School Vouchers and Public School Productivity - The Case of the Swedish Large Scale Voucher Program

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Abstract

Since the school voucher reform in 1992/93 Sweden has experienced a rapid increase in private schools. School regulations allow private and public schools to compete for students on very similar terms. This makes the Swedish educational market interesting for studying how competition affects the provision of education. In this study competition and public school productivity are analyzed for 105 urban municipalities during the period 1998/99 to 2001/02. The empirical estimations are performed in two stages. In the first stage, productivity is estimated using Data Envelopment Analysis (DEA) and a Malmquist productivity index. In the second stage, the estimated productivity is regressed on private school competition and a number of control variables. We cannot reject competition to be exogenous in a Hausman test. The coefficient for competition is not significant at the 5 percent level in any of the empirical specifications.

JEL classification: H73, I21
Key words: Malmquist index, competition, education

1. Introduction

This paper studies if competition from private schools affects public school productivity. The example is from Sweden, which has experienced a rapid increase in the number of private schools after a large scale voucher reform in 1992/93. In the voucher program, each student is given a school voucher that can be used for attending either a public or a private school. Private schools are not allowed to charge for tuition and are thus fully financed by public means. The Swedish school system ensures a market where public and private schools compete on very similar terms. However, the reform has caused questions as to how competition affects the public schools, where the main focus has been on the performance of public school students and on possible cost increases in public schools. Arguments for the latter is that the municipalities, which are responsible for public education, get increased administrative costs and that they are obliged to accept students applying to a public school, which implies that some excess capacity may be necessary. However, Björklund et al (2003) as well as the Swedish National Agency for Education (2004) find no effects from a change in private school competition on the development of public school costs. Interestingly, when splitting the municipalities into major cities (including municipalities close to major cities) and other municipalities, the National Agency for Education finds opposite results for the two groups. In the major cities, costs increase when competition increases, while in the other municipalities, costs decreases when private schools are established. A possible explanation could be that private schools outside the major cities open in order to avoid the closing of a school rather than for the sake of competition. Regarding the achievement of public school students, Ahlin (2005) and Sandström and Bergström (2005) find positive effects from competition on outcomes in mathematics. Björklund et al (2003) find positive effects for native born students but no effects for foreign born students or students with low-educated parents. In the international literature, e.g. Hoxby (1994), Dee (1998) and Couch, Shughart and Williams (1993) find positive effects from competition on the performance of U.S. public schools students. Sander (1999) finds no effect from competition from private schools in Illinois, while Hsieh and Urquiola (2002) primarily find evidence of student sorting in Chile. Newmark (1995) questions the robustness in Couch, Shughart and Williams (1993).

This paper differs from former studies on the Swedish school reform in two ways: The first is that the productivity development in the production of education is explicitly modeled, and the second is that the analysis is restricted to urban areas, where the private schools are thought to compete for students with the public schools. Productivity is estimated using Data Envelopment Analysis (DEA) and a Malmquist productivity index. In a second stage, the productivity estimates are used as dependent variable in a regression with private school competition as independent variable.

From economic theory we expect public monopolies to have high costs due to inefficient use of resources, i.e. costs are higher but achievement is not. In a market with private alternatives to the public providers, the students have the opportunity to choose an alternative school if they are not satisfied with the public education. This will decrease the budget of the public schools in the Swedish system. In theory, public providers are forced to keep students' output as high as possible within the limits of their budgets, i.e. they must be efficient producers in order to stay in the market. However, in the short run the transition to a new market structure and presumably fewer students may cause costs to increase for the public schools. The empirical results on the topic are divergent. Grosskopf, Hayes, Taylor and Weber (2001) study the role of competition for public school efficiency in Texas school districts. Their results show that competition increases allocative but not technical efficiency. Bradley, Johnes and Millington (2001) find that private school competition increases the efficiency in English secondary schools, while Duncombe, Miner and Ruggiero (1997) find that competition decreases cost efficiency in New York school districts. Kirjavainen and Loikkanen (1998) find public schools to be more efficient than private in the provision of Finnish senior secondary schools. Waldo (2003) has studied public school efficiency and competition in the Swedish school market, but finds no relationship in a cross sectional setting between private school enrolment and public school efficiency.

The empirical estimation of effects from competition is problematic due to the possible endogeneity in the establishment of private schools. If private schools tend to start where public school productivity is low, the empirical estimates will be biased towards finding no effects (Hoxby (2000)). Therefore, we test for endogeneity in the empirical models. Student background is important for educational results, and productivity is estimated given the socio-economic and ethnical characteristics of the students. However, increased school choice also increases the possibility for student to sort according to educational preferences. Possible sorting effects, if e.g. high and low ability students attend different schools, are not within the scope of this study.

Data for compulsory education is provided by 105 urban municipalities from 1998/99, when Sweden had 324 private schools, to 2001/2002, when the number had increased to 479 schools (Sweden had approximately 5000 public and private schools in 2002).

The outline of the study is as follows: In section 2 the Swedish school system is discussed. In section 3 Data Envelopment Analysis and Malmquist Index are presented, followed by a discussion in section 4 of the data used. Results from the productivity estimates are presented in section 5, and results from regressions explaining productivity are presented in section 6. Section 7 is a summary of the study.

2. The Swedish School System

Swedish children start primary school at an age of seven. After six years of primary education, they continue in secondary school, which lasts for three years. Primary and secondary school are compulsory, but a majority of the students continue for three years in upper secondary school. The grades achieved when graduating from secondary school have four levels. Students can ’fail’, ’pass’, ’pass with distinction’, or ’pass with special distinction’. Each level corresponds to certain skills defined by the National Agency for Education. The grading system, which was introduced in 1998, has brought much focus on students failing in major subjects.

