeism.

Table 1 summarizes the data for all variables and districts[12]. Resources per student do not include teacher wages (which are funded in a centralized way) and are therefore only around 750 euros per year. Total and operational costs do not differ significantly on average and at the median, but large differences can be seen at the maximum. Additional resources, not included in operational costs, are targeted at some school districts to cover expenses linked to student background and the type of education, irrespective of scale. Therefore, in the remainder of our analysis, we will mainly focus on operational costs.

District size is measured as students per districts[13] and is extremely heterogeneous, as indicated in Figure 1. On average, school districts consist of 1020 students while less than half the districts is larger than 500 students, indicating a skewed distribution. Schools and classes are around 300 and 20 students on average, respectively. Despite some outliers at the maximum, these distributions are less skewed, with mean and median levels close to each other.

Approximately 20 percent of districts are located in urban areas, indicated by a population density above the average value. The majority of school districts offer other levels of schooling (e.g. primary schooling) apart from high schools, and around one in three also provides some type of VET schooling. Gini and Herfindahl indices reflect a great variation in school district structure ranging from 0 to 1. In subsequent analyses only the Gini index is included since both measures are strongly correlated ($\rho = -0.994$).

'Maternal education' and 'GON students' are very low on average, displaying a highly educated population in Flanders. However, variation is high in these measures indicating the need to account for inter-district variation in socio-economic background which affects the cost of education. School district personnel amounts to one third of young teachers on average, with some districts consisting of a share of young teachers equal to almost 85%. The percentage of teachers holding a masters' degree is generally low within districts since only teachers instructing in the final grade (17-18 year old students) are required to hold this type of degree.

Finally, teacher absenteeism also varies widely across districts indicating broad quality differences (Bidwell & Kasarda, 1975; De Witte & Schiltz, 2015; Ehrenberg et al., 1991). The average equals 12.5% and is measured as the percentage of teachers absent due to personal motivation (2%), declining performance (5%), or illness (5%). Including this measure as a control variable allows to "yield estimates of scale that more appropriately indicate the effects of variation in size" (Duncombe et al., 1995).

[12] For the sake of brevity, only data is presented for school year 2012. Also, some variables are not observed for all years and could therefore not be aggregated for all time periods.
[13] An alternative is to use schools per district as an indicator of size. However, variation in the number of schools within a district is close to zero and hence less informative when applying a fixed effects regression.

Table 1: Summary statistics of cost related school district characteristics.

Variables	N*	Mean	SD	Min	Max	Median
Total resources#	1075	759	238	321	3315	668
Operational resources#	1075	739	189	353	2318	661
Students per district	1075	1020	1602	16	17383	469
School size (mean)	1075	307	151	16	1374	284
Class size (mean)	1075	23	14	3	138	20
Population density#	1075	1127	2179	52	23754	558
Maternal education	1075	0.069	0.082	0	0.833	0.046
GON students§	1075	0.010	0.010	0	0.092	0.009
% young (<35) teachers	1075	0.339	0.113	0	0.864	0.333
% master's degree	1075	0.098	0.145	0	0.693	0.019
% absenteeism†	1075	0.125	0.060	0	0.385	0.117
Gini	1075	0.348	0.360	0	0.983	0.5
Herfindahl	1075	0.672	0.345	0.023	1	0.664
Dummy variables	**N**	**Yes**			**No**	
Urban	1075	22%			78%	
Only high schools	1075	12%			88%	
Also VET schools	1075	29%			71%	

* All variables are summarized for y=2012, the most recent year covering all variables. Data for other time periods are not presented here due to limited wordcount but are included in our analyses. # Resources are expressed at the student level. § GON is short for 'integrated education' and GON students are receiving additional support. † Teacher absenteeism is measured as the percentage of teachers absent due to personal motivation, declining performance, or illness.

4 Methodology

In line with our review of the literature, we start our analysis using a Cobb-Douglas functional form including the square of students per district ('SPD') to capture a U-shaped cost curve. This model is highly restrictive but is imposed in most studies estimating the optimal district size. We will show that assumptions on the functional form strongly affect the estimated scale economies and offer two possible extensions to allow more flexibility in the estimation method. We will focus on operational costs to exclude specific programs not uniformly targeted at all school districts. Measures of school and class size are included in order to single out the effect of district size changes. All model estimations are performed using fixed-effect regressions at the district level to control for (time-invariant) unobservable district-specific characteristics.

