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The impact of competition on costs in Sweden's educational sector

- the effects of market forces on public expenditures

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Abstract

When the Swedish educational voucher system was introduced in the beginning of the 1990s, an important rationale was the alleged ability of competition from independent schools to trim costs within the educational sector. In this thesis we study both the elementary and upper-secondary levels of education and employ an econometric approach with panel data regressions to estimate i) the effects of increased competition from independent schools upon the total cost for the municipality per student recorded as living there and ii) the effects from decreased student enrollment on costs within public schools. Our findings imply that the effects differ across levels of education and geographical regions and that increases in competition do not appear to guarantee lower costs for education. We also find support for the notion that economics of scale within public upper-secondary schools induces cost increases as a corollary of decreased student enrollment. This occurs without increases in the fraction of total cost devoted to expenditures such as teaching and educational material. Our results indicate that competition is by no means a universal driver of cost decreases within the educational sector and that higher per student costs for public schools as a result of falling student enrollment may contribute to the failure of market forces to drive down costs.

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Contents

1. Introduction

During the late 1980s and early 1990s several policy measures were enacted and implemented with the aim of changing the educational sector in Sweden. A common denominator for these reforms was an explicit goal to increase diversity and competition. Arguably, the voucher reform was and has remained the most politically controversial of the policy measures. It enables the owners of independent schools to receive public funding on the basis of the number of students enrolled. One crucial argument for introducing the voucher was that excessively high costs should be lowered and resource allocation enhanced. Public schools had hitherto enjoyed an effective monopoly position within their vicinities, and hence had faced few incentives to undertake efforts to keep costs low or to maximize the utility of resource allocation. The advent of free choice for parents and students would alleviate the matter. In the connection to the law proposal it was stated that

> "with greater freedom of choice and more scope for the profile of the individual school will also follow better incentives for cost efficiency […] Hence a larger component of independent schools should in the long term be able to contribute to more efficient resource utilization in the entire educational sector"[1]

Gradually, the reform has had a significant effect in shifting student enrollment from public to independent schools. In the school year 2010/2011, more than 20 percent of Swedish upper-secondary students attended an independent school while the corresponding fraction of elementary school students was slightly above 12 percent.

Is there evidence that this increased competition has induced such efficiency gains in the form of lower costs and better resource allocation? This question is the starting point for the thesis. Previous empirical research concerning impact on educational costs from independent competition in Sweden has focused on elementary schools, and has mainly been based on data collected during a period when the overall student population was growing. We widen the perspective by including data for upper-secondary education and for a period when the student population in the relevant age groups was decreasing while competition from independent schools was simultaneously intensifying, namely the period 2000-2010.

[1] *Proposition*1991/92:95 (law proposal made by the then Swedish government).

The content of the voucher reform is that mainstream education remains publicly funded by the respective municipalities while partially being provided by private actors. For this reason an outcome variable of primary interest is the total average cost to the municipalities for providing a student living there with education across independent and public schools. We hence investigate the net influence on this variable from increased prevalence of independent schooling by employing an econometric approach with panel data regressions.

Since the great majority of Swedish students remain enrolled within the public educational sector, the development of costs within the municipal schools will largely affect total per student cost. The importance is reinforced as law requires the independent schools to be compensated on a per student basis according to the same principles as the corresponding per student cost within municipal schools is decided. It has been proposed that competition may drive higher overall costs because of higher costs for public schools when they are left with overcapacity as a result of the sudden decrease and unpredictable fluctuations in student enrollment. We formalize a model describing this effect and econometrically investigate whether data is in accordance with some of its testable implications.

We find that the effects of increased prevalence of independent schooling are not qualitatively uniform across levels of education and different geographical regions, and that competition does not appear to guarantee a lowering of educational costs. Instead it seems as if competition can result in both higher and lower costs of different magnitude, presumably reflecting the underlying nature of the competition. In particular, the costs for upper-secondary education increases in response to increased pervasiveness of independent schooling, while the costs for elementary education decreases.

We further find that lower student enrollment is correlated with higher total average cost within public upper-secondary schools while such effects cannot be established for public elementary schools. This is noteworthy, but caution should be advised as student enrollment is a crude measure and changes can have non-uniform impact arising from non-uniform costs across different categorizes of students. We finally present statistically significant but practically rather trivial effects of changing student enrollment on various fractions of total costs within the public upper-secondary schools, while corresponding results for the public elementary schools are statistically insignificant.

Our methods and findings will be elaborated below. The remainder of the thesis is structured in eight primary sections. Section (2) provides a background understanding of the characteristics of the present Swedish educational sector, section (3) details the current state of knowledge concerning the effects of competition from independent schools on educational expenditures as well as the connection between educational resources and the quality of education. In section (4) we present the contribution to the current state of knowledge provided by this thesis as well as the precise research question which we investigate. Thereafter section (5) presents the elementary models we use, section (6) details the methodology used to explore the research question, while section (7) presents the results and section (8) provides an analysis interpreting the results in light of the problem statement of the thesis. Finally, section (9) contains a conclusion in which we summarize our findings and their implications.

2. The Swedish elementary and upper-secondary school: structure, resources and costs

In this section, we outline (i) the organization and structure of the Swedish educational system, (ii) the historical conditions of the public schools in Sweden and possible doubts regarding their compatibility to a competitive environment, (iii) resources and costs relevant to the Swedish educational sector. This is relevant to the problem statement since it provides a rationale as to why increased average capacity costs could be a negative corollary of competition during the researched time period. It also explains the content of the cost variables used in our econometric study.

2.1 Organization and structure

The elementary level of Swedish education comprises nine years of mandatory schooling. Students are normally enrolled when aged seven and graduate at age sixteen. Education is at this level homogenous in the sense that only one educational program with a defined curriculum exists. In the school year of 2008/2009 a total of about 900 000 students were enrolled across independent and public schools. During the preceding five years, the total student population had decreased by an average of 30 000 students per year. It has been predicted that no increase in the total student population will occur until the school year 2014/2015.[2] It should, however, be noted that this overall decrease in the student population is unevenly distributed across the nine years of education. While the number of students eligible for the final three years of elementary schooling was predicted to decrease by 60 000 between 2009/2010 and 2015/2016, the corresponding number for the earliest years was expected to increase by 40 000.[3] The total number of elementary schools was 4226 in the year of 2010 and 5090 in the year of 2000. This period has seen a marked decrease in the number of public schools and a rise in the number of independent ones. In 2010 the fraction of independent elementary schools was 16 percent, while they enrolled approximately 12 percent of the student population. This is to be compared to fractions of 8 percent and 4 percent in 2000. The typical municipal elementary school is relatively small with an average student enrollment of circa 183 students in 2010.[4]

[2] *Skolverket (2009),* p. 53
[3] Ibid., p. 54
[4] Calculated from the data obtained from *Skolverket* and presented in the methodology section

Upper-secondary education normally comprises three years. In contrast to the compulsory elementary education the upper-secondary level is non-mandatory. Enrollment takes place at the age of 16 while graduation occurs at the age of 19. The number of students in the relevant age group peaked in the school year 2008/2009 at approximately 400 000. A steep decrease is predicted until the school year 2016/2017, when the student population will comprise approximately 300 000 pupils.[5] The number of upper-secondary schools was 1015 in 2010 and 654 in the year of 2000. The increase in the number of schools has substantially been driven by establishment of independent schools. The number of municipal schools has been relatively constant, varying between 472 in the year of 2000 and 505 in the year of 2010. In fact, 192 of the 290 Swedish municipalities have less than two public upper-secondary schools as of 2010. Beyond the municipal schools, a number of public schools operated by counties (*län*) exist. These are relatively few (21 in the year of 2010) and normally offer education only in health care and nature caretaking.[6] For this reason we will use the concepts public schools and municipal schools synonymously in this thesis, unless we explicitly include the schools managed by the counties. The number of independent upper-secondary schools in 2010 was 489, that is to say more than 48 percent of the total number of schools. These independent schools enrolled slightly more than 20 percent of the student population. It immediately follows that the average independent school enrolled substantially fewer students than corresponding public schools.[7]

The three diagrams below illustrate the development of (i) the fractions of students enrolled in independent schools, (ii) the total student population in elementary schools and (iii) the total student population in upper-secondary schools. As the diagrams make clear, enrollment in independent schools has increased throughout the period (although much more so for the upper-secondary level of education). It is also clear that the elementary schools have experienced a continuous decline in total student population, while the population in upper-secondary schools has been more variable.

Concerning the fraction of students enrolled in independent schools, there is also substantial geographical differences as manifested by variation between municipalities. This variation has also been growing over time. For the upper-secondary level of education, the standard

[5] *Skolverket (2009)*, p. 107
[6] *Skollagen* (2010:800) 15:31
[7] The figures presented in this section have been calculated from the data obtained from *Skolverket*, aside from the one specifically referenced in footnote 5

deviation of the fraction of students enrolled in independent schools has increased from 5.06 to 10.37 during the period. For the elementary level of education, the corresponding increase is from 3.28 to 7.55.[8]

Diagram 1: fraction of student population enrolled in independent schools

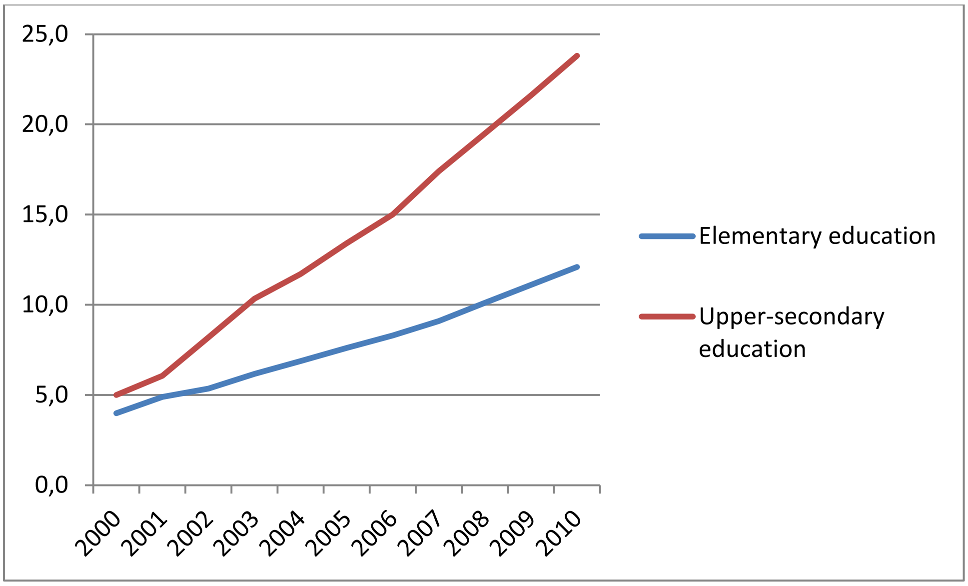
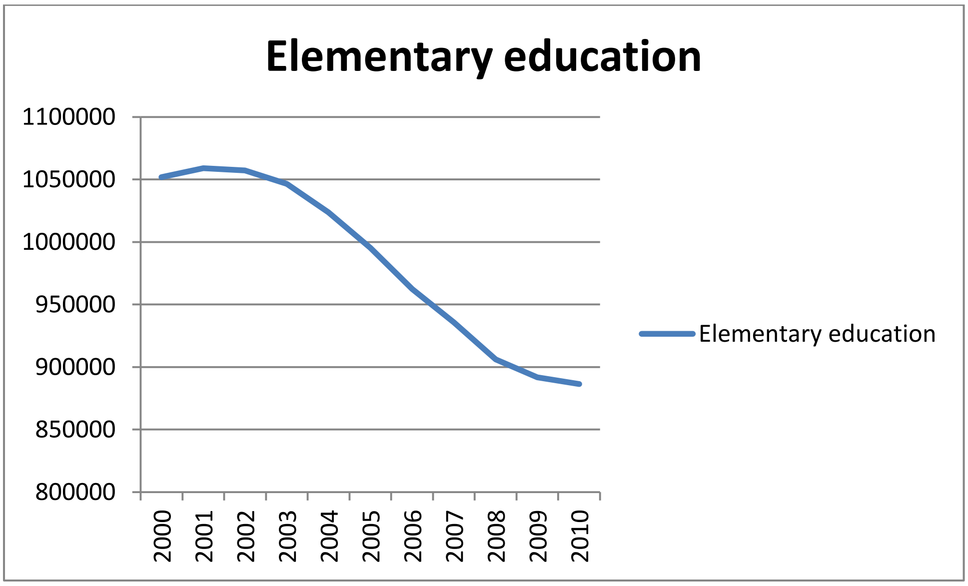
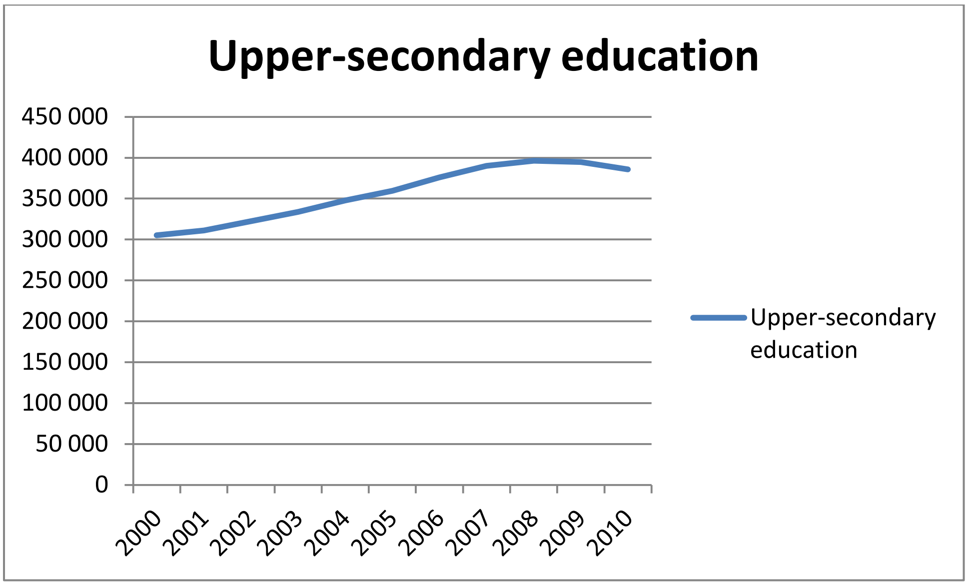