In the early 1990’s Sweden reformed public education in three steps. In 1991 the responsibility for Swedish schools was delegated from central government to the municipalities. The teachers became municipal employees and the organizational freedom increased in order to make the production fit local conditions better. In 1993 the funding for public education changed from directed grants to lump sums, where education has to compete for funding with other municipal activities. The other major responsibilities for the municipalities are daycare for children and health care. Municipalities finance their production mainly by income taxes and governmental grants. In 1992 Sweden introduced a large scale voucher program giving public funding to private schools. All students get a voucher and can choose to attend either a public or a private school. The budget of a school (both private and public) is directly dependent on the number of students attending it, and thus, loosing a student to a competing school will directly decrease the budget. The private schools are not allowed to charge for tuition. Permission to start a private school is given by the National Agency for Education. The municipality in which the school has applied to start has the right to give its opinion but no right to interfere with the project. The reform has lead to the establishment of a large number of private schools. The private schools and their specializations are presented for the school years 1998/99 to 2001/2002 in table 2.1[1]

[1] 7 international schools are left out from the statistics. The source for the table is the National Agency for Education.

Table 2.1. Number of Private schools

Private school category	1998/99	1999/00	2000/01	2001/02
Special teaching methods	121	135	152	165
Regular	105	121	149	177
Confessional	56	55	59	63
Ethnic	18	17	22	24
Special subject areas	13	17	19	24
Other	8	17	17	23
Boarding School	3	3	3	3
Total	324	365	421	479

Contrary to the case in e.g. the U.S.A., the majority of the schools are not confessional (approximately 13% were confessional in 2001/02). The major school categories are regular schools and schools with special teaching methods (e.g. Waldorf or Montessori schools).

3. Methodology

Productivity is estimated as a Malmquist productivity index using linear programming models (Data Envelopment Analysis). In section 3.1, Data Envelopment Analysis is discussed for cross sectional data, and section 3.2 deals with the extension to more than one time period in the Malmquist productivity index.

3.1. Data Envelopment Analysis

Efficiency in a cross sectional setting can be estimated with Data Envelopment Analysis (DEA). Using linear programming an empirical production frontier from observed input and output combinations is estimated, and the efficiency of a production unit is measured as the distance to the production frontier. In this application we use an output oriented measure of efficiency, so the efficiency model described focuses on the possible increase in outputs without increasing inputs. The production possibility set is defined as

$$P(x) = \{x : x \; can \; produce \; y\} \qquad 3.1$$

and efficiency is defined as the maximum possible radial increase in outputs such that production is still within the production possibilities

$$Eff_o = \sup\{\theta : \theta y \in P(x)\} \qquad 3.2$$

The concept is easy to visualize in a production process with two outputs. In figure 3.1 three units, *a, b,* and *c*, are shown. They all have the same amount of inputs but different combinations of the two outputs y^1 and y^2.

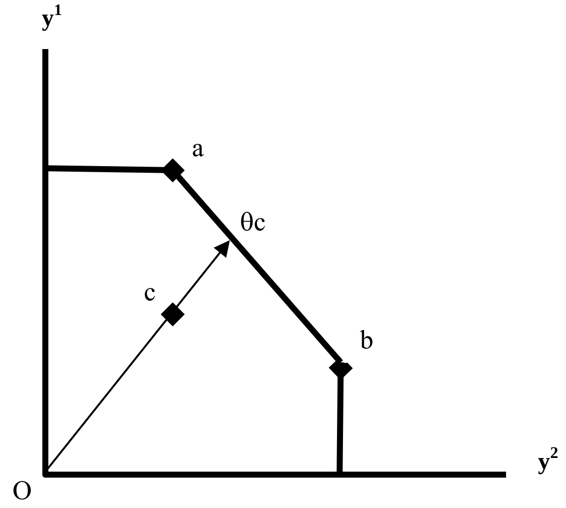

Figure 3.1. Estimation of Efficiency Towards a Production Front

Production units *a* and *b* are efficient, since they are on the production frontier, while unit *c* is inefficient, since it produces less outputs than would be possible. Unit *c* could increase outputs and produce at θ*c*. θ is referred to as the *efficiency score*. An efficient unit will have an efficiency score equal to one and an inefficient unit will have an efficiency score larger than one. We note for the presentation below that θ is equivalent to the ratio Oθc/Oc, i.e. the ratio of the distance from the origin to the efficient production and the distance from the origin to the observed production.

In DEA the production frontier is defined by the best performing production units. Since efficiency for all units is estimated in relation to the frontier, the estimated efficiency is always defined in relation to the best performing observations in the sample. Thus, the efficiency is relative to the other observations, but does not indicate whether these are truly high performing in an absolute sense.

The linear programming problem for a unit j is

$$Eff_o^j = \max_{z,\theta} \theta \tag{3.3a}$$

s.t.

$$\sum_{k=1}^{K} z_k y_{km} \geq \theta y_m^j, \quad m = 1,\ldots,M \tag{3.3b}$$

$$\sum_{k=1}^{K} z_k x_{kn} \leq x_n^j, \quad n = 1,\ldots,N \tag{3.3c}$$

$$z_k \geq 0, \quad k = 1,\ldots,K \tag{3.3d}$$

where M is the number of outputs, N the number of inputs, K is the observations and z is activity variables. y_m^j is thus output m for observation j. In the LP problem each of the M outputs is increased radially by the factor θ. For a more thorough discussion of DEA, see Färe, Grosskopf and Lovell (1994).

3.2. The Malmquist Productivity Index

The output oriented Malmquist productivity index is defined from the output distance function, which is defined as

$$D_o(x,y) = \inf\{\theta : \frac{y}{\theta} \in P(x)\} \tag{3.4}$$

This is the reciprocal of the efficiency measure in equation 3.2. The output distance function and the Malmquist index are illustrated in fig 3.2. The output sets in period t and t+1 are represented by P^t and P^{t+1}. We assume that a production unit is producing at point *e* in period t and at point *b* in period t+1. The output distance function for period t, $D_o^t(x^t, y^t)$, is the ratio of the distances 0e and 0d, i.e. the period t production compared to the period t technology. The output distance function for period t+1, $D_o^{t+1}(x^{t+1}, y^{t+1})$, is the ratio 0b/0c.