Our first model is a quadratic functional form, including district size ($SPD_{i,t}$) and district size squared, in addition to a set of covariates introduced in the previous section ($X_{j,i,t}$), and an intercept capturing the district-level fixed effects (α_{0i}). Operational costs and district size variables are measured as (natural) logarithms to account for possible outliers in the data.

$$C_{i,t} = \alpha_{i0} + \theta_1 SPD_{i,t} + \theta_2 {SPD_{i,t}}^2 + \sum_j \beta_j X_{j,i,t} + u_{i,t} \quad (1)$$

The equation above can be interpreted as an extension of a standard Cobb-Douglas function, or equivalently, as a translog cost function without interaction terms. The results of estimating this model are displayed in the first two columns of Table 2. A graphical representation of this estimation is presented by the blue line ("Quadratic form") in Figure 2. It is clear from this figure that using a quadratic specification the minimal cost cannot be found, since costs are declining, but an increasing rate. This result might be due to two, possibly simultaneously occurring, reasons. On the one hand, there might be no optimal district size and true possibilities of cost savings lie in school or class consolidation (Bickel & Howley, 2000; Lewis & Chakraborty, 1996), or there might simply be no optimal scale at all (Wales, 1973). On the other hand, misspecification of the functional form used to model the relationship between district size and costs per student could offer another explanation. We follow the latter line of reasoning to motivate more flexible cost function specifications to estimate school district scale economies.

Some studies have extended equation (1) by including a number of interaction terms (e.g. Callan & Santerre, 1990; Smet & Nonneman, 2000). The resulting model is known as a translog cost function. This specification is still restrictive but allows more flexibility compared to (1).

$$C_{i,t} = (1) + \sum_{j} \delta_{SPDj} SPD_{i,t} X_{j,i,t} + \sum_{j} \sum_{k} \gamma_{jk} X_{j,i,t} X_{k,i,t} \quad (2)$$

Estimation of this equation and comparison with the base model using an F-test results in the conclusion that including the set of interaction terms offers no 'added value'. The obtained p-value is too large to reject the null hypothesis that the translog model does not provide a significantly better fit than our base model.

We offer two additional and complementary extensions to allow more flexibility in the estimation method that have not been applied in previous studies linking district size to the (operational) cost of education: an 'extended form' and estimation by Fourier specification.

First of all, we extend the assumption of one global optimum towards the possibility of multiple optima by including higher degree polynomials. This less stringent assumption on the functional form is still consistent with the possibility of a parabolic function while also permitting local optima. As a result, the presence of mechanisms in between different optima can be identified. Using both AIC (Akaike) and BIC (Schwarz) criteria, we gradually add a polynomial, starting from the base model (without interactions). This stepwise approach results in the base model, extended by a third and fourth degree district size polynomial. For simplicity, in the remainder of this paper, we label this specification the 'extended form'.

$$C_{i,t} = (1) + \theta_3 {SPD_{i,t}}^3 + \theta_4 {SPD_{i,t}}^4 \quad (3)$$

This specification provides a significantly better fit compared to our base model, as indicated by the F-test, in contrast to the translog cost model. Estimation results are presented in the third and fourth column of Table 2 and are discussed in the next section. Figure 2 displays the graphical representation of the extended form, marked by the green line ("Extended form").

Our second estimation method is known as the Fourier cost function. Estimation using a Fourier cost function is the most flexible parametric approach available. However, to our knowledge, this study is the first in applying this specification to cost functions in education. The Fourier cost function extends our base model by adding *sine* (sin) and *cosine* (cos) terms. The final term in (4) is gradually extended over N, based on a F-test to check the significance of improved model fit.

$$C_{i,t} = (1) + \sum_{k=1}^{N}(\delta_{1k} sin\left(kSPD_{i,t}\right) + \delta_{2k} cos(kSPD_{i,t})) \tag{4}$$

Despite its parametric form, the Fourier specification provides a framework to estimate cost parametric functions with a flexibility comparable to a nonparametric approach (De Witte & Dijkgraaf, 2007). Nonparametric approaches let the 'data speak for itself' and do not impose any type of functional form. However, the advantage of parametric analysis lies in the possibility to control for a larger set of covariates and fixed effects, compared to nonparametric models. By estimating the coefficients of these covariates, we can discuss possible mechanisms causing the peculiar form of both the extended form and Fourier specification, displayed in Figure 2.