Diagram 2: total student population in elementary education over the period



[8] The numbers are based on calculations in STATA concerning the data obtained from *Skolverket*

Diagram 3: total student population in upper-secondary education during the period



The national Swedish agency the Schools Inspectorate (*Skolinspektionen*) must approve the establishment of an independent school at either level of education. The criteria for approval are that the applicant can be expected to fulfill the educational requirements as specified in the corresponding educational guidelines and that no substantial negative effects for the students or the public schools within the municipality can be expected. Concerning upper-secondary schools, effects for neighboring municipalities should also be taken into account, which reflects the substantial student mobility across municipality borders at this level of education.[9]

It should also be noted that the independent schools do not constitute a homogenous population. In particular, the Swedish independent educational sector is dominated by five private equity companies. These are Academia, Baggium, John Bauer, Pysslingen and Theducation. These equity companies may easily centralize administration and move resources between schools and across municipality borders. This is in sharp difference to independent schools that are purely local and lack access to a corresponding national network.[10]

2.2 The public schools and the shift in educational policy

The introduction and impact of the voucher reform should be analyzed against the historical background of the Swedish educational sector. The voucher reform was one of several central

[9] *Skollagen* (2010:800) 2:5
[10] Svensson (2010), p. 22-23

reforms during the late 1980s and early 1990s. Other policy measures included a transfer of responsibility for public schooling from the central government to the municipalities, greater freedom of choice for students between different municipal schools and more flexible guidelines concerning decision-making within the public educational sector. The municipalities also received greater freedom in resource allocation with regard to the public schools.[11] The dominant institutionalized ideology had previously been to ensure equal access to standardized schooling. The new guiding principle became that freedom of choice and influence for parents and students would result in higher quality and efficiency.[12]

In summary, the paradigm introduced some twenty years ago was based on the principle of goals being set by the central government and execution by municipalities and independent schools according to the particular context in which the school was operating. This general framework was in 2010 confirmed in the new Swedish school law.[13]

When the modern public upper-secondary and elementary schools were institutionalized in the 1960s, competition between municipal schools was not envisioned. Instead, the primary emphasis was that students should be provided with high quality and equal education in their vicinity no matter where they lived.[14] The strong emphasis on equality could be seen against the background of previously existing alternative educational systems depending on social statue. This vision of high quality education included access to various utilities, such as libraries, canteens and venues for physical education.

The voucher reform and the accompanying policy changes have affected the environment for public schools. One aspect is the above mentioned increase in the fraction of students enrolled in independent schools. A second aspect is an increase in the number of students living in a municipality who attend public schools in other municipalities. The student mobility in this regard is much higher at the upper-secondary level than at the elementary level. At the upper-secondary level of education approximately 20 percent of the students attended a public school in a different municipality in 2010, while the corresponding fraction for elementary schools was just 1.3 percent. Regarding the first aspect, the relative increase in enrollment in

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[11] Ibid., p. 8
[12] Ahlin & Mörk (2007), p. 2 continued
[13] See *Skollagen (2010:800) 2 kap.*
[14] See SOU 1963 – *Ett nytt gymnasium*

independent schools has mostly occurred during the period 2000-2010, indicating that this interval is a relevant time-unit for analysis.

A potential concern regarding the situation for municipal schools is that the operating conditions have not been changed to match these rapid developments. This could concern the venues available for education, as they were designed to provide large numbers of students with various utilities. It could also concern the organizational design, as the municipality based administration might be more costly per student than for example the centralized administration employed by various private equity companies within the educational sector. It is also possible that the constraints imposed on municipal schools by public law concerning contract negotiations hinder them to buy various utilities at market prices.[15]

The core reasoning in the above paragraph can be summarized as a concern that municipal schools have capacity costs which may be difficult to reduce in the face of competition and potentially decreasing student enrollment.

A further point is that the advent of competition from schools in other municipalities as well as from independent schools will not only decrease student enrollment but also make it more unpredictable. Municipalities are obliged by law to ensure that each student living in the municipality receive elementary education[16], and may hence be forced to maintain a certain overcapacity since student enrollment can increase suddenly with changed student preferences or reduced number of independent schools. While this particular legal obligation does not apply to upper-secondary municipal schools, law requires that they ensure that all students living in the municipality *are offered* this level of education within or outside the municipality.[17] In this case an additional difficulty arises in that the enrollment in any particular educational program can fluctuate, resulting in possible overcapacity related to specific programs such as teachers with particular competencies and particular educational material. Finally, reduction of capacity may require controversial decisions affecting influential groups such as teachers and administrative personnel. Particularly concerning

[15] Compare *Lag (2007:1091) om offentlig upphandling (LOU)*
[16] *Skollagen (2010:800) 7:21 & 10:24*
[17] *Skollagen (2010:800) 15:30*

administrative personnel, one can hypothesize that it is harder to justify reductions since the connection between that activity and student enrollment is less explicit.[18]

To put it shortly, even if capacity *can* be reduced, public schools may to a certain extent be hindered to do so since they cannot effectively predict fluctuations in student enrollment and since any particular school may experience unexpected increases in the demand for capacity.

In summary, a case can be made that the Swedish public school was designed in a context when changes in student enrollment were predictable and competition was low. A potentially interesting question is whether the changing context has been matched by appropriate changes in organizational structure and design.

2.3 Resources and costs

The Swedish elementary and upper-secondary school is financed on a municipal basis. Any municipality will carry the cost for each student recorded as living in the municipality, irrespective of whether that student is attending a public school in the municipality or an independent school inside or outside the municipality or a public school in another municipality.[19] Accordingly, this average total cost per student recorded as living in the municipality can be decomposed into costs for students who are attending the public schools in the municipality, costs for students attending various independent schools and costs for students attending public schools in other municipalities. This average total cost, then, is a measure of the cost for the municipality of educating one of the students recorded as living in the municipality.

Since the reforms of the early 1990s the Swedish municipalities have had the right to make decisions regarding the total cost and cost composition for public elementary and upper-secondary schools belonging to that municipality. This is in sharp contrast to the time preceding the mentioned reforms, during which the cost decisions were highly centralized to the governmental educational administration.[20]

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[18] That this may be the case was argued to the author during discussions with school personnel in charge of executing budgetary decisions during the research phase of the thesis

[19] See *Skollagen (2010:800)*

[20] Ahlin & Mörk (2007), p. 4-5

In the early days of the voucher system, an independent school received a voucher corresponding to 85 percent of the cost per student within the corresponding municipal educational program. The content of the current legislation is that independent schools via the voucher should be compensated on a per student basis *according to the same principles* that the municipality uses to decide costs for students enrolled at comparable educational programs.[21] This has been the guiding principle since 1997 and hence for the entire period researched in this thesis. In order to induce a more uniform application of this principle, legislative changes were introduced in 2010 to further a fair compensation to independent schools.[22] Nevertheless it can be expected that municipal level interpretation of the content of the compensation requirement may have influenced the application of the voucher system during the researched period. In fact, a concern regarding non-uniform application of the voucher compensation system was a motivator behind the 2010 reform.[23]

There is a decisive difference between the elementary and upper-secondary levels of education in that only one program is available at the elementary level. At the upper-secondary level a variety of educational programs exist and in particular the estimated cost per student differs quite substantially between programs that are primarily theoretical on the one hand and vocational programs on the other. Vocational programs usually involve expensive educational material and a higher number of teachers per student. Independent upper-secondary school should be compensated by the voucher according to the principles applied by the municipality in resource allocation to the same national program.[24] Since independent schools may have programs that are not offered by the municipality, a default national price list is provided by the Swedish educational agency according to which compensation should then be decided.

In accordance with the above description, the total average cost for a student recorded as living in the municipality is more heterogeneous for the upper-secondary level than for the elementary level of education. The cost differences between various educational programs can be seen from the national compensation list, where the voucher per student is 71 700 SEK for the theoretical social science program and 160 000 SEK for the nature caretaking program.[25]

[21] Antelius et al. (2004), p. 9
[22] *Skolförordningen (2011:185)*
[23] *Proposition 2008/09:171*
[24] *Skollagen (2010:800) 16:52*
[25] National price list 2011, obtained from *Skolverket*

The compensation for students attending other municipal schools should in the default case for elementary schools be decided according to the same principles as the municipality uses to decide the per student cost.[26] For the upper-secondary level, the compensation is more negotiable but should in the default case be equal to the actual cost for the municipality of providing that student with education.[27]

Of course, total costs could be categorized on different levels of analysis. One alternative is to consider in isolation the total cost for the public schools within the particular municipality. This total cost variable corresponds to the average cost of educating a student within these particular schools and could – if one desires to examine scale effects within the public schools – logically be related to the number of students enrolled in the public schools of the relevant municipality.

Another factor of relevance is the composition of the per student cost. The fraction of total per student cost devoted to teaching in Sweden is markedly lower than the OECD average. This is partially explained by the fact that Swedish education involves expenditures which are uncommon in many other countries (such as school lunches). Costs for venues on a per student basis are also remarkably high in Sweden, while teacher salaries are low.[28]

The accounting system employed to categorize expenditures within the Swedish educational sector entails a number of specified costs:[29]

1. Teaching: salaries for teachers, headmasters and expenditures concerning workplace education

2. Educational material: school literature, computers, student libraries and different technical equipment used by the students

3. School lunches: costs for sustenance, personnel, transportation and accompanying administration

[26] *Skollagen (2010:800) 10:34*
[27] Ibid. 16:50
[28] Gustafsson & Myrberg (2002), p. 151 continued
[29] Compare *Skolförordningen (2011:185)*, which also mentions ad valorem taxes

4. Student health: costs for medical, psychological or psychosocial aid to students

5. Venues: rents, inventory which is not educational material and capital costs (such as interest on loans, but not costs for amortization)

6. Administration: costs for educational administration

In summary, educational expenditures may be categorized and analyzed in several different ways. If the analysis of interest is the cost for the municipality of providing education to a student living in the municipality, the total cost per student recorded as living in the municipality is relevant. If the situation for a particular group of schools – such as public schools – is to be evaluated, the total cost for these schools should be used. Various particular expenditures as a fraction of total cost are another potential vehicle of analysis.

3. Current state of knowledge: contributions from economic theory and empirical studies

In this section we discuss (i) theoretical explanations applied by economists to predict the effects of competition within the educational sector on quality and resource allocation; (ii) empirical studies concerning the effects of competition on public schools; (iii) research concerning the connection between educational expenditures and quality. This is relevant since the current state of knowledge forms the basis against which the contribution of this thesis is to be evaluated.

3.1 Theoretical foundations concerning educational competition

Why competition could lead to lower costs and more efficient resource allocation

Economic theory points to imperfect competition such as monopoly as a source of inefficiency. In the standard interpretation presented in microeconomic textbooks, this often manifests itself as prices charged above the market-clearing level. Bohm presents another implication which is inefficient resource allocation and slow rationalization, resulting in excessively high overall costs and expenditures devoted to wasteful purposes.[30] As pointed out by Antelius et al. and Böhlmark & Lindahl, the latter interpretation is of particular relevance to the educational sector. In the absence of competition for students public schools may lack incentives to use resources efficiently, since students living in the vicinity will attend the school even if the educational quality is low.[31]

Stiglitz emphasizes that the market for education is decisively different from the market for commodities. The assumptions needed for efficiency as presented in the Arrow-Debreu model of perfect competition do not appear to be relevant.[32] Instead, Stiglitz points to the inability to design incentive schemes relating payment to performance and imperfect information regarding whether resources are used efficiently. There are substantial difficulties in ascertaining the output of education, as even a narrow outcome measure such as contribution to the future income of an individual is inadequately captured by standardized tests and grading. To the extent that results of education can be defined, it may be unclear what connection these results have to various inputs. As a corollary, it is difficult for a policy maker to *define guidelines* concerning resource allocation. The voucher system may resolve

[30] Bohm (1996)
[31] Antelius et al (2004), p. 12 and Böhlmark & Lindahl (2008)
[32] Stiglitz (1994)

some of these difficulties as students leave schools of lower quality, and takes the voucher funding with them. This should put local decision-makers under pressure to utilize resources more competitively, effectively redeeming some of the difficulties in creating appropriate incentive schemes for teachers and administrative personnel. Levin summarizes the case for the voucher alternative with a similar argument.[33]

Firstly, the efficient resource allocation is not observable to a policymaker and hence the only way to know what schools are efficient is to give students and parents the freedom of choice to leave less efficient schools. Secondly, the available composition of resources may not be as crucial to school performance as the efficient utilization of resources. This variable is unobservable to an even greater extent, once again implying that freedom of choice for students and parents is more effective than central guidelines.

The theoretical perspective outlined in the previous two paragraphs makes explicit the argument as to why monopoly may be inefficient with regard to resource allocation (and resource utilization) in the context of the market for education.

A complementary perspective is offered by Antelius et al., who points out that in the presence of an increasing student population, public schools may avoid expenditures related to investment in new venues, etc. if independent schools are established. The costs for education will increase, but only in proportion to the number of students.[34] This is a situation where both total cost may be lower and resource allocation more efficient in public schools as a result of "friendly" competition. It should be noted that while the first arguments provided a general critique of the ability to achieve efficient resource allocation without competition, this latter argument made by Antelius et al. is constrained to a particular context. Applying a similar reasoning to opposite circumstances may yield more unfavorable predictions concerning the impact of competition on public schools.

Why competition could lead to higher costs and less efficient resource allocation

There are theoretical arguments that would imply opposite effects of competition. Antelius et al. proposes that establishment of independent schools could make fluctuations in student

[33] Levin (1995), p. 286
[34] Antelius et al. (2004), p. 13

enrollment more unpredictable to public schools. When certain costs are difficult to alter in response to lower student enrollment, this may result in both a higher cost on a per student basis and an increasing fraction of the per student cost devoted to capacity that is no longer needed. Costs for venues and administration could be examples of such sticky costs, inducing benefits of scale for public schools.