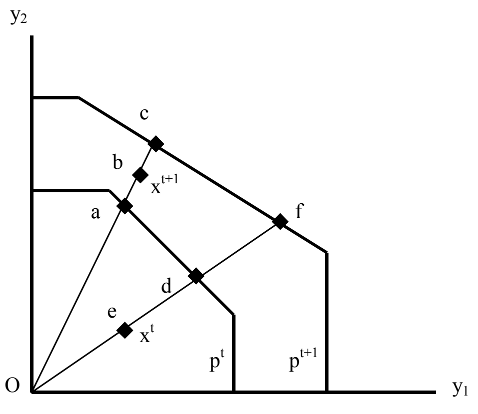

Figure 3.2. Malmquist Productivity Index

Färe, Grosskopf, Lindgren and Roos (1989) define the Malmquist productivity index as

$$M_o(x^t, y^t, x^{t+1}, y^{t+1}) = \left(\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t, y^t)}\right)^{1/2} \qquad 3.5$$

where $D_o^t(\mathrm{x}^{t+1}, \mathrm{y}^{t+1})$ is the production in period t+1 evaluated against the period t frontier, and $D_o^{t+1}(\mathrm{x}^t, \mathrm{y}^t)$ is the production in period t evaluated against the period t+1 frontier. The Malmquist productivity index can be decomposed into a change in the front and a change in efficiency. The change in the front is the technology change (TC) between two periods and defines the change in possible production. The efficiency change (EC) measures if the production unit has moved closer to or further away from the production frontier between the periods. Using distance functions, we express TC and EC as follows:

$$EC = 1/\left(\frac{D_o^{t+1}(\mathrm{x}^{t+1}, \mathrm{y}^{t+1})}{D_o^t(\mathrm{x}^t, \mathrm{y}^t)}\right)$$

$$TC = 1/\left(\frac{D_o^t(\mathrm{x}^{t+1}, \mathrm{y}^{t+1})}{D_o^{t+1}(\mathrm{x}^{t+1}, \mathrm{y}^{t+1})} * \frac{D_o^t(\mathrm{x}^t, \mathrm{y}^t)}{D_o^{t+1}(\mathrm{x}^t, \mathrm{y}^t)}\right)^{1/2}$$

Since the output distance function is the reciprocal of the efficiency measure, the output distance function and the decomposition of the Malmquist productivity index can be estimated using DEA. The distance function for unit j relating the production in period t+1 to the period t frontier is estimated in the following linear programming problem

$$D_o^t(x^{t+1}, y^{t+1})^{-1} = \max_{z,\theta} \theta \qquad 3.6a$$

s.t.

$$\sum_{k=1}^{K} z_k y_{km}^t \geq \theta y_{jm}^{t+1}, \quad m = 1,\ldots,M \qquad 3.6b$$

$$\sum_{k=1}^{K} z_k x_{kn}^t \leq x_{jn}^{t+1}, \quad n = 1,\ldots,N \qquad 3.6c$$

$$z_k \geq 0, \quad k = 1,\ldots,K \qquad 3.6d$$

4. Data and Empirical Models for Estimating Productivity

4.1 Empirical Models

We use two empirical specifications to measure productivity. The difference is on the input side, where the first approach has total costs as input and the second has full time equivalent teachers. Both use aggregate credit value and the number of students who do not fail in any subject as outputs. The estimates are adjusted for the students' socio-economic background as will be described in section 4.2.2. For the cost model, we note that the costs may change between two years due either to change in the underlying inputs or in input prices. We do not, however, have access either to input prices or to a full set of physical inputs. The second approach is a labour productivity model, where labour is defined as the teaching resource. The teaching staff is the most important input under the control of the school manager. The following empirical specifications are used for estimating productivity

Table 4.1. Productivity Models

	Cost	Labour
Inputs		
Total costs	X	
Full time equivalent teachers		X
Outputs		
Adj credit value	X	X
Adj full grades	X	X

The input and output variables are discussed in detail in section 4.2.

4.2 Data

Data is provided by the National Agency for Education in the data base 'Jämförtal för huvudmän'. The data base contains municipal data about resource use and educational results for the students attending public education. The period studied is from the school years 1998/99 to 2001/2002. In 1998 the grading system was changed, so comparisons with years before 1997/98 are difficult to make, and we also exclude the school year 1997/98 because grades may be less reliable for the first year with a new system.

4.2.1 Input

As inputs we consider total costs (cost model) and full time equivalent teachers (labour productivity model). The total cost is defined without the cost for premises and transportation. The cost for premises is set administratively and differs between municipalities for other reasons than quality. The municipalities are also responsible for transportation of students living far from the municipal schools. This cost will vary with the geographical characteristics of the municipality and the cost is not assumed to influence the students' results. When estimating labour models we use full time equivalent teachers as inputs. We treat teachers as a homogeneous group although the educational results of students are dependent on teacher quality. However, the quality of teachers is difficult to measure with formal skills such as educational level or experience (see e.g. Hanushek (1996)). Since it is not possible to calculate a value added output from Swedish educational statistics the students' performance is dependent on input resources achieved throughout their education. In order to take this into account we calculate costs as the mean cost for three years preceding graduation. It is not possible to follow the costs for a longer period of time due to changes in the definition. Costs are presented in 1999 prices. Full time equivalent teachers can be followed for six years.

4.2.2 Output

As outputs we use the credit value achieved by the municipal students and the students graduating with full grades (i.e. students reaching minimum educational goals in all subjects). The latter is motivated by the strong focus on low-performing students caused by the change of the Swedish grade system. When using grades it is important to highlight that grades are given by teachers as a judgment of how the student performs in relation to the educational goals. Teachers may have different interpretations of the goals and individual teachers may change their interpretation over time. However, if there is an overall change in the level, we expect some underlying forces to drive the development. One such process may be that students actually learn either more or less. However, there is also a risk of "grade-inflation", i.e. that higher grades are given for the same level of knowledge. One criticism of the school reform is that competition may lead to grade-inflation since it is more important for a school to show high grades in a competitive market.

The output observed for a municipality is dependent on the family background of the students attending the municipal schools. To control for this we follow Grosskopf et al (1999) and estimate an output regression model. The idea is that outputs are adjusted for differences in the students' characteristics. The estimated models are

$$CREDIT = \alpha_c + \beta_{1c} ETHNICITY + \beta_{2c} SES + \varepsilon_c$$
$$FULLGRADE = \alpha_f + \beta_{1f} ETHNICITY + \beta_{2f} SES + \varepsilon_f \qquad 4.1$$

CREDIT is the mean credit value of the students in a municipality and FULLGRADE is the share of students that have achieved full grades. ETHNICITY is measured as the share of the students that are not born outside Sweden or do not have two immigrated parents. SES is the educational level of the parents where education is divided into a scale with three levels: Primary education, secondary education and university education. This is translated into levels one, two and three. The educational level in the municipality is the average of all students. Summary statistics for the variables is presented in table 4.2.