As a robustness check, and to tackle the issue of simultaneity in district size and quality of schooling[14], we perform an additional estimation by means of a semi-parametric stochastic frontier analysis (SFA). It can be argued that coefficients obtained by mean regression techniques are affected by inefficiencies associated with the set of covariates. Stochastic frontier methods do not assume school districts to operate at full efficiency, in contrast to mean regression techniques (Duncombe et al., 1995). To rule out all time-invariant unobserved heterogeneity from the inefficiency component, we re-estimate the extended form model using a fixed-effects stochastic frontier model[15]. Since the results obtained by SFA estimation are very similar for both estimation methods, mean regression (Fourier and extend form) coefficients are used to calculate the scale effects.

The correspondence between parametric and semi-parametric methods reflects a rather good fit of our Fourier and extended form models with the 'actual' cost function. Despite the likely importance of schooling quality, our estimates of the cost function are not biased, or only to a limited extent, by related endogeneity issues. In the next section, results obtained by these estimation methods are discussed.

[14] Note that we have included a measure of teacher absenteeism to control for quality differences between districts. However, frontier regression methods (e.g. SFA) take into account efficiency differences which are more likely to reflect variation in school- and district-performance.

[15] In addition, we apply the random-effects time-invariant frontier model by (Battese & Coelli, 1988) which returns different results. However, a Hausman test confirms the existence of fixed effects.

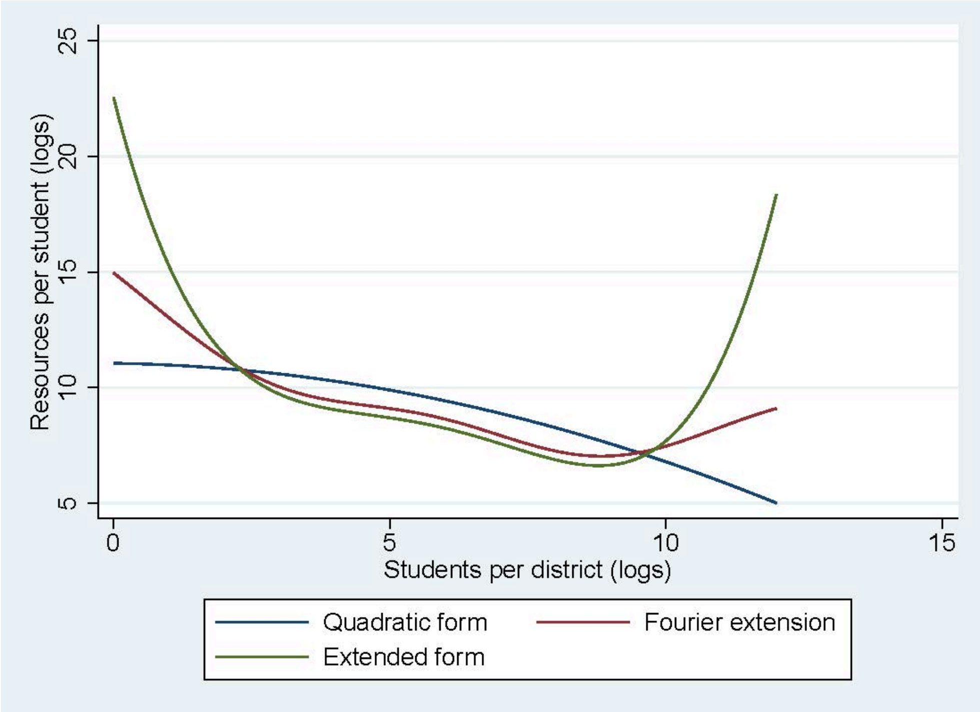

Figure 2: Comparison of methods to estimate the optimal district size.

5 Results

This section of the paper describes results obtained by estimation of the models presented above. Table 2 lists all coefficients of scale variables and covariates. We follow the same order of variables to discuss our findings.

