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School Vouchers in Practice: Competition Won't Hurt You!

by F. Mikael Sandström and Fredrik Bergström

IUI, The Research Institute of Industrial Economics
P.O. Box 5501
SE-114 85 Stockholm
Sweden

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F. Mikael Sandström[2] and Fredrik Bergström[3]

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[2] Corresponding author. Research Institute of Industrial Economics (IUI), P.O. Box 6501, SE-114 85 Stockholm, Sweden, +46-8-665 45 35, mikaels@iui.se.

[3] Swedish Research Institute of Trade (HUI).

Abstract

An important issue in the debate on voucher systems and school choice is what effects competition from independent schools will have on public schools. Sweden has made a radical reform of its system for financing schools. Independent and public schools operate on close to equal terms under a voucher system covering all children. Sample selection models are estimated, using a data set of about 28000 individuals. In addition,panel data models are estimated on 288 Swedish municipalities. The findings support the hypothesis that school results in public schools improve due to competition.

Keywords: public education, independent schools, student achievement,school vouchers, school choice, sample selection model, panel data model,instrumental variable estimation

JEL: H42,H52,I28,L19

1 Introduction

The role of independent schools has been an important focus in the debate on the quality of schooling. A central issue is if the use of public funds to finance privately run schools, through voucher schemes or charter schools, may enhance education. Several states and counties in the US have implemented limited experiments with such systems. In Europe, several countries have a long tradition of independent schools subject to a varying degree of government regulation, which also receive public financing to a varying degree. However, to our knowledge, no country has implemented a more complete reform of school financing than Sweden did in the 1990s. Two parts of the reform are of particular interest. A voucher system has replaced the earlier centralized system of financing and a parental choice reform has been instituted.

The Swedish experience is of interest for at least three reasons. First, the reforms have been radical. Under the Swedish system, municipal schools and independent schools receive public financing on close to equal terms. Provided that they fulfill certain basic requirements, all kinds of schools are eligible, including religious schools and schools run by profit corporations. In this respect, Sweden differs from e.g. Denmark, where private schools have received public funding for a long time, but where only parent-controlled, non-profit schools receive such funding. Further, the Swedish system applies to all children. This sets the reform apart from, e.g., the so-called Milwaukee experiment (See, e.g., Rouse[17] and Greene, Peterson and Du[7].) which only provides vouchers to low-income groups. There are really only two serious limitations to the operation of independent schools. In order to receive public funds, they must pledge not to charge an additional tuition fee from the students. Obviously, this rules out competition in the price dimension. Further, the freedom in setting the rules of admission is limited. In particular, independent schools cannot refuse to accept low ability students.

Second, the country has experienced a rapid growth in the number of independent schools due to these reforms. The impact of the reform also differs between different municipalities[1] in Sweden. Enrollment in independent schools, at the compulsory school level, ranges between zero and almost twenty per cent. As Newmark [14] points out in his criticism of Couch, Shughart and Williams [2], studies of the effects of competition on public schools are in many cases unlikely to find any significant effects simply due to low variability in the data. He also questions the likelihood of competition from independent schools having any marked effect, unless the enrollment in independent schools varies over time. The high variability of private school enrollment in Sweden over time and space implies that these problems are mitigated.

Finally, unlike many other countries, most of the independent schools do not aim at any special group of students, such as any religious group. Rather, most of them are non-denominational and compete with public schools for the same group of students, which is likely to make any effect of competition more noticeable. Further, the socioeconomic composition of students attending independent schools is not radically different from those attending public schools, thereby making inference easier.