Table 4.2. Summary statistics of SES and outputs

		98/99	99/00	00/01	01/02
Student background					
Ethnicity	Mean	0,8657	0,8650	0,8812	0,8829
	Std.	0,0832	0,0831	0,0874	0,0846
Parents' education	Mean	2,10	2,1168	2,1564	2,1680
	Std.	0,1358	0,1338	0,1270	0,1277
Output					
Credit value	Mean	202,44	202,60	203,1771	204,7343
	Std.	8,92	9,3917	10,0968	9,9936
Full grades (%)	Mean	77,79	75,9448	74,7905	75,0781
	Std.	6,51	6,4934	6,3002	6,4768

The residual ε_c in equation 4.2 represents the variation in credit value that is not explained by the ethnicity or SES of the students. ε_f is identically interpreted for the full grades output. To transform the output measures from the individual pupil to total measures of output we calculate

$$ADJ\_CREDIT = (\overline{CREDIT} + \varepsilon_c) * ENROLMENT$$
$$ADJ\_FULLGRADE = (\overline{FULLGRADE} + \varepsilon_f) * ENROLMENT \qquad 4.2$$

where $\overline{CREDIT}$ and $\overline{FULLGRADE}$ are sample means. ADJ_CREDIT can be interpreted as the total credit value a school would have produced if having the same student SES and ETHNICITY as the sample average (see Grosskopf et al (1999) for a further discussion).

4.2.3 Summary Statistics

Summary statistics for the inputs and outputs used in the empirical estimations is presented in table 4.3

Table 4.3. Summary statistics of inputs and outputs

		98/99	99/00	00/01	01/02	% change 98/99-01/02
Inputs						
Total cost (thousand SEK)	Mean	23 763,8	25 728,41	28 035,79	29 488,92	24,1 %
	Std.	30 880,5	34 415,93	37 652,83	38 640,1	
Full time eq. teachers	Mean	48,38	49,44111	51,01353	51,49428	6,4 %
	Std.	55,43	58,06889	61,04406	60,59791	
Outputs						
Adjusted credit value (thousand)	Mean	125,16	130,3956	135,9781	139,0396	11,1 %
	Std.	139,69	147,9538	154,4872	155,4236	
Adjusted full grades	Mean	479,34	486,6564	500,8384	509,6021	6,3 %
	Std.	527,92	541,7365	565,7295	562,5211	

As can be seen in table 4.3, the cost for education has increased by more than 24 % during the period. The teaching staff has increased by 6.4 %, which is more in line with the development of outputs. In the early years of the Swedish school reform, teacher/student ratios declined rapidly, but have increased again since 1998 (Björklund et al (2003)). This increase coincides with the period studied. A large part of the cost increase may be explained by the teaching input, both due to the increase in staff, and to a real wage increase of approximately 10 %. There has been a slight increase in the average credit value over the period, but the adjusted output shows a more rapid development with an increase of more than 11 %. The adjusted full grades have increased with 6.3%. Thus, both inputs and the adjusted outputs have increased during the period. We observe that the general increase both in inputs and outputs to a large extent is due to larger graduating cohorts (about 10 % over the studied period).

5. Productivity Estimates

The average development for estimates using either cost or labour as input is presented below. M represents the development in productivity (the Malmquist index), while the two components efficiency change and technical change are denoted EC and TC respectively.

Table 5.1. Estimated Productivity Change

	98/99-99/00	99/00-00/01	00/01-01/02	98/99-01/02
Cost				
M	0.959	0.955	0.972	0.890
EC	0.978	1.005	0.980	0.963
TC	0.982	0.950	0.992	0.925
Labour				
M	1.012	1.010	1.013	1.035
EC	0.987	0.995	1.007	0.989
TC	1.026	1.015	1.006	1.048

Total costs have increased by 24,1% during the period while the two outputs have increased by 11.1 % and 6.3 % respectively. From the Malmquist estimates it is evident that the productivity with cost as input has decreased between all periods. The decline is between 4.5 and 2.8 % per year. The total decline over the studied period is 11%. The large decrease may be due to increases in input prices, where e.g. Swedish teacher salaries in general have increased by approximately 10% in real terms. TC is the shift in the frontier between periods and the frontier has contracted in all periods. The decrease is especially prominent between the school years 1999/00 and 2000/01 with a decline of 5% explaining the major part of the productivity decline that period. Also efficiency (EC) decreases over the period, except for 99/00-00/01 where average efficiency has increased by 0.5%. For the two other periods the productivity decline is due both to a contracted frontier and to a decrease in average efficiency.

The labour productivity shows a different pattern with a total increase of 3.5% over the period and a continuous increase of approximately 1% in all periods. The technical development has shifted the frontier outwards by 4.8 %, while efficiency has decreased by 1.1 % on average. The outward shift in the frontier means that the best performing units have more outputs in relation to the teaching effort in the later years of the period. The decline in efficiency over the period implies that the municipalities have not been able to keep up with the development.

There may be a connection between cost increases and labour productivity. Labour productivity will improve if the higher costs are due to an increase in inputs like computers, books etc, which are likely to increase outputs for a given teaching effort. However, the relation between school results and other inputs than teaching staff is hard to establish (Gustafsson and Myrberg (2002)). If inputs other than teaching staff have a limited influence on outcomes, changes in these inputs will not affect the labour productivity very much.

6. Explaining the Productivity Development

In section 6, we use competition and a set of control variables to explain the results from the productivity estimates presented in section 5. This is done separately for the productivity development (M) and the efficiency development (EC). The technical development is not analyzed since it describes the development of the point on the front with which the municipality is compared, and this is not expected to be influenced by characteristics of the individual municipality. Section 6 continues with a discussion of the explanatory variables in 6.1, a test for endogeneity of private school competition in 6.2, and the empirical results in 6.3.