As explained in section 2.2 and as mentioned by Antelius et al., there could be institutional reasons as to why such capacity costs are not reduced even when it would be possible, including that municipal elementary schools have a legal obligation to provide schooling. This is intimately linked to competition and freedom of choice of parents and students. That mechanism will not only decrease student enrollment in public schools but also make it substantially more unpredictable from year to year. In consequence, schools may not be able to reduce costs related to overcapacity since they do not know when the relevant capacity will be needed. This is an argument for higher costs and less efficient resource allocation in public schools as a consequence of competition. As Antelius et al. points out, the construction of the voucher system could induce higher costs for the municipality with regard to the independent schools as well since the latter receive a voucher according to the same principles as the corresponding public schools. In fact, independent schools are as a main rule entitled to the same cost for venues as corresponding public schools.[35]

Another implication of competition proposed by Antelius et al. is that independent schools may disproportionately attract more able students, implying that expenditures within the municipal schools must increase to maintain quality. Antelius also states that a logical effect of competition could be an increase of total costs in public schools in order to increase attractiveness to students.[36]

In summary, theoretical arguments can be mobilized that support both higher and lower total per student cost respective more and less efficient resource allocation as a consequence of competition from independent schools. As presented above the current state of knowledge seems to imply that the net effect of the various influences may depend on contextual factors, and one such factor which is particularly obvious would be the compatibility of competition with size of the total student population.

[35] Antelius et al. (2004), p. 13
[36] Ibid., p. 13

While the implementation of voucher systems in countries such as Chile and Sweden were largely supported by *favorable* theoretical arguments, the validity of these explanations is arguably a matter of empirical investigation.

3.2 Empirical studies concerning the effects of competition on municipality costs

Since the Swedish voucher reform was partially motivated as a way of inducing economic efficiency in the educational sector, a number of studies have been conducted with the purpose of investigating the effects on total cost per student living in the municipality. These studies have been focused on the elementary level of education. According to Antelius this is due to fact that the elementary level of education is more homogenous across municipalities and hence that the heterogeneity in costs is lower, facilitating conclusions concerning causal effects.[37]

A study presented by the Swedish Labor Organization *(LO*) in 2003 finds evidence of higher per student cost for elementary education as a result of higher competition as measured by the number of students enrolled in independent schools.[38] These results are challenged in a study by the think tank the Study Association for Business and Society (*SNS*) in the same year which found no significant effects.[39] The latter study uses a different statistical technique with municipality fixed effects which estimate the predicted growth in total costs per municipality resulting from changes in the fraction of students enrolled in independent schools. This specification was partially motivated by the potential problem of reverse causality as independent schools could be assumed to primarily establish themselves in municipalities where educational costs are high, as they are entitled to a voucher decided according to the same principles as the average total cost per student in the public schools. The authors argued that this problem should be reduced compared to the cross-sectional specification that only describes total average costs as a function of the fraction of students enrolled in an independent school per municipality and year.

[37] Mail conversation with Antelius in April 2012
[38] Fransson & Wennemo (2003)
[39] Björklund et al. (2003)

Using the same specification as *SNS*, Antelius et al. finds no statistically significant effects on total costs per student paid by the municipality for increased prevalence of independent schooling within elementary education. Antelius et al. also controls for a number of structural factors per municipality. Reviewing the establishment of independent elementary schools, the authors find that they to a large extent have been established in the three main urban regions of Stockholm, Göteborg and Malmö. For the municipalities in these particular regions, Antelius et al. finds a statistically significant positive effect of increased relative enrollment in independent elementary schools. For the remaining municipalities this effect is negatively statistically significant. Antelius et al. comes to the conclusion that higher competition does not lower total educational costs, since the increase in educational costs is significant for the municipalities were the increase of relative independent student enrollment has been most notable. They also conclude that the data has been collected for a period during which the total student population has been primarily increasing, and that this could explain the lack of overall statistically significant results as well as the small practical magnitude of the coefficients.[40]

In our opinion the recent combination of high competition and declining student enrollment offers an interesting opportunity to examine how a voucher system performs during more adverse competition. While we recognize the merit in the methods employed by Antelius et al. we believe that both levels of education should be investigated and also that scale effects within public schools should be investigated explicitly (see section 4.1 below).

3.3 The connection between educational expenditures and academic results

While the primary focus of this thesis is on the resource allocation itself, the question of how efficiently existing resources are actually utilized is important to keep in mind in order to interpret the significance of changed resource allocation. This forms the rationale for the following paragraphs dealing with the impact of educational expenditures on academic results.

Econometricians have since the 1960s tried to estimate the so called pedagogical production function. This predominantly empirical approach has linked outcome variables representing

[40] Antelius et al. (2004), p. 17-20

academic results to input variables representing various resources, such as educational expenditures and number of students per teacher.[41]

According to Gustafsson & Myhrberg, the prevailing paradigm regards individual estimations as insufficiently representative. Instead the favored approach has been to combine the results of several studies and make overall inference from different forms of "meta- analysis". Early such studies, for example Hanushek[42], did not find any systematic connection between resources and academic achievements. However, later studies such as Hedges et al.[43] respective Hedges & Olkin[44] found statistically significant effects. Comparing these contrary results, a number of methodological differences are apparent. The arguably most important is that Hanushek's technique has been predominantly focused on the number of cases in which an effect is apparent rather than accounting for the strength of the effect in different cases. Gustafsson & Myhberg consider the methods of Hanushek's critics more credible.[45]

In a study conducted by Murnane & Levy, a court decision allocating more resources to 15 low performing schools was exploited as a natural experiment. The authors found that in 13 of the cases no significant effects could be detected, but in the remaining three cases the effect was strong enough to produce a statistically significant increase compared to the control group consisting of other schools in the region. The authors come to the conclusion that the *specific way* in which the resources were used in the three successful schools was crucial, while a consistent causal effect between resources and results cannot be established. In other words, resources may be a necessary but not sufficient condition for improvement of academic results.[46]

Concerning individual studies, potential omitted variable bias has been a recurring concern for this field of research. Reviewing the current state of knowledge, Gustafsson & Myhrberg points to compensatory resource allocation as a primary distorting factor. Since students with lower propensity to academic achievement are often allocated more resources (such as teaching hours) a case of reverse causality can be present in statistical analysis. For example,

[41] Gustafsson & Myrberg (2002), p. 17
[42] Hanushek (1979)
[43] Hedges et al. (1994)
[44] Hedges & Olkin (1985)
[45] Gustafsson & Myrberg (2002), p. 36-39
[46] Murnane & Levy (1996)

the authors criticize a study by the Swedish educational agency *Skolverket*. The study found no statistically significant effect of more teacher hours on academic achievement of students during the final years of elementary education. In their critic, Gustafsson & Myhrström argue that previous academic achievement is positively correlated with current achievement while negatively correlated with the number of teacher hours allocated to a student. The study did not control for this variable, and might hence have underestimated the actual effect and made the wrong inference.[47] Individual studies have also been criticized for including independent variables with an excessively high correlation, inducing a case of multicollinearity where the individual coefficients are artificially small.[48]

Does the current state of knowledge imply that particular categorizes of resources can on average be assumed to be more important for academic results than others? Several studies have been conducted concerning the closely related concepts of class size and number of students per teacher. Gustafsson & Myhrberg cites the extensive STAR-project which evaluated the actual and subsequent performance of students that had been randomly assigned to smaller classes during early elementary schools. This study benefits from utilizing exogenous assignment to the treatment group and hence carries a high degree of credibility. The findings were that smaller class size in early elementary school had a significant positive effect on current and future academic performance and that this was persistent over time.[49] Lindahl reached the same result with a different method that in particular carefully controlled for compensatory resource allocation.[50] Gustafsson & Myrberg conclude that smaller class size has a beneficial effect, but also regard the success of schools employing large class sizes as evidence that small class size is neither a necessary nor a sufficient condition for high educational quality.[51]

A large numbers of studies investigating the connection between teachers' education, pedagogical abilities and workplace training have been conducted. See for example Strauss & Sawyers[52], Elliot[53] and Angrist & Lawy[54]. In their review, Gustafsson & Myrberg conclude

[47] Gustafsson & Myrberg (2002), p. 19-23
[48] Krueger (1999)
[49] Gustafsson & Myrberg (2002), p. 60-75
[50] Lindahl (2001)
[51] Gustafsson & Myrberg (2002), p. 86-87
[52] Strauss & Sawyers (1986)
[53] Elliot (1998)
[54] Angrist & Lawy (1998)

that the results of these studies are relatively uniform and that for all the relevant measures of teacher competence, the results seem to indicate a beneficial effect on academic achievement.[55]

In contrast, Gustafsson & Myrberg concludes that resources spent on venues and administration cannot be established as systematically correlated to student results, although the number of studies investigating this is far fewer than for class size or teacher competence.[56]

In summary, methodological difficulties notwithstanding there is empirical support for the hypothesis that more resources *can* result in better academic results. According to Gustafsson & Myhrberg, the current state of knowledge does however not support a *consistent causation* in this regard.[57] As the authors state, this may not be surprising since the way in which resources are spent should matter more than the amount of resources per say.

For the purpose of the following analysis, the important lesson from the research presented in this section is that increases or decreases in total resources committed to education have ambiguous effects on academic results. Hence, our regressions on total educational expenditures cannot ultimately support conclusions regarding the possibilities of providing efficient education. This does of course not prevent us from drawing other important conclusions, as for example whether competition is likely to trim the costs for education.

When considering particular subsets of total per student cost, the research presented above provides *some* evidence for the case that particularly teaching expenditures may be conducive to positive academic results (expenditures on teaching incorporates expenditures on further training for teachers as explained above).

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[55] Gustafsson & Myrber (2002), p. 139
[56] Gustafsson & Myrber (2002), p. 146
[57]Ibid.

4. The contribution of this thesis and research question

In this section we present (i) the way in which this thesis strives to enhance the current state of knowledge, (ii) the research question that constitutes the problem statement of this thesis.

4.1 The contribution of this thesis to the current state of knowledge

Our primary starting point is the studies referenced in section 3.2 and focused on the relationship between the prevalence of independent schooling at the elementary level and the costs for the municipality for such education. These studies focused on the period before 2004.

This thesis aims to widen the perspective. Firstly we focus on the period 2000-2010. This period saw rather marked changes in the student enrollment for the respective levels of education while competition from independent schools has simultaneously intensified (compare the graphs on page 9). Secondly, we include data for both levels of education (elementary and upper-secondary), while the cited studies where only concerned with the elementary level of education. Thirdly, we directly investigate whether fluctuations in student enrollment of public schools affect the per student cost for education which to our knowledge has remained unexplored by existing research.

We believe that inclusion of data for the upper-secondary level of education provides a broader view of the overall effects of the introduction of the voucher system. We also argue that scale effects of student enrollment within public schools should be tested econometrically as it has been a frequently cited theoretical explanation for potentially adverse effects of competition from independent schools.

In order to investigate the effects of increased prevalence of independent schooling we essentially base our approach on the methods employed in the study by Antelius et al. cited in section 3.2. Concerning the potential scale effects of student enrollment within public schools, we develop a model in section 5.1 below and investigate its implications. Firstly, will lower student enrollment result in higher total per student cost for the public schools? Secondly, and in order to analyze resource allocation, we also investigate the composition of the total average cost within public schools: will variable costs that are plausibly important for educational quality be relatively less prevalent on a per student basis as student enrollment decreases? This will be elaborated below.

4.2 The research question of this thesis

- *Does increased prevalence of independent schooling induce a higher total cost per student for the municipalities?*
- *Does lower student enrollment in public schools result in higher total average cost and more of the per student expenditures devoted to fixed costs?*

5. Modeling of per student costs in relation to student enrollment

In this section we (i) present a model which provides an explanation for returns to scale and (ii) attempt to apply the model to a context of educational expenditures. This section is relevant since it formalizes our reasoning and makes explicit the reasoning concerning possible scale effects.

5.1 Average total costs and returns to scale

We use the concept of average total cost. This is defined as total cost divided by the number of units of output, and it is also the sum of average variable cost and average fixed cost. Costs that are defined as fixed remain static over some time interval while variable costs change directly in response to the level of output. This dichotomy is in theory mutually exclusive and collectively exhaustive.

Average fixed costs will decrease asymptotically with increasing level of output. Marginal cost is defined as the cost of producing one additional unit of output and is often assumed to be increasing in total quantity of output. If this is the case, average variable cost is also increasing in total quantity. If the decrease in fixed costs per student with increased output is eventually offset by an increase in variable costs per student, we will find a convex function which can be written on the form:

$$y = a \cdot x^2 - b \cdot x$$

where y is average total cost and x is the level of output.