In all three models, class and school size effects appear significantly related to costs per student. Larger classes correspond to lower costs, which also holds for larger schools. This latter relationship is negative, but at a decreasing rate. Note that we included school size squared to allow the possibility of a non-linear relationship between school size and per student costs[16].

When estimating the quadratic model, coefficients of school district size and its square are alternately significant, depending on the inclusion of school and class size variables, implying a misspecification of the underlying cost function. In our two other specifications, all district size variables (higher degree polynomials, sine and cone) are significantly related to per student costs[17]. Comparison of the coefficients results in the conclusion that inclusion of school and class size variables mitigates the estimated scale economies, especially at the lower tail of the district size distribution. This finding is supported by the last row of Table 2, indicating lower optima when school and class size variables are included. Significance of the selected higher degree polynomials, sine and cosine terms supports our hypothesis of multiple optima, as opposed to the stringent assumption of a U-shaped cost function.

---

[16] We also included a squared class size variable to capture possible non-linearities but this quadratic term appeared to be insignificant and was therefore left out in later specifications.
[17] This finding is an immediate result of the selection methods applied to obtain the estimated specifications (AIC, BIC, and F-tests).

Table 2: Factors affecting school district per student operational costs: Fixed-effects regression results for Flanders.

Variable	Quadratic form		Extended form		Fourier extension	
Intercept	9.712***	11.049***	23.304***	22.554***	13.267***	14.527***
SIZE§						
SPD	-0.572***	-0.038	-10.652***	-9.524***	-1.845***	-1.630***
SPD^2	0.009	-0.039***	2.667***	2.537***	0.112***	0.095***
SPD^3			-0.298***	-0.301***		
SPD^4			0.012***	0.013***		
sin(SPD)					-0.041	-0.235***
cos(SPD)					0.449***	0.429***
School size		-1.117***		-0.712**		-0.862***
School size^2		0.119***		0.087***		0.102***
Class size		-0.121***		-0.132***		-0.137***
STRUCTURE						
Only high schools	-0.002	-0.071	0.001	-0.075*	0.001	-0.077*
Also VET schools	0.019	0.026	0.027	0.038	0.026	0.032
Gini#	-0.026	0.179**	-0.021	0.235**	-0.022	0.255**
ENVIRONMENT						
Population density	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
SES	YES	YES	YES	YES	YES	YES
PERSONNEL						
Teacher absenteeism	YES	YES	YES	YES	YES	YES
Composition	YES	YES	YES	YES	YES	YES
N	4213	4213	4213	4213	4213	4213
R^2	0.25	0.28	0.28	0.30	0.28	0.30
SPD*	N.A.	N.A.	7619	6517	7794	6868

The dependent variable is the natural logarithm of per student operational costs. For brevity, coefficients of personnel and SES characteristics are not reported in this table, but they are included as control variables and discussed in the text. Also, standard errors and t-statistics are not included in this table. SPD is the abbreviation of students per district. * Indicates significance at the 10% level, ** Indicates significance at the 5% level, *** Indicates significance at the 1% level. § All size variables are measured in logarithms. #: Robustness checks are performed using Herfindahl indices.

Structural variables related to type (VET or non-VET) and level (primary vs high school) of schooling do not appear to be significantly related to per student costs. In contrast, the internal organization (or equivalently, within district competition) of a school district, captured by the Gini index (or Herfindahl index) is strongly linked to the cost of education in all three specifications. Interestingly, this finding only holds when class and school size variables are included in the equation. The negative coefficient observed when school and class size variables are excluded from the regressions might be due to higher average school and class sizes in more diverse districts. Once these factors are accounted for, we single out the effect of diversity in organizational structures, which is significantly positive. Inspection of the data reveals that half of the school districts consist of only 1 school and are hence characterized by a Gini index equal to 1. Districts with an index above 0.5 entail higher costs per student, the higher this index, reflecting possible mismanagement or unequal representation of schools' aspirations in more diverse (with respect to size) school districts.

Environmental variables are related to the costs of schooling in a predictable way. Higher percentages of low SES students result in higher per student costs, corresponding with the funding mechanism in Flanders. A similar relationship can be observed with respect to more densely populated areas. When we estimate our models separately for both rural and urban areas, we observe different intercepts in addition to a disparity in coefficients, indicating higher overall costs in urban areas. Scale economies of the smallest school districts are more pronounced within urban areas, possibly linked to less barriers to coordination and organization[18].