6.1. Data and Theoretical Considerations

If competition from private schools influences public school productivity, a change in the share of students attending private schools will cause a change in productivity. From economic theory we expect competition to enhance productivity in the long run, but in the short run productivity may decrease due to adjustment costs when the market conditions are changing. Also, the regulatory system under which the municipal schools operate causes the municipalities to claim that their operating costs increase with the establishment of private alternatives. Björklund et al (2003) and the National Agency for Education (2004) find no general cost increases due to competition, but the National

Agency for Education finds that costs increase in a sample of large urban municipalities. For the productivity estimates it is of interest what kind of costs increase. If the effect is on administrative costs, we do not expect a change in costs to have an impact on the outcomes for the public school students. However, another possible cost increase stems from the fact that the municipalities are obliged to accept all students wanting to attend a public school. Due to uncertainty concerning how many students will attend public education, the municipalities will have to keep some excess capacity. With added resources, e.g. more teachers than would otherwise be the case, the result will be an increase in the teacher/student ratio and a possible increase in student outcomes.

A potentially problematic feature is if the students attending private schools on average have higher ability than public school students, so called *cream-skimming*. This will cause the public school grades to decrease due to the loss of high-ability students, which may give a negative correlation between public school grades and private school competition. Thus, if there is cream-skimming, the expected effect is a downward bias of the coefficient for competition. We also note that it is possible for a student to change to a private school during the education. No matter the ability, the cost for education up to that point in time will not result in output for the public school. Of course the same is true for private schools loosing students to public ones, but as long as the share of students in private schools increases the dominant effect will be on public schools. The result will be a downward bias of the coefficient for competition. In a competitive environment it is important for providers of education to show high outcomes in order to attract students. Ideally, this will lead to improved teaching methods etc., but it may also cause “grade-inflation”, i.e. higher grades are given for the same level of knowledge. With grade-inflation, the coefficient for competition will tend to be biased upwards.

A problem in the econometric estimation of competition is the possible endogeneity in the location of private schools, i.e. private schools may be more likely to start where funding is high and public school quality is low. The funding of private schools is based on the costs for public schools in the municipality where the private school is located. If public schools perform poorly considering the resources spent (i.e. if they are inefficient producers), there will be incentives for private schools to enter the market. If private schools are located where public schools perform poorly, the estimated relation will be downward biased. Before estimating the empirical models we test for endogeneity.

The National Agency for Education provides data on the share of the municipal students that attend private schools. Both students attending a school in the municipality and students commuting to other municipalities are included. Such a measure of competition includes both competition from schools within and outside the local market.

The relative efficiency in the first year of the Malmquist period is included to estimate catching up effects. A municipality that produces poorly during one period may have a potential to increase productivity more than a highly efficient municipality. Comparisons of output and input measures for all municipalities are available and thus individual municipalities may get to know if they do not produce as efficiently as possible compared to others. Also, a temporary decrease in productivity is possible due to e.g. organizational changes etc.

To control for other factors influencing the productivity development we include variables measuring *population*, *political priorities* and *teacher characteristics*. A decreasing population is a problematic reality for many municipalities. It influences the municipal budget and thus the possibilities to provide education and other municipal responsibilities. We therefore include the population and population change as control variables. In Sweden, the political majority in the city council is a significant factor for the view on how education shall be organized since local politicians are responsible for the provision of education. To reflect the political view on the organization etc. of education, we use the share of children under school age attending private day-care centers in the municipality. Day-care for children is privatized to a larger extent than education, and day-care and education are related areas on the municipal political agenda. Private day-care is used as a proxy for the attitude among municipal politicians towards how to organize education, but we do not expect private day-care to explain productivity in itself. Further research concerning the role of local politics for the establishment both of private schools and private day-care would be interesting for the analysis of the changing educational market. The teacher quality is important for educational outcomes and in Sweden much attention is paid to e.g. teachers' education. To control for teacher quality, we use the share of the teachers with formal pedagogical education. A teacher with pedagogical education is expected to have better skills in educating children, and thus a larger share of skilled teachers is expected to increase productivity.

In the empirical estimates we use a fixed effects model with 105 municipalities and 3 periods which gives a total of 315 observations. Summary statistics of the explanatory variables are presented in table 6.1.

Table 6.1 Explanatory variables – cost model

Variable	Mean	Std.Dev.	Minimum	Maximum
Competition – change	0.4605	0.7025	-2.3000	6.0000
Cost efficiency level	0.8317	0.0790	0.6062	1.0000
Population	61.0131	85.8830	7.8967	743.3880
Population – change	0.0024	0.0090	-0.0247	0.0353
Private day-care	12.8492	8.7297	0.0000	46.3333
Private day-care – change	0.0475	0.1514	-1.0000	0.7333
Pedagogical skill	91.9365	4.0899	80.0000	98.6667
Ped skill – change	-0.0310	0.0192	-0.0564	0.0079

The correlations between the explanatory variables are presented in table 6.2.

Table 6.2 Correlations between explanatory variables – cost model

	Comp - ch	C-eff	Pop	Pop - ch	Priv d-c	Priv d-c ch	Ped skill	Ped - ch
Comp - ch	1.0000							
C-eff	-0.1460	1.0000						
Pop	0.1009	-0.2927	1.0000					
Pop - ch	0.2981	-0.1018	0.1414	1.0000				
Priv d-c	0.4264	-0.0387	0.1377	0.4721	1.0000			
Priv d-c ch	0.2099	-0.0138	0.0234	0.1298	0.1206	1.0000		
Ped skill	-0.2621	0.2975	-0.0544	-0.2102	-0.1217	-0.0479	1.0000	
Ped - ch	-0.1782	0.0624	-0.0180	-0.1852	-0.1291	-0.0151	0.4592	1.0000

Only tree correlations are larger than 0.3. The share of private day-care is positively correlated to the share of private schools (the correlation coefficient is 0.4264). Since the political ideology is expected to play a role in the establishment both of private schools and private day-care, the positive correlation is not surprising. The share of private day-care is also positively correlated to population change (the correlation coefficient is 0.4721). A possible explanation is that when the population increases in a municipality private day-care may emerge as a response to increased demand, especially if the municipality reacts slowly to the change in demand. The share of teachers with formal pedagogical skills is correlated to the change in the share (the correlation coefficient is 0.4592). The corresponding summary statistics and correlations for the labour productivity model are presented in appendix B.