Graphically, the model can be depicted as in the picture below:

Diagram 4: depiction of a total average cost curve

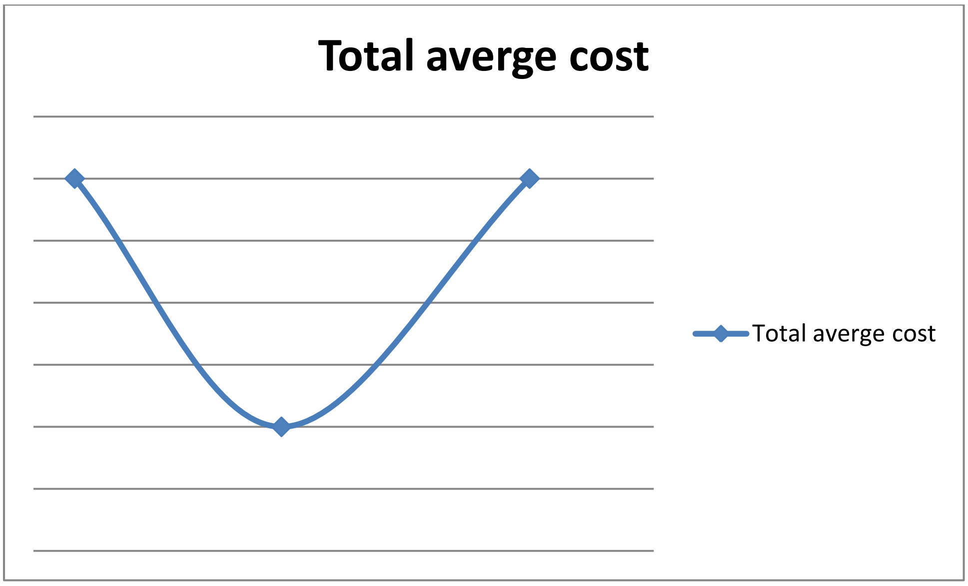
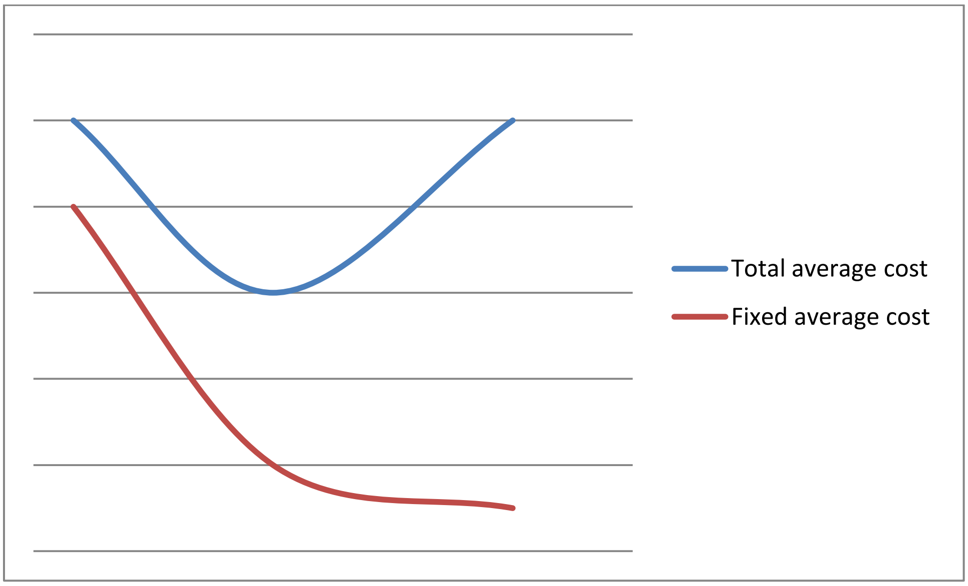


Diagram 5: depiction of total average cost together with average fixed cost



The model has several characteristics:

- ➔ we find the minimum by obtaining the derivative and setting the expression equal to zero, then solving for x: $x^* = \frac{b}{2a}$
- ➔ the minimum represent the most cost-efficient level of production

- ➔ to the left of the minimum, increased level of output will decrease average total cost. Conversely, to the right of the minimum, increased level of output will increase average total cost.

This model has the following testable implications: (i) higher total average cost with decreasing student enrollment to the left of the minimum; (ii) higher relative prevalence of fixed costs in the per student expenditures with decreased student enrollment.

There are other ways beyond the cited quadratic function in which returns to scale can be captured. We may want to consider the case in which all costs are largely fixed, producing a graph for total average cost similar to the one for average fixed cost in diagram 5 above. That would produce similar effects of scale but would affect the composition of the average total cost differently. This will be elaborated below.

5.2 Interpretation of the average cost model within a context of educational expenditures

In the context of educational expenditures, the average total cost is the cost per student and the level of output is the number of students enrolled. The model provides a possible link between these two variables.

It appears plausible that a school which operates below optimal capacity will be unable to alter capacity costs, at least within a limited time-frame. The total cost per student is then predicted to increase. An important qualification is that the extent to which total cost per student increases is dependent upon the development of more variable costs. If total variable costs are allowed to increase as well, the increase in total per student cost will be more substantial, while the effect upon variable cost as a fraction of total cost will be less pronounced.

This can be exemplified by comparing two cases. In both cases we assume that at an initial level of student enrollment the variable costs are equal to 60 and the fixed costs equal to 40, resulting in a total cost of 100. In the first case, a certain decrease in the student enrollment is assumed to increase average variable costs per student to 66 while fixed costs are increased to 44. Here the total cost per student will increase to 110, while the two cost types remain the same compared to total costs. This could correspond to the case when variable costs are increased in proportion to the fixed cost increase per student in order to maintain a target ratio. In the second case, the same decrease in the student enrollment will result in fixed costs of 50 while the variable costs remain at 60, resulting in the same total per student cost of 110. In this case, however, variable per student cost does not increase in proportion to the increase in fixed costs. Both cases entail the same economics of scale, but it is only in the second case that the composition of the total per student cost is affected.

Generally, the interval to the right of the minimum represent a situation where average capacity costs are low, while the marginal cost per student is high enough to offset the decrease in capacity costs per additional student enrolled. This may be thought of as representing a situation where expenditures are incurred in order to expand capacity which has become inadequately small for the number of students enrolled. Considering the examples in the previous paragraph, this turning point could only be achieved if the decrease in fixed costs per student is offset by a bigger marginal increase in the variable cost. In other words, a convex function requires that the variable costs at some point begin to increase more per student than the fixed costs decrease per student. In what follows this interval will be of less interest.

The model is a simplification in the sense that few costs are completely variable. Since there can be substantial fluctuations over time in the number of students applying for a particular program or course, a school may be unable to predict the need for particular teacher competence and hence not be able to alter teaching expenditures according to the student enrollment decrease. Nor are there many costs that are completely fixed. This is arguably a matter of time-frame; while costs for venues may be fixed in the short run, on a longer term basis they could arguably be at least partially reduced by for example subletting them to other actors.

It should of course also be noted that *costs for public schools* could be affected by competition in other ways than through the benefits of scale effects of fluctuating student enrollment. One cited example in section 3.1 above is that increased competition from independent schools may induce policy makers to commit more resources to public schools in order to increase their competitiveness.

Nevertheless, the model may be viewed as a valid approximation in the following sense. A school facing a decrease in student enrollment with certain costs remaining constant will have to increase average total cost sufficiently or face a decrease in more variable costs on a per student basis.

6. Methodology

Our methodology involves the following three components. Firstly, we perform regression analysis relating the total cost per student recorded as living in the municipality to the fraction of these students that attend an independent school for the upper-secondary and elementary levels of education respectively. Secondly, we test two implications of the model presented in section 5.2: higher total average cost respectively higher relative prevalence of fixed costs on a per student basis following decreased student enrollment in public schools.

The set of regressions described in component one and two above is the primary statistical investigation applied in this thesis. Thirdly, we perform further regression analysis on parts of the panel data to investigate if the effects differ between certain types of municipalities.

In this section we (i) present the data which is used in the statistical analysis, (ii) the general controls applied in the regression analysis, (iii) the first primary regression which relates total per student cost for education to the level of competition, (iv) the second and third primary regressions which relates total costs respective resource allocation within public schools to student enrollment, (v) methods for further statistical analysis employed to segments of data.

6.1 Data

We collect data for student enrollment and educational expenditures concerning the upper-secondary and elementary school for the 290 Swedish municipalities during the year 2000-2010 from the databases *Nyckeltal för kommunernas gymnasie och gymnasiesärskola efter kommun* and *Nyckeltal för förskoleklass, grundskola och obl. särskola efter kommun* respectively, which the Swedish statistical bureau *SCB* is responsible for. We use data attributable to ordinary school forms; that is to say not relating to the so-called special school (*särskolan*), which concerns students with severe leaning or behavioral difficulties. This is motivated on the grounds that these special schools may have different costs per student while constituting a minor part of the overall number of schools.

Firstly, we obtain the total average cost per student paid per municipality and year for the elementary and upper-secondary levels of education. This is used as the dependent variable in regression (1) presented in section 6.3 below. Secondly, we generate the total cost *per student* within the public schools per municipality at the respective levels of education, and subsequently also the expenditures for teaching, educational equipment, school lunches, venues and other as a fraction of total costs *per student* for public schools per municipality. The content of the mentioned subgroups of total per student cost has been explained in the section detailing resources and expenditures within the Swedish educational sector. Together the costs explicitly mentioned above constitute an average of about 80 percent of the costs for both public elementary and upper-secondary schools over the analyzed time-period, with other costs constituting an average of 20. These cost measurements specific to the public schools are used as dependent variables in regressions (2) and (3) presented below. Using data obtained from *SCB* we also calculate the fraction of immigrants to emigrants per municipality and year in the age groups eligible for student enrollment. This last measure is used as a control variable (see section 6.2 below).

From *Skolverket* we obtain the fraction of students recorded as living in the municipality who attended an independent school for each year in the period 2000-2010. From this source we moreover find variables describing characteristics of the municipalities: average taxable income, political majority, average distance between inhabitants in the municipality, the fraction of inhabitants who are not Swedish citizens and the fraction of immigrants to emigrants in the age groups eligible for the respective levels of education. Moreover and from the same source we obtain structural variables describing characteristics of the public educational sector in the respective municipalities. For both levels of education this includes the fraction of students recorded as living in the municipality who attend public school in a different municipality and the number of public schools. For the elementary level of education, we find the number of students per municipal school and the fraction of inhabitants in the municipality who are foreign citizens. For the upper-secondary level of education, a further available measure is the fraction of students enrolled in the public schools within the municipality who are recorded as living in a different municipality. Further, we can obtain the fraction of students in upper-secondary schools who have at least one parent born outside of Sweden.

The measures described in the previous paragraph are used as control variables in our regression analysis, and the rationale for introducing them is outlined below.

6.2 General regression format: controls for endogenity

In the below regressions we use data at the municipal level to test for effects of the independent variables student enrollment respective level of competition on a dependent variable which is various educational expenditures. The regressions test for correlations between the dependent and independent variables. The crucial concern in the below econometric analysis is that a potential correlation does not reflect causality. For various reasons, other variables could be correlated with both the independent and the dependent variable, resulting in a perceived effect of the independent variable that is in reality caused by some other factor. In the case when we analyze the effect of student enrollment, it is perfectly possible that students may be attracted to municipalities which have characteristics correlating with higher total cost (especially for the upper-secondary level, where movements across the municipal borders may be substantial). Concerning the analysis of the effects of competition from independent schools, it is hardly plausible that they are randomly assigned to municipalities, but rather that they establish themselves in municipalities with certain characteristics that may themselves influence the dependent variable total average educational expenditures.

The available remedy is to introduce controls for these factors. Since the observations are organized in a panel data set with the same municipalities appearing over several time periods we can introduce fixed effects for municipalities. This method will for each municipality calculate the effect of growth in the independent variables on growth in the dependent variable, and as a corollary of the differencing between time periods any factor which is constant over time per municipality will be eliminated. This is a generic form of control which addresses concerns of the type that municipalities with higher educational costs over the time period may attract more independent schools (that are compensated according to the public school cost per student), producing a spurious correlation between establishment of independent schools and higher educational costs. It should be noted that municipality fixed effects only correct for the factors that are constant over the time period. It follows that the value of this control is lower if many factors have changed over the time period, and – *ceteris paribus* – stronger if applied to a shorter time period. An available partial remedy is however to introduce time-varying variables as elaborated shortly below.

In addition to this, we use years as time-fixed effects controlling for occurrences in a certain year. This is clearly relevant to control for inflation if the dependent variable is expressed in nominal currency, but could also for example capture potential price fluctuations concerning educational material or food prices.

Beyond the generic controls we introduce a number of variables representing structural characteristics of the municipality which are plausibly correlated with both the expenditure measure and the measures for independent school prevalence respective student enrollment in public schools. These variables are potentially time-varying (and hence not corrected through municipality fixed effects). In the selection of these variables we also draw on Antelius study referenced above.[58]

Variables describing overall characteristics of the municipality are[59]:

1. **average taxable income in the municipality**: higher taxable income may *ceteris paribus* induce higher educational expenditures and may simultaneously be correlated with number of students in the municipality as well as with demand for and establishment of independent schools

2. **average distance between inhabitants living in the municipality**: this could reflect costs for transportation of students to school and also impact resource availability in the form of governmental subsidies[60]

3. a binary variable representing "**socialistic majority" in the legislative municipal body**: this may be correlated with priority assigned to educational expenditures and may also be negatively correlated with demand for of independent schools and the corporative stance of the municipality officials with regard to independent schools

4. **fraction of inhabitants aged 20-64 living in the municipality who are not Swedish citizens**: since the fraction of students enrolled in the public school with foreign background is not available for the elementary level of education, this variable is used to capture potential effects of costs for teaching native languages

[58] Antelius et al. (2004)
[59] A precise definition of the variables is found in appendix B
[60] Antelius et al. (2004), p. 11

5. **fraction of immigrants to emigrants for the respective municipality and consisting of individuals in the respective age groups eligible for student enrollment**: this can capture a source of student enrollment fluctuation affecting schools in the municipality

6. **fraction of students recorded as living in the municipality who attend an independent school**: this is introduced as a control variable in the regressions relating student enrollment in public schools to different measures of costs in public schools; this is motivated on the grounds that increased prevalence of independent schooling is expected to correlate with decreased student enrollment in public schools while simultaneously affecting costs in public schools through other mechanisms

Variables describing characteristics specific to the public educational sector in the municipality are:

7. **fraction of students recorded as living in the municipality who attend public school in a different municipality** at the elementary and upper-secondary levels respectively: this capture effects on municipal costs from students attending school in other municipalities where costs could be different and which are simultaneously arguably correlated with higher competition from independent schools in other municipalities

8. **fraction of students enrolled in the public schools who are recorded as living in a different municipality**: this reflects that a municipality will be compensated for costs incurred from harboring students from other municipalities

   This variable is only available for the upper-secondary level of education, but it is undoubtedly most relevant for this level of education since mobility across municipality borders is much more pronounced than at the elementary level.

9. **number of public schools**: this is expected to be correlated to the changes in the student enrollment and would also affect capacity costs and hence educational expenditures

10. **number of students per municipal school**: this is predicted to reflect potential effects of scale from larger schools; this measure is only available for the elementary level of education

11. **fraction of students in the public schools of the municipality with foreign background**: this is predicted to influence costs for teaching native languages and is presumably a more relevant measure than the fraction of municipality inhabitants who are not Swedish citizens

    Unfortunately, measure 11 is only available for the upper-secondary level of education.