An empirical analysis of competition between schools is necessary, since the theoretical predictions are unclear. On the one hand, public schools may lose the best teachers and the best students to independent schools which, in turn, may have an adverse effect on students remaining in public schools. Epple and Romano [5] have shown theoretically that in the presence of a peer-group effect, i.e. a positive "learning externality" from sharing the class-room with more able students, low-ability

[1] In Sweden, schooling is primarily the responsibility of the municipalities, the lowest tier of government.

students may be adversely affected by school choice. Hoxby [10] and Hanushek et al. [9] find empirical evidence supporting the existence of peer group effects. On the other hand, increased competition and the risk of losing students and resources, give public schools incentives to improve education and which may lead to more experimentation with regard to, e.g., pedagogical methods. In addition, competition may have a beneficial impact on teachers for two reasons. First, it may induce them to increase their work effort, thus reducing x-inefficiency. Second, if public schools in effect form a monopsony for teachers' services, competition may result in higher salaries, which would attract able people to the profession. Both these effects have been documented empirically. Rapp [15] finds that teachers work more diligently when school choice is introduced. Vedder and Hall [20] and Hoxby [12] find that teachers' salaries tend to rise due to increased competition from private schools.

Competition between schools have received increased attention among economists. Noting that the predominant form of competition between schools in the US is through the Tiebout choice, Hoxby [11] examines the effects of varying sizes of school districts on student performance. The underlying logic is that the Tiebout choice is more effective when the number of jurisdictions in a given area is large. Her results suggest that competition through the Tiebout choice enhances the productivity in public schools. In fact, productivity increases due to changes in both the numerator and the denominator: Student achievements improve, while the costs of schooling fall. Hoxby also finds that private school enrollement is lower where the Tiebout choice is more intense, plausibly because the demand for private education is smaller when public schools are of high quality. Since school district boundaries may be endogenous - there is an incentive to merge poorly performing school districts with neighboring districts - Hoxby uses an instrumental variable estimation. An important methodological finding is that an estimation that does not take this endogeneity into account is biased towards finding no effect of Tiebout choice.

A few papers have explicitly examined the competition between public and private schools. The question asked in these studies is thus if the achievement of students in public schools is improved when the proportion of students in private schools is larger. A central empirical issue in such studies is that the key variable, i.e. the number of students attending private schools, may be endogenously determined. If public schools are of poor quality, the demand for private schools may be larger. If this is not accounted for, the effects of competition may be underestimated. To address the endogeneity problem, Dee [3] instruments for the private school share, using the population concentration of Catholics. The rationale for this is that since many private schools in the US are run by Catholic institutions, this variable will be highly correlated with the presence of private schools. Dee uses data on school districts in 18 states in the USA, and finds that competition significantly improves the high school graduation rates. Hoxby [12] uses a somewhat similar strategy, but uses a richer set of denominational variables as instruments, and uses data on individual student achievements. Her conclusion is that competition from private schools has a significantly positive effect on the quality of public schools in terms of educational attainment, measured as the highest grade completed by the age of 24, wages, also measured by the age of 24, and high school graduation rates. Couch, Shughart and Williams [2] also find a positive effect of competition on public school performance, using the average scores in a compulsory mathematics test in all counties in North Carolina. However, this study have been criticized by Newmark [14] who claims that the results are not robust.

The central contribution of the present paper is that we use an extensive data set to study the effects of a truly radical reform of school financing. Before the reforms began in the early 1990s, Sweden had a completely centralized school system.

Financing of schools was mainly provided by the national government. Hardly any independent or private schools existed. Today, Sweden has more generous rules for the use of public funds to finance independent schools than any other country, with the possible exception of the Netherlands. We use a data set of around 28 000 ninth-graders in public and independent schools in the scholastic year 1997/98, containing information on grades, test results and socioeconomic background variables. Our approach differs somewhat from previous research in that we use sample selection models in order to simultaneously model both the students' choice of school and their educational results. This approach is used to take account of the fact that students choosing public schools are not a random sample of all students. This is one of the two key identification problems we meet when we want to study how competition from independent schools affects public schools.

The second identification problem is caused by the fact that independent schools are not established by chance. In particular, the availability of independent schools may be a function of the quality of public schools, causing the key explanatory variable to be endogenous. As discussed above, the demand for alternatives to public education is likely to be greater if public schools are of poor quality. In the Swedish setting, there may be a counteracting effect on the supply side. The entitlement to an independent school is determined on the basis of the cost of schooling in the municipality where it operates. Since independent schools are not allowed to charge tuition fees, the financial viability of an independent school will depend on the policy of the municipality, and on how "costly" the students are. In municipalities with many students with, e.g., limited knowledge of Swedish or with social problems, it may be difficult to start an independent school.