6.2. Testing for Exogeneity of Private School Competition

Endogeneity is frequently discussed when estimating the role of competition in public school outcomes, where e.g. Hoxby (1994) address the problem by using instrumental variables based on the Catholic population. This approach is not valid for the Swedish case since few schools are confessional. Both Ahlin (2005) and Sandström and Bergström (2005) have performed extensive testing for endogeneity of private school competition in Sweden. They do not find competition to be endogeneous. Their first test is to see if school quality before the reform is correlated to the establishment of private schools. They also both perform endogeneity tests in their estimated models, where the instruments are based on political variables. We do not use political variables since they are expected to influence efficiency. Rather, we use the average tax base (which is based on incomes) in the municipality as instrument for competition. A high tax base is assumed to be exogenous since the citizens' income is not expected to be influenced by characteristics in the educational system in the short run. We do not expect the tax base to have an influence on productivity on its own since differences in socioeconomic background is already taken into account in the productivity models. It could be argued that tax base is correlated e.g. to the voters' attitudes towards education in the municipality, but this factor is assumed to be captured by local politics and we have included private day-care as a proxy for this. By using panel data and a fixed effects model all municipal specific effects will be taken into account and are thus not captured by tax base as could be the case in a cross sectional setting.

A requirement for an instrument is that it is correlated with the variable for which it serves as instrument. The correlation between tax base and competitions is presented in table 6.3.

Table 6.3 Correlation between competition and instruments

	Tax base (cost model)	**Tax base (labour model)**
Competition (cost model)	0.44367	-
Competition (labour model)	-	0.47208

In table 6.3 we can see that there are positive correlations between competition and tax base.

To test if competition is endogenous we perform a Hausman test according to Kennedy (1998), p 151. The estimated model is

$Y = X\beta + W\gamma + \varepsilon$

where X is the explanatory variables (including the potentially endogenous variable) and W is the instruments (in this case only one). The Hausman test is performed by testing the restriction that γ=0. The null hypothesis is that competition is exogenous. Test statistics for the two models is presented in table 6.4

Table 6.4 Hausman Test Statistics

	Cost				**Labour**			
	Productivity (M)		**Efficiency (EC)**		**Productivity (M)**		**Efficiency (EC)**	
	Test statistic	P-value	Test statistic	P-value	Test statistic	P-value	Test statistic	P-value
Competition change 3 years	1.3867	0.2404	1.0649	0.3033	-	-	-	-
Competition change 6 years	-	-	-	-	0 .6668	0.4151	0.0068	0.9342

The Hausman test is not significant in any of the models, so the non-IV specifications are used for the empirical estimates. However, the results using instrumental variables are presented in appendix D.

6.3. Empirical Results

6.3.1. Cost Development

The empirical estimates when using cost as input are presented in table 6.5. The columns under M are the explanation of the productivity and the columns under EC is the explanation of the efficiency change part in the decomposition of M.

Table 6.5 Explaining Cost Development - fixed effects model with period effects

Variable	M		EC	
	Coeff	**p-value**	**Coeff**	**p-value**
Competition – change	-0.0096	0.0671	-0.0055	0.3171
Cost efficiency	-0.7420	0.0000	-0.8966	0.0000
Population	0.0028	0.2802	0.0014	0.6110
Population - change	1.7426	0.0497	1.6876	0.0673
Private day-care	-0.0030	0.1071	-0.0038	0.0460
Private day-care - change	0.0182	0.4434	0.0144	0.5586
Pedagogical skill	0.0022	0.5470	0.0044	0.2395
Pedagogical skill – change	-0.1424	0.7295	0.1015	0.8126
Constant	1.2402	0.0011	1.2913	0.0010
Adjusted R2	0.3063		0.3739	

Competition has a negative sign both in the M and EC models, but is insignificant at the 5 % level in both models. However, the sign is negative in both models and the coefficient is significant at 10% for the M model, which indicates that competition may be negatively correlated to the cost development. There may be several reasons for this. The first is that it may be a short term effect. It is costly for the public providers to decrease capacity when students leave public education for the private alternatives. Hoxby (1994) finds teacher salaries to increase due to the establishment of private schools. This will cause costs to increase and productivity to decrease in the short run, but attract high ability teachers in the long run. Another possible reason for the negative sign is the cream-skimming effect. If high ability students tend to leave the public schools, and we have no information about student ability to control for this, the estimated productivity will tend to decrease. Private day-care is correlated to competition and multicollinearity may cause the insignificant results. Excluding private day-care from the explanatory variables we get the following coefficients: The coefficient for competition in the M model is -0.0122 (p-value 0.0161) and the coefficient for competition in the EC model is -0.0087 (p-value 0.0974). The level of private day-care is significant for the EC model, but insignificant in the other cases. Although the coefficient for competition is insignificant in the main model, the tendency is that competition rather has a negative than a positive effect.

The catching up effect measured as the previous efficiency level is significant in both models. The variable has a negative sign implying that low cost efficiency is related to large improvements. Bradley, Johnes and Millington (2001) interpret the lagged efficiency variable as an error correction mechanism. A large deviation from some "equilibrium" efficiency score will cause the change in the efficiency score to increase. Population change has a positive sign in both models and is significant at 5% in the M model and at 10% in the EC model. This is in line with the expectations based on the fact that a decreasing population is a problematic reality for many municipalities, while a positive development of the population is in favor of local public production. The teachers' pedagogical training is insignificant in both models. The interpretation of the result may be that this training does not have the intended effect on the teachers' skills, or, which is in line with the concept of managerial inefficiency, that the teachers are not used optimally by the school management. The latter could be if a teacher is formally skilled, but teaching a subject that he or she is not educated for.

6.3.2. Labour productivity

The estimates for the labour productivity model are presented in table 6.6 for M and EC.