The fixed effects specification entails that the coefficient for each variable in the regression represents the predicted effect of growth in the independent variable on the growth in the dependent variable per municipality.

A factor which we do *not* control for is the variability of educational programs at the upper-secondary level. There is every reason to expect that municipalities with higher prevalence of vocational programs will have higher total average costs for students living there (compare page 13 above). If the increase in the prevalence of independent schooling is correlated with the prevalence of vocational programs, a bias in the coefficients for regression (1) will arise. Similarly, regressions (2) and (3) will be biased if increases in the student enrollment in public schools are correlated with the prevalence of vocational programs. We do not have the necessary data to control for this, and this may be a reason to interpret the results for the upper-secondary level of education with caution.

Where indicated below we the variables in logarithmic form. This can be motivated partially on of grounds interpretative convenience, but also as it takes account of non-uniform effects of fixed unit increases. This is particularly relevant for a variable such as student enrollment. The number of students enrolled per observation in the panel data ranges from just a few to more than 18 000. There is consequently every reason to believe that a fixed number increase in the number of students enrolled in the public schools of a municipality will not be linear, and we may instead want to use a logarithmic variable. Throughout this thesis and for purposes of interpretative convenience, we refrain from using a fractional variable in logarithmic form.

When the dependent variable is expressed in logarithmic form, the interpretation of the coefficient is that it shows the percentage change in the in dependent variable for a one unit change in the independent variable (to be more precise the effect is equal to $100 \cdot \beta$ percentages per unit change in the dependent variable). When, instead, the independent variable is expressed in logarithmic form, the interpretation of the coefficient is the percentage change in the independent variable for a one-unit change in the dependent variable (the effect is equal to $\frac{\beta}{100}$ units per percentage change in the dependent variable).

Since the effects of the primary independent variable may not be linear, we test for functional form. This is accomplished through obtaining the residual in the regression where the independent variable is only present in linear form. This residual is subsequently squared and cubed and the resulting variables are introduced in the original regression. The null hypothesis is that neither variable is statistically significant, since the variation in the dependent variable should only be explained by linear variables. If the null hypothesis is rejected, a rationale for introducing higher order terms exists.

We also use robust standard errors in all regressions to correct for heteroskedasticity, that is to say that variance in the error term may not be constant across different values of the independent variable.

6.3 The total per student cost as a function of the level of competition

The municipality pays for each student recorded as living in the municipality, irrespective of what school that student is attending. Is the average of this cost affected by increased prevalence of independent schooling? To test this we use the following regression:

$$\mathrm{Y}_{\mathrm{i,t}} = \beta_0 + \partial_i + \gamma_t + \beta_1 \cdot fraction_{\,i,t} + \beta_X X_{i,t} + \in \qquad (1)$$

where $\mathrm{Y}_{\mathrm{i,t}}$ represents the total cost per student across public and independent schools in level form, *fraction* measures the fraction of students recorded as living in the municipality who attend an independent school, ∂_t is related to time fixed effects and γ_i represents municipality fixed effects. Finally, $\beta_X X_{i,t}$ represents controls for various characteristics of the municipality. We include control variables 1-6 and 8-11 with the restriction that all control variables are not available for both levels of education, as outlined above.

This regression investigates the general effect of competition and can be used to answer the question: is the total cost per student for the municipality predicted to increase with larger prevalence of independent schooling? To phrase it differently, can we achieve lower costs for education by allowing increased competition from independent schools?

6.4 Total costs and resource allocation within public schools as a function of student enrollment

The aim of this component of our methodology is to investigate the implications of the model of effects of scale presented in section 5.2 above. The first implication is that average total cost may increase with lower student enrollment, at least within a certain interval. A second implication is that fixed costs will constitute a higher fraction of the total average cost when student enrollment decreases. We use the below regressions:

$$\mathrm{Y}_{\mathrm{i,t}} = \beta_0 + \partial_i + \gamma_t + \beta_1 \cdot studenr_{\,i,t} + \beta_2 \cdot studenr_{\,i,t}{}^2 + \beta_X X_{i,t} + \in \qquad (2)$$

where $\mathrm{Y}_{\mathrm{i,t}}$ represents total per student cost within the public schools of the municipality in Swedish Crowns, *studenr* measures the student enrollment in public schools, while ∂_t, γ_i and $\beta_X X_{i,t}$ have the same interpretations as above. For both regressions (2) and (3) we additionally use the fraction of students recorded as living in the municipality as a control variable. In this specification we allow the total per student cost to be expressed as a non-linear function of the student enrollment. If the average cost curve presented above holds, the coefficient β_1 is predicted to be negative, while the coefficient β_2 should be positive. An alternative specification of this regression is to capture the non-linear influence of student enrollment by using the student enrollment variable in logarithmic form (instead of introducing a quadratic term). The rationale for this has been explained in section 6.2 above (that fixed unit increases may not have uniform effects across municipalities). We next turn to the second testable implication: will fluctuations in student enrollment affect the composition of the average total cost so that there is a higher relative prevalence of fixed costs?

$$\mathrm{Y}_{\mathrm{i,t}} = \beta_0 + \partial_i + \gamma_t + \beta_1 \cdot \ln\,(studenr_{\ i,t}) + \beta_X X_{i,t} + \in \tag{3}$$

where $\mathrm{Y}_{\mathrm{i,t}}$ represents different fractions of total educational expenditures while *studenr*, ∂_t and γ_i and $\beta_X X_{i,t}$ have the same interpretations as above. The components used as dependent variables in this regression are teaching, educational material, school lunches and other expenditures. We use the dependent variable in level form while the student enrollment variable is in logarithmic form. The interpretation of β_1 in the case of a fractional dependent variable deserves further comment. In this case the variable expresses by how many percentage points the fraction of total per student cost devoted to the relevant expenditure type changes in response to a one percent change in student enrollment. Concerning expenditures for teaching, educational material and school lunches, a positive sign for β_1 could be interpreted as evidence for higher fixed costs crowding out more variable educational expenditures on a per student basis when student enrollment decreases in accordance with the second testable implication of the model presented in section 5.1. Concerning costs for venues, a negative sign for β_1 could conversely be interpreted as higher student enrollment resulting in lower relative prevalence of costs for venues per student as this potentially fixed cost is spread out over a larger student population.

In summary, the two regressions proposed above aim to test whether lower student enrollment is related to higher total cost or higher relative prevalence of fixed costs on a per student basis or both for public schools.

6.5 Further statistical analysis

Establishment of independent schools has been largely occurring in the three urban regions of Stockholm, Göteborg and Malmö relative to the rest of Sweden. If the overall regression results are ambiguous it could be because of heterogeneity between these two groups of municipalities. To see if the effects of competition are generally similar across different types of municipalities, we run the regressions separately for the entire time period for the urban regions respective the remainder of Sweden. For the purpose of defining the respective groups, we use the official classification of municipalities made by the Swedish municipal and regional organization (*Sveriges Kommuner och Landsting*).[61]

A remaining concern is that the above controls may fail to capture important variables. Concerning regressions (2) and (3) in particular, there is also a potential problem of reverse causality as investments in educational quality could potentially attract students and hence influence the independent variable.

A more rigorous way to control for omitted variable bias and reverse causality between the primary independent and dependent variable would be to introduce two stage least squares. The method of two stages least squares works through selection of an instrument variable which should be correlated with the independent variables but otherwise not affect the dependent variable through any factor not controlled for in the regressions.

In the context of a panel data regression, the instrument variable must fulfill two requirements:

i) its growth per observation must be correlated with the growth in the explanatory variable

ii) it must not be correlated with the growth in the dependent variable except through the growth rate of the explanatory variable

These mutual requirements are not easily fulfilled. An example of a variable which is (negatively) correlated to the student enrollment in public schools is the number of independent schools. Hence, the first requirement is fulfilled. However, there is every reason to believe that the independent schools do not establish themselves randomly across municipalities. This makes the validity of the second assumption suspect, since characteristics of municipalities that are conducive to establishment of independent schools may also be correlated to various measures of costs for public schools. It could also be the case that competition from independent schools affects costs through other mechanisms, for example by affecting teacher salaries. We do not have data for variables which we consider valid as instruments.

[61] We use the categorization from 2005, available at the webpage of the association: http://www.skl.se/

7. Empirical results

Our results are shown as follows: we (i) first present the results of the primary regressions 1-3 and then (ii) the results of the methods of the further statistical methods outlined in section 6.5.

7.1 Primary regressions

A complete overview of our regression results are presented in **tables 1-8**. The results are below presented thematically, firstly addressing the total cost paid by the municipality and secondly the costs within the public schools.

Total educational cost and competition: the effects of the fraction of students enrolled in independent schools

For the elementary level of education, we find a statistically significant and linear negative effect on total costs per student for the municipalities. There is predicted decrease of 314 SEK following a one percentage point increase in the fraction of students recorded as living in the municipality that attend an independent elementary school. After testing for non-linear effects of the fraction variable according to the method presented in page 34, we find none. The estimated coefficient seems to imply that an increase in the fraction with eight percentage points (the average increase during the period) would convey a decrease in total costs for education per student of the municipality by 2512 SEK. This is in comparison to the average total cost for the home municipality which is about 75 000 SEK over the time period. See **table 4** for the full results of this regression.

For the upper-secondary level of education, we find a statistically significant positive linear effect on total per student cost (of 259.6 SEK per percentage point increase of the fraction). When we test for non-linearity, we find that the function is best described by introducing a quadratic term, which has a negative coefficient (-4.7 SEK). This would imply that total costs per student for the municipality increase in the fraction of students recorded as living in the municipality who attend an independent school until the fraction is equal to 27.6; thereafter the cost is decreasing in the fraction. The number of observations that has a fraction above this number is only 176 out of 3168, implying that the positive effect on total costs is of greater relevance. The values should be compared to the average total cost per student for the municipality of about 91 000 SEK over the period. See **table 1** for the full results of this regression.

It should be noted that the data material contains greater percentage point increases for the upper-secondary level of education than for the elementary level. To be more specific, a typical actual increase in the fraction of students enrolled in independent education at the upper-secondary level may be more than twice as big as a corresponding increase at the elementary level during the researched period. The practical significance of the estimated increase per fraction percentage point must of course be interpreted against this background.

Costs within public schools and student enrollment

For the upper-secondary level of education, we find a statistically significant effect of changes in the student enrollment on total cost per student for the public schools (the first implication of the model presented in section 5.1). This effect is quadratic, with a negative coefficient on the linear term (-39.85 SEK) and a positive coefficient on the quadratic term (0.0022 SEK). This yields the hypothesized convex function, with a turning point of 9057 students, which is less than the value for all but 29 observations in the sample. Since the student enrollment in this regression is measured in number of students, the estimated effects of scale are not negligible. According to this regression then, a decrease of 300 students is for example predicted to increase the total cost per student by 12 894 SEK in an average Swedish municipality. An alternative specification of the same regression is to capture the non-linear effect by using the number of students in logarithmic form. In this case, the coefficient for student enrollment is – 38736.49. Since the independent variable is measured in logarithmic form, the effect of a one percentage decrease in the student enrollment is interpreted as a $\frac{\beta}{100} = \frac{38736.49}{100} = 387.36$ SEK increase in the cost per student. Hence, a 50 percentage decrease in the student enrollment is predicted to result in a 19 368 SEK increase in the cost per student. There are of course reasons to believe that this specification results in a generally more correct magnitude of the benefits of scale, since a fixed number decrease in student enrollment should have more impact for a municipality with a lower level of student enrollment and since student enrollment across the sample ranges from just a few students to more than 18 000. See **tables 7.1–7.2**

Beyond these overall effects of scale, we estimated the effects on various components of the total per student cost as a fraction of total costs per student (the second implication of the model in section 5.2). None of these correlations showed signs of non-linearity, and student enrollment is here measured in logarithmic form. Teaching as a fraction of total costs is statistically insignificant, while the point estimate is 1.29. Since student enrollment is measured in logarithmic form, we recall from the paragraph above that the correct interpretation is that a $\frac{\beta}{100} = \frac{1.29}{100} = 0.0129$ percentage points' change in the fraction of teaching expenditures to total costs will follow in response to a one percent change in the student enrollment. Such effects are rather negligible, since it implies that a 25 percent decrease in the student enrollment will only result in a 0.32 percentage points' decrease in the fraction of teaching relative to total costs (this should be seen against the background that teaching expenditures constitute an average fraction of circa 47 percent of total costs during the time period). See **table 7.3**.

The effects of changes in student enrollment on educational material, school lunches and venues as a fraction of total cost are all positive and statistically significant. The point estimates are 1.59, 0.63 and 2.46 respectively. The predicted effect of a one percentage decrease in the student enrollment is in other words that educational material, school lunches and venues decrease as a fraction of total costs with 0.016, 0.0063 and 0.025 percentage points respectively. Once again the effects appear practically negligible. See **tables 7.4-7.6**.

We do however find that the remaining and uncategorized costs decrease as a fraction of total costs with a statistically significant coefficient of -5.9. This coefficient is also the least practically insignificant, since for example a 25 percent decrease in the student enrollment would increase this fraction with $25 \cdot 0.059 = 1.475$ percentage points (compared to the average of this fraction which is around 20 percentage points).

For the elementary level of education, we find no statistically significant results concerning the effects of decreasing student enrollment on total costs. As described by a quadratic relationship, neither of the coefficients is statistically significant and both are also extremely small. Nor is the effect on any particular cost as a fraction of total cost statistically significant. See **tables 8.1-8.7**. It should however be noted that in **table 8.1**, the control variable constituting the number of students per public elementary school is negatively correlated with total average cost. This could possibly be indicative of effects of scale, which will be discussed later.

In summary, a striking difference between the levels of education is that total costs per student within public upper-secondary schools appear to be much more sensitive to fluctuations in student enrollment than in public elementary schools. This does not necessarily reflect a causal effect, however, as discussed in the analysis section.

7.2 Further regressions

In order to investigate the studied statistical phenomena more closely, we conduct regressions (1), (2) and (3) for two different data sets containing only the observations from municipalities in the three primary urban regions of Sweden (Stockholm, Göteborg and Malmö) and the remaining municipalities of the country respectively.