A complication is that the use of variables on religious affiliation as instruments for the share of independent schools is clearly not appropriate in Sweden. First, only a minority of the independent schools are denominational. Second, around 85 percent of the population belong to the Lutheran Church of Sweden[2], and the variability is small across regions. Instead, we use a number of political variables to construct an instrument. The motivation for this approach is that if the local authorities are hostile to independent schools, which in some cases they are, this may limit the expansion of such schools.

A further empirical complication is that unobserved heterogeneity between municipalities or between schools may exist. Since the data on individuals are from one year only, any panel data estimation is ruled out. However, robust standard errors of the coefficients are estimated. To complement the analysis of the data on individuals, we also run a separate set of regressions on data from all of Sweden's municipalities for the years 1993-1997. We estimate panel data models with the average grades in the municipalities as the dependent variable.

We find that the extent of competition from independent schools, measured as the proportion of students in the municipality that goes to independent schools, improves both the test results and the grades in public schools. This is confirmed by the results from the panel data models. The improvement is significant both in statistical and real terms. This result holds for test results, final grades and for the likelihood that a student will leave school with no failing grades. Thus, our results confirm findings from earlier research which indicate that competition is beneficial for students in public schools.

The remainder of the paper is organized as follows. Section 2 treats the Swedish reforms, and the development since these were enacted. In section 3, the data and the empirical analysis are presented. Section 4 concludes.

[2] The Church of Sweden was not disestablished until the year 2000, which accounts for the high membership rate.

2 The Swedish experience

In Sweden, the compulsory schools have traditionally been the responsibility of the municipalities, the lowest tier of government. However, the municipal schools operated under strict national rules and regulations, and received funding from the national government. They also had to follow a national curriculum. Only a few independent schools, approved by the government, received government funding. In 1990, the system was altered and the municipalities were given wider authority over their own schools, and were also given full financial responsibility for the school system.[3] In 1992 a new reform was implemented, under which the municipalities are obliged to give funding to independent schools, amounting to 85 percent of the calculated average cost per student in the municipal schools. Parents were also given the right to choose school for their children. The purpose of the reform was to give independent schools funding on terms equal to those of municipal schools. The 85 percent-rule was introduced to account for administrative costs and over-head costs related to the municipalities' over-all responsibility for the educational system.[4] Similar reforms have been instituted for the upper secondary schools ("gymnasium"- roughly equivalent to high school). However, this paper mainly deals with compulsory schooling, which in Sweden is nine years, from age seven to fifteen.

The independent schools must be approved by the National Agency for Education to receive funding. There are some provisions for approval. The schools must meet certain quality requirements, and must work in line with the targets set for the

[3] A general reform of the financial relationship between the different tiers of government has meant that municipalities pay to or receive money from the central government based on various socio-economic and demographic variables. This has largely replaced an earlier system with ear-marked subsidies to schooling, care for the elderly, and other municipal responsibilities.

[4] The grounds for calculating the grants given to independent schools were altered in 1995, including some costs not previously included, and instead reducing the percentage rule from 85 to 75. The rules were altered again in 1996. It is a matter of debate whether the independent schools are over- or undercompensated, in comparison with municipal schools, and if the changes in the grant system made the system more or less generous. A government committee that undertook to explore this issue reached no firm conclusions.[19]

compulsory educational system. They must also be open to all children. Thus, they may not base admission on ability or on religious or ethnic origin. Finally, they are not allowed to charge tuition. Among the approved schools are schools owned by teacher or parent cooperatives, non-profit organizations and privately owned firms. The municipalities are allowed to give an opinion on whether they consider the establishment of an independent school to be harmful to existing schools, and their views are taken into account by the National Agency for Education. However, the municipalities have no veto, and are bound by law to finance an independent school once it has been approved. On several occasions, the Agency has approved schools against the will of the municipalities. While municipalities have no formal authority to stop the establishment of independent schools, the attitude of the municipal authorities is important in practice. As we will see below, such attitudes may affect the likelihood that an independent school is established.