Table 6.6 Explaining Labour Productivity – fixed effects model with period effects

Variable	M		EC	
	Coeff	**p-value**	**Coeff**	**p-value**
Competition – change	-0.0009	0.8991	0.0042	0.5519
Labour efficiency	-1.2938	0.0000	-1.3209	0.0000
Population	-0.0009	0.5875	-0.0004	0.8325
Population - change	0.6682	0.5464	0.5540	0.6114
Private day-care	-0.0031	0.1570	-0.0037	0.0938
Private day-care - change	-0.0092	0.7266	-0.0144	0.5791
Pedagogical skill	0.0052	0.1446	0.0025	0.4828
Pedagogical skill – change	-0.0982	0.8176	-0.0745	0.8589
Constant	1.7442	0.0000	1.9807	0.0000
Adjusted R2	0.4162		0.4730	

Competition is insignificant in both models, but in the EC model the sign is positive. Private day-care is correlated to competition also in the labour model, and when excluding the variable we get the following coefficients for the competition variable: -0.0045 (p-value 0.4997) for the M model and -0.00003 (p-value 0.9964) for the EC model. Thus, excluding private day-care does not affect the significance level. The catching up effect (labour efficiency) has a negative coefficient as expected and is significant at the 5% level. None of the control variables are significant.

7. Summary and Discussion

After the school reform in 1992/93, the cost and teacher/pupil ratio for compulsory education declined substantially in Sweden. The trend turned in the second half of the decade and the teacher/pupil rate, e.g. has increased after the lowest level in 1998 (Björklund et al (2003) figure 4.1). A question that has been raised is how the reform affects the public schools. Sandström and Bergström (2005) study students graduating in 1998 and find a positive relation between competition and public school outcomes. There seems to be no general cost increases due to the establishment of private schools (Björklund et al (2003) and The Swedish National Agency for Education (2004)), but the Swedish National Agency for Education (2004) find that cost increases due to increased competition when restricting the sample to urban areas, and that cost decreases for other municipalities. For urban municipalities, the literature thus indicates an increase both in resources spent and in educational outcomes, the two components of productivity, as a result of increased competition.

In the present study, the productivity development between the school years 1997/98 and 2001/02 is studied. Two models are estimated, one with costs and one with the teaching resource as input. As outputs we use grades and students passing all subjects, where both outputs are adjusted for differences in the students' socio-economic background. From economic theory we expect competition to have a positive influence on productivity in the long run, while the adjustment process to new market conditions may be costly in the short run. In the empirical analysis the coefficient for competition is insignificant at the 5% level in all models. Thus, we find no evidence that competition is correlated to public school productivity. Besides short run effects, there may be a number of reasons why we do not find a positive correlation. One is the positive correlation between population change and competition. If private schools are established as a response to an increase in demand, they may not be seen as competitors by the municipalities, but rather as a complement to public education. Actually, politicians might even prefer private schools for ideological reasons. Also, teachers may prefer private employment and thus do not view the competing schools as a threat but as an opportunity.

The results may be influenced by a number of empirical issues that are not possible to estimate with the Swedish data. A possible explanation for the insignificant result is cream-skimming. If high ability students tend to leave the public schools, the positive effects from competition may not show in the estimations due to lower student inputs in the educational process. We also note that endogeneity in the establishment of private schools could potentially lead to an under-estimation of the coefficient (see e.g. Hoxby (2000)), but we find no endogeneity problem when testing for this in the empirical estimates. Grade-inflation, on the other hand, may cause the estimated coefficient to be over-estimated. If higher grades are given for the same level of knowledge it will appear to be an increase in knowledge.

An interesting question is whether competition could be more extensive for specific schools within the municipalities. Although competition will affect the entire educational production, parents tend to prefer private schools that are located in the neighbourhood. The distribution of both private and public schools within a large municipality may be of importance as well as differences in quality between public schools. Thus, the establishment of private schools may primarily affect low-performing public schools, at the same time as other municipal schools are affected less by the competition. Also, competition between public schools within a municipality may play a role for the development of individual schools. This is an interesting topic for further research.

The primary finding in the paper is that, with the methods and data used, we find no empirical evidence that competition is either improving or deteriorating public school productivity. At least we can say that concerning productivity there seem to be no reasons to worry about any alarming negative effects due to the voucher reform, or as

Björklund et al (2003) write concerning school choice: "It seems to us that proponents as well as critics exaggerate the prospective benefits and costs".

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Appendix A Variable List

Output Regression

Variable	Definition
Merit	Mean credit value for graduating students year t
Nofail	Share of the graduating students that have passed all subjects year t
svensk	Share of the graduating students that have a Swedish origin
Morutb	Mean educational level of the mothers of the graduating students, defined from SUN-codes

Productivity Models

Variable	Definition
Total cost	Cost per student excluding costs for premises and costs for school buses. 1999 year prices. Mean for the years t to t-2
Full time eq. teachers	Full time equivalent teachers per student. Mean for the years t to t-5 1992 to 1995 are approxiamated due to a small change in the variable definition
Adjusted credit value	Aggregated credit value for graduating students year t adjusted for Ethnicity and SES
Adjusted full grades	Number of the graduating students that have passed all subjects year t adjusted for Ethnicity and SES

Explanatory variables

Variable	Definition
Level	
Competition	Share of students (%) attending a private school, mean for t to t-2
Competition - change	Cost models: Change in % private school students from t to t-2
	Labour models: Change in % private school students from t to t-5
Population	Municipal population, mean for t to t-2
Population - change	Cost models: Change in population from t to t-2 / population in t-2
	Labour models: Change in population from t to t-5 / population in t-5
Efficiency level	Efficiency score for school year t using DEA (CRS)
Private childcare	Contracting out childcare, mean t to t-2
Private childcare	Cost models: Change in contracting out from t to t-2 (observe that data is not available before 1997)
	Labour models: Change in contracting out t to 1997
Pedagogical skill	Share of teachers with formal pedagogical training, mean t to t-2
Pedagogical skill - change	Cost models: Change in % teachers with training from t to t-2
	Labour models: Change in % teachers with training from t to t-5

Note: For variables that are not provided per school year, year t is the year of the autumn term. E.g. for the school year 1998/99, t is 1998. In the M-index, t is 1998 for the index between 1998/99 and 1999/00.

Appendix B Statistics for Labour Model Data

The summary statistics for the explanatory variables in the labour model are based on the the last six years to make them correspond to the definition of labour input which is defined as the average teaching over the last six years of schooling.