Finally, data on the age and education of teachers are only observed in 2012 and are dropped accordingly when fixed-effects regressions are carried out. Teacher absenteeism is observed for all time periods and is found to be higher in districts with a higher per student cost. After controlling for student and school characteristics, this result remains statistically significant. Studies linking teacher absenteeism to school district management could serve as a possible explanation for this higher per student cost (De Witte & Schiltz, 2015; Hartog & Verburg, 2004; Theobald, 1990). Again, sound management performance could explain discrepancies in school district performance with respect to costs, and possibly also with respect to student outcomes, through its impact on HR management (teacher hiring and retention).

Using the obtained coefficients of school district size, scale economies are estimated while holding all other variables at the district average. Results are displayed in Figure 2. Preliminary findings are in line with consent in the literature about scale economies, the largest potential cost

[18] Another explanation could be related to increased competition between districts in urban areas, resulting in better financial management by the school boards. Since the Gini index only captures within-district competition, the between component is not accounted for.

savings can be found within the smallest school districts (<500 students) and at the threshold of around 6000 students, diseconomies appear within the largest districts.

However, closer inspection of Figure 2 reveals an apparent slowdown in cost savings in medium-sized school districts (300-1100 students). Once beyond this ‘transition period’, cost savings from school district consolidation increase again, up to the optimal size of around 6500 students. As indicated before, our hypothesis links school district management and organizational structures to school district (financial) performance. This relationship was supported by proxies such as the Gini index and teacher absenteeism trying to capture these school district characteristics. In addition, earlier research identified a connection between school district size and school board organizational characteristics (Sleegers et al., 1994). Transition from small to large school districts is found to be characterized by changes in organisational structures. The observed transition period could hence be due to adaptive difficulties encountered by school boards when transforming small, community-based, school districts into relatively large overarching organizations, while higher costs observed in the smallest and largest school districts could be due to scale (dis)economies.

Also, ‘transition’ is more pronounced in urban areas, suggesting relatively easy cooperation since schools are closer to each other in cities. In rural areas, the cost function is more flattened out implying immediate complications when districts consolidate due to possible coordination issues between diverse community (and schools’) needs. Once a threshold of around 700 students is reached, both types (urban and rural) entail larger economies of scale until the optimal scale is attained, which is the same for both types of school districts (6-7000 students).

6 Conclusion

The main contribution of this paper lies in its use of Flemish data. Despite broad differences in the educational landscape in Flanders and countries analysed in the literature, we confirm the general findings. Potential cost savings are the largest within the smallest districts, up to the optimal scale of 6-7000 students per districts. Consolidations beyond this optimum result in diseconomies of scale.

In addition, we imposed less stringent assumptions on the cost function specification, thereby allowing multiple optima. Although the optimal district size is the same in our model as in previous studies, estimating more flexible functional forms reveals anomalies in the cost function which cannot be observed when estimating a U-shaped curve. We identified a ‘transition period’ in between small and large school districts characterized by less pronounced scale economies. Duncombe et al. (1995) also noted that “principal cost savings of increased enrolments are exhausted by the time a district reaches an enrolment of 500 to 1000 pupils”, but the authors did not provide an explanation for this apparent slowdown. Including variables capturing school district structure and management practices (Gini coefficient and teacher absenteeism), we offered a suitable explanation for this transition period. This linkage between organizational effectiveness and district performance can be seen as complementary to available studies suggesting large cost savings due to economies of scale in small districts (e.g. centralizing administrative tasks) and diseconomies of scale in large school districts due to the creation of burdensome bureaucracies (Andrews et al., 2002; Robertson, 2007).

Further research is needed to identify the drivers of organizational effectiveness (e.g. why do less diverse districts perform better?) and to offer alternative mechanisms driving the curvature of the estimated cost function. Competition between school districts might offer an explanation for the observed trend in scale economies. Leach, Payne, & Chan (2010) state the following: "Although the impact of reduced competition across school boards [due to consolidation] is at least partially offset by greater competition among schools, Urquiola (2005) argues that competition occurs mainly among the boards.". Inclusion of a distance-based competition measure would enable disentangling within- and between-district competition and their effect on school district performance.