The regression results for the upper-secondary level of education are shown in **tables 2-3** respectively commented on in connection to **table 7**. The urban regions show: i) a stronger predicted increase in total educational costs associated with a given increase in the fraction of students attending independent schools; ii) a stronger increase in total cost for public schools as a consequence of decreased student enrollment; iii) less distinct effects on the composition of the total per student cost in public schools following changes in student enrollment.

Concerning the effects of increased prevalence of independent schools, the urban regions show estimates for the linear and quadratic terms of 620.5 and -10 respectively, while they are 75.6 and 1.53 in the remaining country. The latter terms are not statistically significant. As mentioned in connection to **table 7**, the terms in the regression describing the total cost per student in municipal schools are -45.17 and 0.0033 in the regression which excludes the urban regions, while the group of urban regions has estimates of -56.8 and 0.0028. In the alternative logarithmic specification, we find a decrease of 316.84 SEK in response to a one percentage increase of the student enrollment while the corresponding coefficient for the three urban regions is 875.78 SEK. These differences are certainly noteworthy.

For the elementary level of education the findings are summarized in **tables 5-6** respectively commented on in connection to **table 8**. They indicate that an increase in the fraction of students attending an independent school has a smaller negative effect in the three urban regions than for the remainder of the country (namely, -192.94 compared to -254.53). Concerning the total per student cost in the public schools and its components, we find that the results remain insignificant for either group of municipalities.

8 Analysis of the empirical results

In this section we discuss possible interpretations of the above results and to what extent they cast light on the respective components of our research problem. Specifically, we evaluate whether the regression results conclusively reflect causal effects of changes in the respective primary independent variables. We (i) discuss the correlation between the fraction of students living in the municipality that is enrolled in an independent school and the total per student cost for education as well as (ii) the correlation between the student enrollment and costs for public schools

8.1 The effects of competition on total average educational costs paid by the municipality for each inhabitant student

Main econometric findings

In summary, the econometric analysis shows that for the period 2000-2010 total costs for elementary education did on average decrease when the fraction of students enrolled in independent schools increased in the municipality. For the secondary level of education, the picture is reversed. For the three urban regions of Stockholm, Göteborg and Malmö, the positive effect of increased competition on total average cost is decisively stronger than for the other parts of Sweden, in fact to the extent that this effect appears to be primarily an urban region phenomenon. This can be seen in **tables 1-6**.

The part of our investigation presented in **tables 4-6** closely replicates the study by Antelius et al. referenced in section 3.2, but in contrast to that study we find statistically significant *negative* results for the urban regions as well.

What effects of competition do the regression results reflect?

As discussed in section 3.1, contrary theoretical arguments can be mobilized to predict the effects of competition on total costs for education. We have also found differing effects across levels of education and geographical regions. This can give rise to several interpretations.

It should be emphasized that the public upper-secondary schools have faced a higher level of competition from independent schools, both within their municipalities and across municipality borders (the latter reflects that upper-secondary students are significantly more mobile). It *could* be the case that modest levels of competition generally induce cost rationalization, while higher levels of competition entails that opposite effects become dominant.

It should, however, be noted that we find larger *cost decreases* following increases in competition for the elementary level of education than did Antelius et al., while we studied a period when the competition was higher for that level. This seems to indicate that differences between elementary and upper-secondary schools are explained by other factors than just that a larger fraction of upper-secondary students attend independent schools than the corresponding fraction of elementary students.

Another interpretation which may be particularly relevant for the upper-secondary level of education where students are more mobile within and across municipalities is that high competition changes the composition of students. Possibly, public schools disproportionally lose study orientated pupils, forcing them to commit additional resources to maintain the educational outcomes.

Further of interest are the effects of decreased student enrollment on total costs and resource allocation within public schools. For the public upper-secondary schools such effects were discernible, while no significant results in this regard could be detected for the elementary level of education. It could be the case that this higher sensibility to fluctuating student enrollment is reflected in competition as an overall cost driver for upper-secondary education. However, the observed lack of significance for the elementary level of education does not obviously reflect a real lack of correlation. This will be discussed in the next section.

Concerning the variation across geographical regions, competition could systematically take a different shape in three primary urban areas. For the elementary level of education and contrary to Antelius et al., we did not find opposite results comparing these regions to the remainder of Sweden. But while the effect of competition was a decrease in total educational costs also for the urban regions, this effect was decisively smaller. Referring to the results of the regression corresponding to the upper-secondary level of education, the effects of competition that decreases total educational costs generally appear to be weaker in the regions of Stockholm, Göteborg and Malmö. Compared to the rest of the country, the competition could be less complementary to public schools. One may hypothesize that independent schools have been approved and established in spite of declines in the student population and contrary to public school interest. Moreover the regions may be characterized by higher marginal propensity to shift to independent education and a subsequent disproportionately large interest from entrepreneurs to establish themselves. In contrast, the remaining municipalities may to some extent have been complemented by independent school establishment reducing the need for investments in for example new buildings. A further potential adverse characteristic is that student mobility across municipality borders in these regions is particularly high, which could make a decrease in student enrollment more unpredictable (it should be remembered that the measure of independent school enrollment applied in this thesis captures such enrollment both within and outside the particular municipality). For the upper-secondary level of education, the extent to which independent schools offers the same educational programs as the public competitors must also be taken into account. It could be the case that the municipal schools in the urban regions face more adverse competition, directed towards their own goal-group of students.

A second hypothesis is that the urban municipalities have been more generous in increasing public school educational expenditures in response to competition. Thirdly, it could be the case that municipalities in these regions have applied a more generous interpretation of the legal requirements regarding the size of the voucher, meaning that students enrolled in independent schools have systematically cost more in these municipalities.

On a final note, we should caution against spurious regression results. While several controls have been employed to isolate the effect of increased competition, the issue of omitted variable bias may remain. A particular concern for the upper-secondary level of education is that variations in the educational programs offered by the respective schools could correlate with the prevalence of independent schooling, and hence contribute to spurious results (compare section 6.2). Possibly, the establishment of independent schools primarily involves vocational programs with high per student costs. This can be the real reason behind the observed cost increases. The problem could be at least partially controlled for with access to data from the sample period for the fraction of students that attend various types of programs.

It could also be the case that growth in the total cost of education results in changes of the fraction of students enrolled in independent schools. If it is expected that public school costs increase in the municipality, independent schools might choose to establish themselves there to receive higher voucher payments. Plausibly, however, the most serious form of reverse causality bias has been controlled for by choosing the fixed effects specification. It appears more likely that growth in the analyzed fraction carries effects on educational costs than that independent schools predict the per municipality change in per student educational cost and establish themselves accordingly.

An important conclusion from the results of regression (1) is however that we do not see a dramatic lowering of educational costs for the municipalities following increased prevalence of independent schools in any case. While the estimated coefficient of -314,6 SEK for the elementary level of education may appear large, it is to be seen against the background that actual increases in the fraction of students enrolled in independent elementary schools have been limited to relatively few percentage points during the period (certainly not rivaling the corresponding increases for the upper-secondary level of education). Hence, neither the elementary nor the upper-secondary levels of education offer examples of radically lower costs induced by competition.

Do the estimates convey relevant effects of competition?

The problem statement concerning the effects of competition employed in this thesis was very precise: does an increase in the fraction of students attending independent schools result in changed total average costs for education?

Firstly, this obviously leaves out a myriad of potential effects of competition from independent schools that are not reflected in changed total average costs. These include a potentially greater choice set between alternative modes of education and pedagogical techniques, incentives to use existing resources more or less efficiently, overall effects on teachers' working conditions, adverse social effects of segregation between independent and public schools and many other factors. Several of these effects are clearly very relevant, but beyond the scope of this thesis.

Secondly and as the present state of knowledge concerning the pedagogical production function (see section 3.3) indicates, the practical significance of the estimated effects is far from obvious. If the fraction of students enrolled in independent upper-secondary schools increases, it may well increase the per student cost for the municipality with some hundred Swedish Crowns, but what does it ultimately entail for the possibilities to provide students with a high-quality and beneficial education?

But seen from the alternative angle that a primary argument for the voucher reform was the ability of competition to trim costs within the public educational sector, the predicted effects appear to be much more relevant, as they indicate that this policy goal may not have been fully achieved. While costs for elementary education have been lowered following increased competition, the opposite has been true for upper-secondary schools, at least in the urban regions where the competition has been most intense. Moreover, the practical significance of the observed decrease per percentage point for the elementary level of education must be seen against the background that the average increase is only eight percentage points compared to more than twice as much for the upper-secondary level of education (compare above).

Conclusion

What the regression results seem to point to is that: i) an increased level of competition is not today in any case dramatically lowering the costs for education within the Swedish educational system; ii) the cost consequences of competition are highly contextual, as they differ dramatically across levels of education and across geographical regions.

With reference to the previous studies cited in section 3.2 our results seem to support the conclusion drawn in the study by Antelius et al. that effects of competition are context-dependent. It could of course still be the case that independent schools universally provide strong positive results through other effects of competition, but it is not through inducing dramatically lower costs for education for the taxpayers.

8.2 The effect of student enrollment upon costs for public schools

Main econometric findings

As mentioned in section 7 our results show a clear contrast between the upper-secondary and elementary levels of education. For the upper-secondary level we find evident effects of scale, as increasing student enrollment is predicted to decrease the total per student cost. We also find that the composition of the average upper-secondary student cost in public schools changed only marginally following fluctuations in the student enrollment. For the elementary level of education we find no discernible effects of changing student enrollment on total average student cost in public schools. No correlation could be established. Similarly, the components of average student cost were not expected to change as a consequence of changes in the student enrollment.

Comparing the three urban regions to the rest of Sweden, we find that the predicted cost increase that follows from decreased student enrollment is significantly larger, but also that the effects on the composition of the total per student cost are less conclusive.

How does changes in student enrollment affect total per student cost and resource efficiency within public schools?

Concerning the upper-secondary level of education, the results appear to support that decreasing student enrollment which for example results from competition may induce higher cost within public schools (in accordance with the first testable implication of the model).

It must be said that the second testable implication of the model presented in section 5.1 does not appear to be fully satisfied. Changes in the composition of the total average cost are not practically large, and expenditures for venues actually increase marginally as a fraction of total average cost with increased student enrollment. Particularly concerning cost for venues, one interpretation is that they can be reduced more efficiently than we anticipated. Perhaps the municipality can find alternative uses for the buildings by locating other activities there or by renting the venues to other actors. This could potentially make the costs for venues more variable, even in the short term. Another complementary interpretation is that total costs are increasing faster than the cost for venues, that is to say that the fractional nature of the variable affects the result.

On a general level, it could be the case that all the expenditures are relatively fixed, so that the composition on a per student basis is not altered. This might reconcile returns to scale within the upper-secondary municipal schools and lack of evidence of decreases in the fraction of variable costs per student, and explain the apparent failure of the second testable implication of the model presented in section 5.2. This could be further studied by investigating changes in the absolute level of various expenditures per student.

A matter of fact is that the regression results leave us in the unsatisfactory position of not knowing what other costs increases relative to total costs when student enrollment decreases. It is beyond the scope of this thesis to apply a further investigation, but based on the method of exclusion we can consider what is left when teaching; educational material, school lunches and venues have been accounted for. These remaining costs constitute an average fraction of 20 percentage points during the time period and would include costs for student health care, various costs for administration, costs for paid union activities, costs for other personnel than teachers, etc.[62]

[62] Compare the cost-definitions issued by *Skolverket*

For the elementary level of education we find no statistically significant results of decreasing student enrollment. Comparing this to the regression analysis which was focused on determining the effects of competition from independent schools, it may seem suggestive that the higher sensibility to lower student enrollment explain part of the phenomena that competition is a cost-driver for upper-secondary but not elementary schools. However, total student enrollment at the elementary level of education in the municipality may be a crude measure for two reasons. Firstly, there are typically a large number of public elementary schools per municipality (in contrast to the situation at the upper-secondary level). A large fluctuation in student enrollment could have very different effects depending upon whether it is centered to relatively few schools or is dispersed across a large number. Secondly, fluctuations in student enrollment should arguably have different effects depending upon which level of schooling is affected; the impact on the school operations from accommodating fewer first graders could plausibly be different from the impact of accommodating fewer last year graders.

It should also be noted that the control variable *average number of students per public school in the municipality* is negatively correlated with costs in public schools; if the average elementary public school enrolls more students costs are lowered. This could be interpreted as a sign that there are after all scale effects which the student enrollment variable in this case fails to capture.

There *could* however be plausible reasons as to why fluctuations in student enrollment should be more strongly tied to cost increases in upper-secondary schools.

One possible explanation is that the student turnover is substantially higher for public upper-secondary schools than for elementary schools. Since the upper-secondary school only comprises three years, a substantial fraction of the students will graduate every year and it is not known beforehand how many students will replace them. In comparison, most elementary schools comprise six years or more. As a consequence, short-term adaption of capacity may generally be more difficult for upper-secondary schools, resulting in higher fixed costs per student and hence lower variable costs as a fraction of total costs. This could be magnified by the fact that public upper-secondary schools are typically constructed to accommodate large number of students compared to public elementary schools. Our results for upper-secondary schools seem to indicate that at this level of aggregation the different costs have on a per student basis largely increased in proportion, with the uncategorized costs however taking a larger relative share. This of course entails a larger increase in total per student cost than if merely one component had been increasing while the other costs had been maintained at the same absolute level.

Another potential factor that could make student enrollment more unpredictable for upper-secondary schools is the mobility of students. At the elementary level, most students attend a school located in their immediate vicinity. The older and more independent upper-secondary school students often leave the neighborhood (or even the municipality).[63] Hence, the upper-secondary schools enjoy lower barriers to entry from competitors than the elementary schools. When competition is unpredictable it may be harder to plan for fluctuations in student enrollment beforehand. This could also constitute a partial explanation to the greater observed returns to scale within urban regions.

Without a more nuanced measure of student enrollment in elementary schools, for example accommodating the different stages of education, we believe it to be difficult to further investigate the content of the observed disparity between upper-secondary and elementary levels of education.