Table B.1 Explanatory variables – labour model

Variable	Mean	Std.Dev.	Minimum	Maximum
Competition – change	0.3874	0.4934	0.3000	3.3000
Labour efficiency level	0.8716	0.0612	0.6641	1.0000
Population	60.6389	84.5596	6.6242	731.1810
Population – change	0.0025	0.0082	-0.0187	0.0320
Private day-care	12.7164	8.4960	0.0000	39.2500
Private day-care – change	0.0322	0.1018	-0.3333	0.7333
Pedagogical skill	93.2496	3.5596	81.3333	99.1667
Ped skill – change	-0.0314	0.0295	-0.0719	0.0265

The correlations between the explanatory variables are presented in table B.2.

Table B.2 Correlations between explanatory variables – labour model

	Comp - ch	L-eff	Pop	Pop - ch	Priv d-c	Priv d-c ch	Ped skill	Ped - ch
Comp - ch	1.0000							
L-eff	0.0500	1.0000						
Pop	0.1134	-0.1341	1.0000					
Pop - ch	0.3998	0.2490	0.1749	1.0000				
Priv d-c	0.4779	0.2935	0.1370	0.5253	1.0000			
Priv d-c ch	0.2032	0.1380	0.0130	0.1125	0.0602	1.0000		
Ped skill	-0.2679	0.3261	-0.0400	-0.0460	-0.0283	0.0073	1.0000	
Ped - ch	-0.1467	0.0567	-0.0099	-0.0591	-0.0869	0.0641	0.2664	1.0000

Appendix C Explaining Productivity and Efficiency Change with Competition Measured in Level

We perform the second stage regression analysis using competition measured as the share of students attending a private school rather than as the change in the share as in the main analysis. The correlation between competition and the instrument is higher as shown in table C.1.

Table C.1 Correlation between competition and instruments

	Tax base (cost model)	**Tax base (labour model)**
Competition – level (cost model)	0.5730	-
Competition – level (labour model)	-	0.5969

The test statistics for the Hausman test presented in table C.2 is insignificant for all models. We do not use instruments for the empirical estimates.

Table C.2 Hausman test statistics

	Cost				**Labour**			
	Productivity		**Efficiency**		**Productivity**		**Efficiency**	
	Test statistic	P-value	Test statistic	P-value	Test statistic	P-value	Test statistic	P-value
Competition level (cost)	1.1084	0.2937	0.7124	0.3997	-	-	-	-
Competition level (labour)	-	-	-	-	0.9349	0.3348	0.0716	0.7892

In table C.3, the estimates for the cost development are presented.

Table C.3 Explaining Cost Development – fixed effects model with period effects

Variable	**M**		**EC**	
	Coeff	**p-value**	**Coeff**	**p-value**
Competition – level	-0.0049	0.3164	-0.0069	0.1692
Cost efficiency	-0.7659	0.0000	-0.9155	0.0000
Population	0.0023	0.3758	0.0012	0.6528
Population –change	1.6035	0.0719	1.5855	0.0842
Private day-care	-0.0033	0.0882	-0.0034	0.0862
Private day-care – change	0.0112	0.6320	0.0112	0.6443
Pedagogical skill	0.0035	0.3367	0.0052	0.1609
Pedagogical skill – change	0.0381	0.9269	0.2623	0.5404
Constant	1.1945	0.0017	1.2650	0.0012
Adjusted R2	0.2981		0.3767	

In table C.4, the estimates for the labour productivity models are presented.

Table C.4 Explaining Labour Productivity – fixed effects model with period effects

Variable	M		EC	
	Coeff	**p-value**	**Coeff**	**p-value**
Competition – level	0.0026	0.5283	0.0029	0.4742
Labour efficiency	-1.2953	0.0000	-1.3236	0.0000
Population	-0.0011	0.5194	-0.0005	0.7647
Population – change	0.6035	0.5839	0.5756	0.5958
Private day-care	-0.0036	0.0934	-0.0036	0.0881
Private day-care – change	-0.0115	0.6440	-0.0105	0.6685
Pedagogical skill	0.0057	0.1171	0.0028	0.4324
Pedagogical skill – change	-0.0946	0.8227	-0.1069	0.7972
Constant	1.7125	0.0000	1.9540	0.0000
Adjusted R2	0.4174		0.4734	

The interpretation of the main results is the same for the models with competition measured in level as for the models using competition measured as change. Using competition measured as the share of students attending a private school rather than the change in the share, the competition variable is insignificant in all models.

Appendix D Explaining Productivity and Efficiency Change with Instrumental Variable Estimation

Table D.1 Explaining Cost Development – IV estimation, fixed effects model with period effects

Variable	M		EC	
	Coeff	**p-value**	**Coeff**	**p-value**
Competition – change	-0.0925	0.2323	-0.0836	0.2963
Cost efficiency	-0.7734	0.0000	-0.9190	0.0000
Population	0.0021	0.4203	0.0009	0.7254
Population - change	1.3977	0.1247	1.4136	0.1330
Private day-care	-0.0028	0.1786	-0.0033	0.1199
Private day-care - change	0.0142	0.5474	0.0134	0.5821
Pedagogical skill	0.0030	0.3989	0.0048	0.1977
Pedagogical skill – change	-0.0509	0.9011	0.1466	0.7293
Constant	1.2713	0.0010	1.3347	0.0008
Adj R2	0.2996		0.3742	

Table D.2 Explaining Labour Productivity – IV estimation, fixed effects model with period effects

Variable	M		EC	
	Coeff	**p-value**	**Coeff**	**p-value**
Competition – change	-0.0675	0.4175	-0.0090	0.9123
Labour efficiency	-1.2962	0.0000	-1.3220	0.0000
Population	-0.0010	0.5413	-0.0003	0.8468
Population - change	0.6140	0.5765	0.6245	0.5649
Private day-care	-0.0024	0.2897	-0.0031	0.1727
Private day-care - change	-0.0041	0.8751	-0.0084	0.7441
Pedagogical skill	0.0050	0.1641	0.0023	0.5187
Pedagogical skill – change	-0.1013	0.8104	-0.1051	0.8009
Constant	1.7925	0.0000	1.9944	0.0000
Adj R2	0.4181		0.4721	