Focus should be shifted towards *long-run effects* of district consolidation on costs, and most importantly, student outcomes, to evaluate costs and benefits of consolidation. Brasington (1998) argues that net savings are negative, caused by lower house prices, as a result of weaker student outcomes after district consolidation. If this relationship holds, gains of increasing the scale of education are absent and consolidation should not be pursued. However, as stressed before, a lack of flexible production function specifications has resulted in conflicting evidence in the (school district) production literature[19] (Andrews et al., 2002). Also, analysis based on long-run (panel data) studies enables controlling for selection issues related to consolidation. School districts that have already consolidated are those experiencing the greatest economies, so a cross-sectional analysis tends to overestimate the benefit of scale increases (Leach et al., 2010).

We introduced a flexible way of measuring scale economies based on the analysis of panel data to account for endogeneity and selection issues related to quality differences and consolidation. We also offered an innovative approach to explain differences in scale economies by school district structure and management practices. Although our application is limited to compulsory education in Flanders, our methodology can be easily extended to other countries or non-profit sectors looking for reduced per unit costs. In addition, the method developed could also be valuable to the estimation of production functions in order to obtain the *actual* scale economies and cost savings generated by school district consolidation.

[19] A recent study by Duncombe, Yinger, & Zhang (2014) found a positive impact on house prices following school district consolidation (especially in low-income census tracts). Hence, if student outcomes are related to house prices, this finding suggest long-term benefits of consolidation in terms of student achievement.

References

Alonso, J. M., Clifton, J., & Díaz-Fuentes, D. (2013). Did New Public Management Matter? An empirical analysis of the outsourcing and decentralization effects on public sector size. *Public Management Review*, *9037*(4), 1–18.

Andrews, M., Duncombe, W., & Yinger, J. (2002). Revisiting economies of size in American education: are we any closer to a consensus? *Economics of Education Review*, *21*(3), 245–262.

Angrist, J. D., & Lavy, V. (1999). Using Maimonides' Rule to Estimate the Effect of Class Size on Scholastic Achievement. *The Quarterly Journal of Economics*.

Battese, G. E., & Coelli, T. J. (1988). Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data. *Journal of Econometrics*, *38*(3), 387–399.

Bickel, R., & Howley, C. (2000). The influence of scale on school performance: A multi-level extension of the Matthew principle. *Education Policy Analysis Archives*, *8*(22), 1–32.

Bidwell, C. E., & Kasarda, J. D. (1975). School District Organization and Student Achievement. *American Sociological Review*, *40*(1), 55–70.

Bloom, N., Lemos, R., Sadun, R., & Van Reenen, J. (2015). Does Management Matter in schools? *The Economic Journal*, *125*(584), 647–674.

Brasington, D. M. (1998). School District Consolidation, Student Performance, and Housing Values. *SSRN Electronic Journal*, *6658*, 1–25.

Callan, S. J., & Santerre, R. E. (1990). The Production Characteristics of Local Public Education: A Multiple Product and Input Analysis. *Southern Economic Journal*, *57*(2), 468.

De Witte, K., & Dijkgraaf, E. (2007). Mean and bold? On separating merger economies from structural efficiency gains in the drinking water sector. *Tinbergen Institute Discussion Paper*, *92*(3).

De Witte, K., & Schiltz, F. (2015). Explaining school district performance by school district management and organizational practices. Evidence from Flanders. *Working Paper*.

Downes, T. A., & Pogue, T. F. (1994). Adjusting school aid formulas for the higher cost of educating disadvantaged students. *National Tax Journal*, *47*(1), 89–110.

Driscoll, D., Halcoussis, D., & Svorny, S. (2003). School district size and student performance. *Economics of Education Review*, *22*(2), 193–201.

Duncombe, W. D., Ruggiero, J., & Yinger, J. (1995). Alternative Approaches to Measuring the Cost of Education. In *Holding Schools Accountable: Performance-Based Reform in Education* (pp. 327–356). The Brookings Institution.

Duncombe, W. D., Yinger, J., & Zhang, P. (2014). How Does School District Consolidation

Affect Property Values? A Case Study of New York. *Public Finance Review*, *44*(1), 1–28.

Duncombe, W., Miner, J., & Ruggiero, J. (1995). Potential cost savings from school district consolidation: A case study of New York. *Economics of Education Review*, *14*(3), 265–284.