Finally, we should caution against the possibility that the regressions are subject to spurious correlations. It could be the case that there are omitted variables. As in the previous set of regressions a potential concern is that changes in the educational programs offered by upper-secondary schools could distort the results. This has been discussed in section 8.1 above. An example for these regressions is that an upper-secondary school which introduces a new educational program with higher costs may attract more students through that program. Such concerns can of course not be completely invalidated. In these particular regressions, there is also the possibility that a school which increases per student educational expenditures will attract students rather than that more students will result in lower per student cost. These potential problems could in principle be addressed by applying a valid instrumental variable, but as explained in the methodology section this may not be easy in the context of a panel data regression of this nature and the thesis does not attempt that approach. It should be emphasized that the reverse causality case presupposes that changes in expenditures directly influence the choice of school by students.

[63] This is a plausible interpretation of the high mobility of students across municipality borders at the upper-secondary level of education

Conclusion

Decreased student enrollment appears to make education within public upper-secondary schools more expensive, in accordance with the model presented in section 5.1. We do not find evidence of increased relative prevalence of fixed costs, which could be for several reasons. For the elementary level of education we do not find that student enrollment affects costs within public schools, but this could possibly reflect crudeness in the measurement variable.

9. Conclusion

The important results of this thesis can be summarized as follows:

- ➔ the impact of increased prevalence of independent schools differ significantly across levels of education and types of municipalities, presumably reflecting underlying characteristics of the competition
- ➔ there is support for the notion of benefits of scale within the upper-secondary public schools as lower student enrollment is observed to increase average total costs, and while such effects cannot be verified for the elementary level of education it is possible to argue that this reflect crudeness in the student enrollment measure for elementary education

In the introduction of this thesis we cited the positive vision of competition within the educational sector as a driver of lower costs presented by the Swedish legislators when the voucher system was implemented. Our findings suggest that the impact of competition upon expenditures for the overall educational sector is context dependent. For different levels of education and different geographical regions, we saw non-uniform results. This is however in itself a refutation of the vision of competition from independent schools as a universal instrument for achieving lower cost. It is particularly so since the upper-secondary level of education in urban regions (where the competition has been most intense) shows practically large cost increases associated with competition.

This non-uniformity also indicates that underlying characteristics of schools and their environment can influence the effects of competition. It appears as if incentives to rationalize can be offset by other factors. This may give policy-makers pause concerning the carefulness with which anticipated effects of allowing independent schools to establish themselves should be evaluated. Another normative implication to which the results of the thesis lends some tentative support is that decisions concerning establishment of independent schools should be decentralized as local circumstances such as the compatibility of competition to the size of the total student population are plausibly important for the actual effects of competition. While the Schools Inspectorate is obliged to take account of local circumstances as outlined in section 2.1, a more direct role for the municipalities might be desirable.

We find support for the notion that decreasing student enrollment in public upper-secondary schools may be a mechanism through which competition drives higher per student costs for public education and hence higher overall educational costs. This constitutes a possible link between the two components of the research question. Admittedly, we could not establish statistically significant effects of decreased overall student enrollment in public elementary schools. Our hypothesis is that this may reflect differing impact from changed student enrollment in a municipality depending on whether the changes are centered to particular municipal schools or dispersed across many schools respective uneven effects depending on affected years of education. We lack the data to test this hypothesis more carefully.

Low costs for education are obviously not an end in itself, and higher costs for education could be justified if they entailed more efficient resource allocation. The results of the thesis lend some support to the notion that decreases in student enrollment in public upper-secondary schools not only results in higher per student costs but also that this increase does not correspond to increases in the fraction of total costs devoted to quality investments such as teaching and educational material.

Some concerns regarding econometric validity remains as omitted variable bias cannot be completely dismissed. This has been extensively discussed in the analysis section. Beyond applying a more rigorous econometric approach, we see as avenues for future research to formulate more specific hypothesis concerning effects of particular contextual factors such as for example the connection between high student mobility across municipality borders and higher costs induced by competition. In the analysis section we have suggested several *plausible* connections between such structural factors and competition outcome but which have unfortunately been beyond the scope of this thesis to test.

On a final note, the difficulties in assessing the ultimate impact of competition go much deeper than those encountered in this thesis. To consider this question we must establish the effects of competition on a *valid measure* of educational quality, which may be far from easy. If we want to take account of social outcomes such as segregation and equal access to education the problems will be even more pronounced.

Thus our results cast doubt on independent education as a driver of cost efficiency but does not account for many of the other (and arguably more important) effects of a voucher system. On the other hand the results may serve to illustrate how particular structural features can undo the expected ability of markets to induce cost rationalization.

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Tables

Comment: We use three stars (***) to signify that a coefficient is statistically different from zero at the 1 percent level, two stars (**) to signify that it is so at the five percent level and finally one star (*) to signify that it is statistically different from zero at the 10 percent level. When a dependent variable is expressed in SEK it means that the coefficient shows the effects of changes in the independent variable in Swedish Crowns.

Table 1

Panel data regressions for the upper-secondary level of education, relating total per student municipality expenditures in SEK to the fraction of students enrolled in independent schools, with fixed effects applied to municipalities and years for the period 2000-2010

Number of observations: 2757
Number of municipalities: 267
R-square: 0.3545

	Coef.	Robust Std. Err.	t	P>t	Significance
Fraction enrolled in independent schools	259,57	107,78	2,41	0,02	**
Fraction enrolled in independent schools, squared	-4,70	1,81	-2,60	0,01	***
Fraction enrolled in public schools in different municipality	-96,74	46,13	-2,10	0,04	**
Average taxable income	0,06	0,06	0,99	0,32	
Socialist majority	-563,51	567,86	-0,99	0,32	
Average distance between inhabitants	19,95	13,36	1,49	0,14	
Fraction of students in public schools from different municipality	13,68	34,79	0,39	0,69	
Number of public schools in the municipality	75,05	276,86	0,27	0,787	
Fraction of students with foreign background	-44,69	26,38	0,39	0,69	
Net immigration to the municipality of students	843,63	714,55	1,18	0,24	
Constant	67747,19	7498,40	9,03	0,00	***

Table 2

Panel data regressions for the upper-secondary level of education in the three urban regions Stockholm, Göteborg and Mamlö, relating total per student municipality expenditures in SEK to the fraction of students enrolled in independent schools, with fixed effects applied to municipalities and years for the period 2000-2010

Number of observations: 432
Number of municipalities: 41
R-square: 0.1361

	Coef.	Robust Std. Err.	t	P>t	Significance
Fraction enrolled in independent schools	620,53	230,70	2,69	0,01	***
Fraction enrolled in independent schools, squared	-9,99	3,26	-3,06	0,00	***
Fraction enrolled in public schools in different municipality	-269,36	103,34	-2,61	0,01	***
Average taxable income	0,09	0,09	0,95	0,35	
Socialist majority	-1125,00	1082,99	-1,04	0,31	
Average distance between inhabitants	-17,22	25,62	-0,67	0,51	
Fraction of students in public schools from different municipality	84,74	44,25	1,92	0,06	*
Number of public schools in the municipality	-327,17	479,07	-0,68	0,5	
Fraction of students with foreign background	-7,39	49,77	-0,15	0,88	
Net immigration to the municipality of students	-753,06	1888,84	-0,4	0,69	
Constant	79731,96	22242,82	3,58	0,00	***

Table 3

Panel data regressions for the upper-secondary level of education in the municipalities not belonging to the three urban regions, relating total per student municipality expenditures in SEK to the fraction of students enrolled in independent schools, with fixed effects applied to municipalities and years for the period 2000-2010

Number of observations: 2325
Number of municipalities: 226
R-square: 0. 4041

	Coef.	Robust Std. Err.	t	P>t	Significance
Fraction enrolled in independent schools	75,57	148,35	0,51	0,61	
Fraction enrolled in independent schools, squared	1,53	4,03	0,38	0,70	
Fraction enrolled in public schools in different municipality	-43,15	47,95	-0,90	0,37	
Average taxable income	0,11	0,01	1,17	0,24	
Socialist majority	-496,22	614,49	-0,81	0,42	
Average distance between inhabitants	24,74	15,13	1,64	0,10	*
Fraction of students in public schools from different municipality	10,01	41,01	0,24	0,81	
Number of public schools in the municipality	154,24	353,64	0,44	0,663	
Fraction of students with foreign background	-53,22	29,20	-1,82	0,07	*
Net immigration to the municipality of students	914,33	776,71	1,18	0,24	
Constant	59523,53	10941,52	5,44	0,00	***

Table 4

Panel data regressions for the elementary level of education, relating total per student municipality expenditures in SEK to the fraction of students enrolled in independent schools, with fixed effects applied to municipalities and years for the period 2000-2010

Number of observations: 3164
Number of municipalities: 289
R-square: 0.6498

	Coef.	Robust Std. Err.	t	P>t	Significance
Fraction enrolled in independent schools	-313,95	51,94	-6,04	0,00	***
Fraction enrolled in public schools in different municipality	324,68	242,32	1,34	0,18	
Average taxable income	-0,04	0,05	-0,90	0,37	
Socialist majority	-584,09	362,40	-1,61	0,11	
Average distance between inhabitants	24,22	11,08	2,19	0,03	**
Number of students per public school	-19,76	9,30	-2.12	0,03	**
Number of public schools in the municipality	-125,31	86,21	-1,45	0,15	
Fraction of adults with foreign citizenship	-123,77	103,11	-1,20	0,23	
Net immigration to the municipality of students	-398,14	287,16	-1,39	0,167	
Constant	62300,54	6397,91	9,74	0,00	***

Table 5

Panel data regressions for the elementary level of education in the three urban regions of Stockholm, Göteborg and Malmö, relating total per student municipality expenditures in SEK to the fraction of students enrolled in independent schools, with fixed effects applied to municipalities and years for the period 2000-2010

Number of observations: 450
Number of municipalities: 41
R-square: 0.4576

	Coef.	Robust Std. Err.	t	P>t	Significance
Fraction enrolled in independent schools	-192,54	83,21	-2,31	0,03	**
Fraction enrolled in public schools in different municipality	462,18	313,11	1,48	0,15	
Average taxable income	-0,08	0,10	-0,81	0,43	
Socialist majority	-639,68	823,06	-0,78	0,44	
Average distance between inhabitants	0,94	17,82	0,05	0,96	
Number of students per public school	-8,38	14,24	-0,59	0,56	
Number of public schools in the municipality	-36,57	65,52	-0,56	0,58	
Fraction of adults with foreign citizenship	-123,77	103,11	-1,20	0,23	
Net immigration to the municipality of students	-239,29	622,48	-0,38	0,703	
Constant	108366,10	18773,07	5,77	0,00	***

Table 6

Panel data regressions for the elementary level of education in the municipalities not belonging to the three urban regions, relating total per student municipality expenditures in SEK to the fraction of students enrolled in independent schools, with fixed effects applied to municipalities and years for the period 2000-2010

Number of observations: 2714
Number of municipalities: 248
R-square: 0.7294

	Coef.	Robust Std. Err.	t	P>t	Significance
Fraction enrolled in independent schools	-254,45	73,36	-3,47	0,00	***
Fraction enrolled in public schools in different municipality	307,29	262,94	1,17	0,24	
Average taxable income	0,05	0,06	0,80	0,43	
Socialist majority	-594,20	388,06	-1,53	0,13	
Average distance between inhabitants	22,83	11,37	2,01	0,05	**
Number of students per public school	-20,45	11,75	-1,74	0,08	*
Number of public schools in the municipality	-139,32	119,02	-0,9	0,368	
Fraction of adults with foreign citizenship	-98,41	109,11	-0,90	0,37	
Net immigration to the municipality of students	-376,97	300,24	-1,26	0,21	
Constant	51574,47	8033,89	6,42	0,00	***

Table 7

Panel data regressions for the upper-secondary level of education, relating total average cost within public upper-secondary schools in SEK respectively different expenditures as a fraction of total average cost to the number of students enrolled in these schools within the municipality, with fixed effects applied to municipalities and years for the period 2000-2010

7.1 – total average cost within public schools as function of student enrollment within these schools

Number of observations: 2682
Number of municipalities: 260
R-square: 0.1544

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment	-39,85	12,22	-3,26	0,00	***
Student enrollment, squared	0,0022	0,0007	3,32	0,00	***
Fraction of students enrolled in independent schools	242,59	274,98	0,88	0,38	
Fraction enrolled in public schools in different municipality	117,21	270,44	0,43	0,67	
Average taxable income	0,62	0,59	1,06	0,29	
Socialist majority	-2719,66	1621,97	-1,68	0,10	*
Average distance between inhabitants	-26,75	47,94	-0,56	0,58	
Fraction of students in public schools from different municipality	391,51	204,60	1,91	0,06	*
Number of public schools in the municipality	-69,21	502,54	-0,14	0,89	
Fraction of students with foreign background	-278,22	169,19	-1,64	0,10	*
Net immigration to the municipality of students	366,86	3236,97	0,11	0,91	
Constant	42602,44	52995,32	0,80	0,42	

7.2 – total average cost within public schools as a function of student enrollment, but with student enrollment expressed in logarithmic form

Number of observations: 2682
Number of municipalities: 260
R-square: 0.1544

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment, logarithmic	-43170,76	9425,16	-4,58	0,00	***
Fraction of students enrolled in independent schools	-576,57	331,41	-1,74	0,38	
Fraction enrolled in public schools in different municipality	-830,44	377,89	-2,20	0,03	**
Average taxable income	0,54	0,52	1,04	0,30	
Socialist majority	-2319,39	1416,12	-1,64	0,10	*
Average distance between inhabitants	-61,00	50,96	-1,20	0,23	
Fraction of students in public schools from different municipality	835,46	235,73	3,54	0,00	***
Number of public schools in the municipality	-223,56	506,73	-0,44	0,66	
Fraction of students with foreign background	-257,16	162,80	-1,58	0,12	
Net immigration to the municipality of students	288,86	3095,99	0,09	0,93	
Constant	313928,30	52271,54	6,01	0,00	***

7.3 – Teaching as a fraction of total cost within public schools as a function of student enrollment within public schools

Number of observations: 2678
Number of municipalities: 260
R-square: 0.0072

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment, logarithmic	1,29	1,76	0,73	0,47	
Fraction of students enrolled in independent schools	-0,08	0,07	-1,15	0,25	
Fraction enrolled in public schools in different municipality	-0,03	0,07	-0,46	0,65	
Average taxable income	0,00	0,00	0,74	0,46	
Socialist majority	-0,12	0,48	-0,24	0,81	
Average distance between inhabitants	0,00	0,01	0,15	0,88	
Fraction of students in public schools from different municipality	-0,07	0,06	-1,27	0,21	
Number of public schools in the municipality	0,19	0,23	0,85	0,4	
Fraction of students with foreign background	0,01	0,04	0,25	0,80	
Net immigration to the municipality of students	0,58	0,68	0,85	0,40	
Constant	33,67	14,37	2,34	0,02	**

7.4 – Expenditures for educational material as a fraction of total cost as a function of student enrollment within public schools

Number of observations: 2672
Number of municipalities: 260
R-square: 0.0595

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment, logarithmic	1,59	0,51	3,10	0,00	***
Fraction of students enrolled in independent schools	0,00	0,03	-0,04	0,97	
Fraction enrolled in public schools in different municipality	0,03	0,03	1,03	0,30	
Average taxable income	0,00	0,00	-0,21	0,84	
Socialist majority	0,04	0,19	0,19	0,85	
Average distance between inhabitants	-0,01	0,00	-1,37	0,17	
Fraction of students in public schools from different municipality	0,01	0,01	0,44	0,66	
Number of public schools in the municipality	0,12	0,13	0,86	0,4	
Fraction of students with foreign background	0,00	0,01	0,49	0,62	
Net immigration to the municipality of students	0,15	0,23	0,66	0,51	
Constant	-0,63	4,38	-0,14	0,89	

7.5 – Expenditures for school lunches as a fraction of total costs as a function of student enrollment within public schools

Number of observations: 2671
Number of municipalities: 260
R-square: 0.0154

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment, logarithmic	0,63	0,28	2,26	0,03	**
Fraction of students enrolled in independent schools	0,00	0,01	-0,23	0,82	
Fraction enrolled in public schools in different municipality	0,01	0,01	0,52	0,60	
Average taxable income	0,00	0,00	2,25	0,03	**
Socialist majority	0,22	0,77	2,86	0,01	***
Average distance between inhabitants	0,00	0,00	-0,24	0,81	
Fraction of students in public schools from different municipality	-0,02	0,01	-3,22	0,00	***
Number of public schools in the municipality	0,08	0,03	2,56	0,01	***
Fraction of students with foreign background	-0,01	0,01	-1,20	0,23	
Net immigration to the municipality of students	-0,02	0,11	-0,24	0,81	
Constant	-2,22	2,25	-0,99	0,32	

7.6 – Cost for venues as a fraction of total cost and as a function of student enrollment within public schools

Number of observations: 2671
Number of municipalities: 260
R-square: 0.3491

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment, logarithmic	2,46	0,88	2,78	0,01	***
Fraction of students enrolled in independent schools	0,05	0,04	1,24	0,22	
Fraction enrolled in public schools in different municipality	0,01	0,01	0,52	0,60	
Average taxable income	0,00	0,00	1,15	0,25	
Socialist majority	-0,61	0,30	-2,06	0,04	**
Average distance between inhabitants	0,01	0,01	0,76	0,45	
Fraction of students in public schools from different municipality	-0,01	0,03	-0,5	0,62	
Number of public schools in the municipality	-0,07	0,18	-0,45	0,65	
Fraction of students with foreign background	-0,01	0,03	-0,34	0,74	
Net immigration to the municipality of students	-0,03	0,40	-0,07	0,94	
Constant	-2,99	8,53	-0,35	0,73	

7.7 – Other costs as a fraction of total costs and as function of student enrollment within public schools

Number of observations: 2670
Number of municipalities: 260
R-square: 0.2157

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment, logarithmic	-5,95	2,15	-2,77	0,01	***
Fraction of students enrolled in independent schools	0,03	0,08	0,4	0,69	
Fraction enrolled in public schools in different municipality	-0,01	0,09	-0,10	0,92	
Average taxable income	0,00	0,00	-1,64	0,10	*
Socialist majority	0,45	0,60	0,75	0,45	
Average distance between inhabitants	0,00	0,01	-0,10	0,92	
Fraction of students in public schools from different municipality	0,01	0,05	0,07	0,88	*
Number of public schools in the municipality	-0,31	0,29	-1,08	0,28	
Fraction of students with foreign background	-0,01	0,03	-0,34	0,74	
Net immigration to the municipality of students	-0,72	0,84	-0,86	0,39	
Constant	72,19	18,28	3,95	0,00	***

Comment: the effects of student enrollment fluctuations on total costs are somewhat less pronounced when the data analysis is applied to only the municipalities outside the three urban regions (the coefficient is - 33502.27 in the specification where student enrollment is expressed in logarithmic form). When the regression is applied to only the urban regions we find stronger effects of scale (the coefficient is -127313.6 in the specification where student enrollment is expressed in logarithmic form). Simultaneously, for the urban regions the coefficients for all the component expenditures as a fraction of total cost are statistically insignificant. For the remaining municipalities the responding coefficients are statistically significant and in line with the results for the overall regression. None of the coefficients for the fractional expenditures could however be regarded as practically significant.

Table 8

Panel data regressions for the elementary level of education, relating total average cost within public elementary schools in SEK respectively different expenditures as a fraction of total average cost to the number of students enrolled in these schools within the municipality, with fixed effects applied to municipalities and years for the period 2000-2010

8.1 –Total average cost as a function of student enrollment within public elementary schools

Number of observations: 3075
Number of municipalities: 289
R-square: 0.6482

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment	0,26	0,55	0,47	0,64	
Student enrollment, squared	0,00	0,0000	0,97	0,33	
Fraction of students enrolled in independent schools	-78,4	58,62	-1,34	0,18	
Fraction enrolled in public schools in different municipality	405,85	269,57	1,51	0,13	
Average taxable income	0,62	0,59	1,06	0,29	
Socialist majority	-656,27	366,74	-1,79	0,08	*
Average distance between inhabitants	18,95	10,03	1,89	0,06	*
Number of students per public school	-24,40	8,33	-2,93	0,00	***
Number of public schools in the municipality	-196,99	88,04	-2,24	0,026	**
Fraction of adults with foreign citizenship	-121,80	98,62	-1,23	0,22	
Net immigration to the municipality of students	-347,13	297,21	-1,17	0,24	
Constant	57119,90	3958,93	14,43	0,00	***

8.2 – Costs for teaching as a fraction of total cost per student and as a function of enrollment within elementary public schools

Number of observations: 3069
Number of municipalities: 289
R-square: 0.0005

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment, logarithmic	0,00	0,00	-1,64	0,10	*
Fraction of students enrolled in independent schools	0,04	0,04	0,87	0,38	
Fraction enrolled in public schools in different municipality	-0,11	0,16	-0,71	0,48	
Average taxable income	0,00	0,00	1,74	0,08	*
Socialist majority	0,08	0,25	0,32	0,75	
Average distance between inhabitants	0,01	0,01	1,59	0,11	
Number of students per public school	0,01	0,01	1,62	0,11	
Number of public schools in the municipality	0,01	0,082	0,17	0,87	
Fraction of adults with foreign citizenship	0,11	0,07	1,56	0,12	
Net immigration to the municipality of students	0,06	0,17	0,34	0,73	
Constant	42,18	3,93	10,74	0,00	***

8.3 – Costs for educational material as a fraction of total cost and as a function of student enrollment within public elementary schools

Number of observations: 3069
Number of municipalities: 289
R-square: 0,1847

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment, logarithmic	0,00	0,00	0,19	0,85	
Fraction of students enrolled in independent schools	0,01	0,01	1,09	0,28	
Fraction enrolled in public schools in different municipality	-0,05	0,03	-1,74	0,08	
Average taxable income	0,00	0,00	-0,33	0,74	*
Socialist majority	-0,03	0,06	-0,53	0,60	
Average distance between inhabitants	0,00	0,00	-0,44	0,66	
Number of students per public school	0,00	0,00	0,79	0,43	
Number of public schools in the municipality	-0,03	0,016	-1,6	0,11	
Fraction of adults with foreign citizenship	0,02	0,01	1,07	0,27	
Net immigration to the municipality of students	-0,03	0,04	-0,86	0,39	
Constant	6,67	0,78	8,59	0,00	***

8.4 – Costs for school lunches as a fraction of total cost and as a function of student enrollment within public elementary schools

Number of observations: 3069
Number of municipalities: 289
R-square: 0.0417

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment, logarithmic	0,00	0,00	-0,66	0,51	
Fraction of students enrolled in independent schools	-0,01	0,01	-0,8	0,43	
Fraction enrolled in public schools in different municipality	-0,01	0,03	-0,27	0,78	
Average taxable income	0,00	0,00	-0,21	0,83	
Socialist majority	0,03	0,07	0,43	0,68	
Average distance between inhabitants	0,00	0,00	-0,25	0,80	
Number of students per public school	0,00	0,00	-0,45	0,65	
Number of public schools in the municipality	-0,01	0,01	-0,65	0,52	
Fraction of adults with foreign citizenship	0,02	0,02	0,95	0,34	
Net immigration to the municipality of students	-0,05	0,04	-1,24	0,22	
Constant	7,13	0,91	7,82	0,00	***

8.5 – Cost for venues as a fraction of total cost and as a function of enrollment within public elementary schools

Number of observations: 3069
Number of municipalities: 289
R-square: 0.0090

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment, logarithmic	0,00	0,00	0,22	0,82	
Fraction of students enrolled in independent schools	-0,01	0,03	-0,23	0,82	
Fraction enrolled in public schools in different municipality	0,08	0,11	0,70	0,48	
Average taxable income	0,00	0,00	-0,08	0,94	
Socialist majority	0,05	0,19	0,26	0,79	
Average distance between inhabitants	-0,01	0,00	-2,51	0,01	***
Number of students per public school	0,00	0,00	-0,74	0,46	
Number of public schools in the municipality	0,05	0,04	1,27	0,21	
Fraction of adults with foreign citizenship	0,00	0,05	0,02	0,98	
Net immigration to the municipality of students	-0,06	0,11	-0,51	0,61	
Constant	21,87	3,41	6,41	0,00	***

8.6 – Other expenditures as a fraction of per student cost and as a function of student enrollment within public elementary schools

Number of observations: 3069
Number of municipalities: 289
R-square: 0.0027

	Coef.	Robust Std. Err.	t	P>t	Significance
Student enrollment, logarithmic	0,00	0,00	1,53	0,13	
Fraction of students enrolled in independent schools	-0,03	0,04	-0,73	0,46	
Fraction enrolled in public schools in different municipality	0,10	0,14	0,69	0,49	
Average taxable income	0,00	0,00	-1,28	0,20	
Socialist majority	-0,13	0,28	-0,46	0,65	
Average distance between inhabitants	0,00	0,01	0,34	0,74	
Number of students per public school	-0,01	0,01	-1,12	0,27	
Number of public schools in the municipality	-0,03	0,09	-0,31	0,76	
Fraction of adults with foreign citizenship	-0,15	0,08	-1,90	0,06	
Net immigration to the municipality of students	0,08	0,21	0,39	0,70	
Constant	22,15	4,47	4,96	0,00	***

Comment: neither the municipalities in the three urban regions nor the municipalities in the remainder of the country showed significant deviations from these statistically insignificant results for the effects of fluctuations in student enrollment on costs within public schools.

Appendix A – variable definitions

Costs

All the cost measures are available for the elementary and upper-secondary levels of education, respectively.

- **Educational costs as a fraction of total costs within public schools**: expenditures per student concerning salaries for teachers, headmasters and expenditures concerning workplace education as a fraction of total average cost within public schools.

- **Educational material costs as a fraction of total costs within public schools:** expenditures per student concerning school literature, computers, student libraries and different technical equipment used by students as a fraction of total average cost within public schools.

- **Other costs as a fraction of total costs within public schools:** expenditures per student for costs other than those accounted for separately as a fraction of total average cost in public schools.

- **Schools lunch costs as a fraction of total costs within public schools:** expenditures per student concerning sustenance and accompanying personnel, transportation and administration as a fraction of total average cost in public schools.

- **Total per student municipality cost for education**: the average total cost paid by the municipality for each student recorded as living in the municipality, across independent and public schools.

- **Total average cost for education within public schools:** the average total cost paid by the municipality for each student who attends the public schools within the municipality.

- **Venues costs as a fraction of total costs within public schools:** expenditures per student concerning rents, inventory which is not educational material and capital costs (such as interest on loans, but not costs for amortization) as a fraction of total average cost in public schools.

Other

- **Average distance between inhabitants living in the municipality**: the number of square kilometers per inhabitant in the municipality.

- **Average taxable income in the municipality:** taxable income in the municipality divided by the number of inhabitant.

- **Fraction of immigrants to emigrants for the respective municipality and consisting of individuals in the respective age groups eligible for student enrollment:** the fraction of immigrants to emigrants in the age groups eligible for elementary and upper-secondary education respectively.

- **Fraction of inhabitants in the municipality aged 20-64 who are not Swedish citizens:** fraction of inhabitants in the municipality who are not Swedish citizens as of 31 December of the relevant year.

- **Fraction of students in the public schools of a municipality who are recorded as living in another municipality:** as described in the variable name; only available for the upper-secondary level of education.

- **Fraction of students recorded as living in the municipality who attend an independent school:** fraction of students recorded as living in the municipality who attend an independent school within or outside the municipality.

- **Fraction of students recorded as living in the municipality who attend a public school in another municipality:** as described in the variable name

- **Fraction of students in the public schools of the municipality with foreign background:** either students born in a foreign country or students with both parents born in a foreign country.

- **Number of public schools in the municipality**: as described in the variable name.

- **Number of students per public school in the municipality:** total number of students in the public schools of the municipality divided by the number of public schools.

- **"Socialistic majority":** a binary variable which assumes the value 1 if the social democratic party and the leftist party have a majority in the legislative body of the municipality and zero otherwise.