Ehrenberg, R. G., Ehrenberg, R. a., Rees, D. I., & Ehrenberg, E. L. (1991). School District Leave Policies, Teacher Absenteeism, and Student Achievement. *The Journal of Human Resources*, *26*, 72–105.

Fox, W. F. (1981). Size Economies in Local Government Services : A Review. *U.S. Department of Agriculture*, (22).

Friedkin, N. E., & Necochea, J. (1988). School System Size and Performance : A Contingency Perspective. *Educational Evaluation and Policy Analysis*, *10*(3), 237–249.

Gordon, N., & Knight, B. (2008). The Effects of School District Consolidation on Educational Cost and Quality. *Public Finance Review*, *36*(4), 408–430.

Hartog, D., & Verburg, R. (2004). High performance work systems, organisational culture and firm effectiveness. *Human Resource Management*, *14*(1), 55–78.

Heinesen, E. (2005). School district size and student educational attainment: Evidence from Denmark. *Economics of Education Review*, *24*(6), 677–689.

Hoxby, C. M. (2000). Does Competition Among Public Schools Benefit Students and Taxpayers? *American Economic Review*, *90*(5), 1209–1238.

Jarl, M., Fredriksson, A., & Persson, S. (2012). New Public Management in Public Education: a Catalyst for the Professionalization of Swedish School Principals. *Public Administration*, *90*(2), 429–444.

Johnes, G., & Johnes, J. (2009). Higher education institutions' costs and efficiency: Taking the decomposition a further step. *Economics of Education Review*, *28*(1), 107–113.

Jones, J. T., Toma, E. F., & Zimmer, R. W. (2008). School attendance and district and school size. *Economics of Education Review*, *27*(2), 140–148.

Kenny, L. W. (1982). Economies of scale in schooling. *Economics of Education Review*, *2*(1), 1–24.

Leach, J., Payne, a. A., & Chan, S. (2010). The effects of school board consolidation and financing on student performance. *Economics of Education Review*, *29*(6), 1034–1046.

Leithwood, K., & Jantzi, D. (2009). A Review of Empirical Evidence About School Size Effects: A Policy Perspective. *Review of Educational Research*, *79*(1), 464–490.

Lewis, W. C., & Chakraborty, K. (1996). Scale Economies in Public Education. *Regional Analysis & Policy*, *26*(1), 23–35.

Luyten, H., Hendriks, M., & Scheerens, J. (2014). *School size effects revisited: a qualitative and quantitative review of the research evidence in primary and secondary education.* (H. Luyten, Ed.). Springer.

Moe, T. M. (1984). The New Economics of Organization. *American Journal of Political Science*, *28*(4), 739–777.

Robertson, F. (2007). Economies of scale for large school districts: A national study with local implications. *The Social Science Journal*, *44*(4), 620–629.

Rose, H., & Sonstelie, J. (2010). School board politics, school district size, and the bargaining power of teachers' unions. *Journal of Urban Economics*, *67*(3), 438–450.

Saatcioglu, A., Moore, S., Sargut, G., & Bajaj, A. (2011). The Role of School Board Social Capital in District Governance: Effects on Financial and Academic Outcomes. *Leadership and Policy in Schools*, *10*(1), 1–42.

Sleegers, P., Bergen, T., & Giesbers, J. (1994). The Policy-making Capacity of Schools Results of a Dutch Study. *Educational Management and Administration*, *22*(3), 147–159.

Smet, M., & Nonneman, W. (1998). Economies of scale and scope in Flemish secondary schools. *Applied Economics*, *30*(9), 1251–1258.

Strang, D. (1987). The Administrative Transformation of American Education : School District Consolidation, 1938-1980. *Sage Publication Inc*, *32*(3), 352–366.

Theobald, N. D. (1990). An examination of the influence of personal, professional, and school district characteristics on public school teacher retention. *Economics of Education Review*, *9*(3), 241–250.

Urquiola, M. (2005). Does School Choice Lead to Sorting ? Evidence from Tiebout Variation. *American Economic Review*, *95*(4), 1310–1326.

Wales, T. J. (1973). The Effect of School and District Size on Education Costs in British Columbia. *International Economic Review*, *14*(3), 710–720.