The 1992 reform has had a drastic effect on the number of independent schools. In 1991/92, Sweden had 90 independent schools at the compulsory level, a number which had increased to around 400 in the academic year 2001/02. The rapid growth continues. The National Agency for Education has received 251 applications for the academic year 2002/03. Over the past years, only about half of the approved schools have actually started, but it is clear that the number of independent schools will continue to increase. Still, the number of independent schools is small compared to the total number of schools, which is about 5000. The number of students in independent schools is a very small fraction of the total number of students, around 4 percent. However, this share is rapidly increasing, as the enrollment in independent schools has grown by 10-12 percent a year in the past few years. Further, there is also a considerable variation between different municipalities. While around half of Sweden's municipalities have no independent schools, in several municipalities, around ten percent of the students or more attend independent schools, the largest share being above 18 percent for the academic year 1999/2000.

While religious or ethnic origin may not be a requirement for admission, there is no rule against denominational schools, or schools with a focus on specific ethnic groups. Muslim and Jewish schools have been approved, as well as Christian schools of various denominations. About 15 percent of the independent schools are denominational. However, the majority are either "general" schools (30 percent) or schools applying some distinct pedagogical idea, such as Montessori, Waldorf, Freinet or Reggio Emilia (30 percent). The remaining 25 percent are ethnic schools, schools with teaching in another language than Swedish, or schools with a focus on some special subject, e.g. artistic schools, etc. The largest number of independent schools are found in the main urban areas, but several schools have also been started in rural areas. In fact, some of the municipalities with the largest share of students in independent schools are to be found in the sparsely populated northern part of Sweden.

Not surprisingly, this development has triggered a fierce debate. While some municipalities have embraced the reform, others see it as a threat to local democracy, and view independent schools as a serious financial burden. The governing social democratic party is divided on the issue, with one fraction wanting to reverse the reform, or at least allow municipalities the right to veto the establishment of independent schools. The main concern of those opposing independent schools is that they may hurt the public school system. Our goal is to analyze if this concern is warranted.

3 Empirical analysis

3.1 Model specification

The objective of this paper is to analyze how competition from independent schools has affected the quality of public schools. Thus, the dependent variable should be some measure of student performance. We will discuss how this performance variable is defined below. The key explanatory variable should be a gauge of the degree of competition from independent schools. As such a gauge, we use the share of students attending independent schools on each "market". Each municipality is defined as a "market", since students almost invariably attend schools in their own municipality. If the municipal schools are considered to be a single "firm", this variable is in fact one minus the 1-firm concentration ratio. It should be noted that this variable is not calculated from our data. Instead, it is a figure for the independent school share in the municipalities in the entire compulsory school system, i.e. grades 1 through 9.

We can formulate the "main" equation in our analysis as:

$$y_i = \beta_1 S_i + \mathbf{X}_i \beta_2 + \varepsilon_i \tag{1}$$

where y_i is a measure of student i:s performance in public schools, S_i is the share of students attending independent schools in the municipality where student i lives, $\mathbf{X}_i$ is a vector of other explanatory variables, β_1 and β_2 are the parameters to be estimated, and ε_i is an error term. The elements of vector $\mathbf{X}_i$ are characteristics of the individual, the municipality and the school, which will be discussed further below.

A central empirical challenge is to take account of the potential endogeneity of S_i, that is, the share of students attending independent schools. If public schools are of poor quality, the demand for alternatives is likely to increase. Failing to take this into account may lead us to falsely conclude that there is no positive effect of competition, or indeed to find a negative effect of competition on the quality of public schools.

There is an additional complication in the Swedish setting, making the sign of the endogeneity bias ambiguous. Recall that independent schools are not allowed to charge a tuition fee from students. Thus, the revenues of an independent school are determined by the amount of funding they receive from the municipality. This amount, in turn, is determined based on a calculation of the municipality's average costs for schooling. In addition, independent schools may not refuse to accept low performing students. Since some such students, e.g. socially disadvantaged students, or immigrant students with limited knowledge of Swedish, may give rise to additional costs for the school, there are also some factors on the cost side that the individual school might have difficulties in controlling. Thus, if there is a large number of low ability students in a municipality, for which the independent schools are not sufficiently compensated, an independent school may not be viable.

In conclusion, our key explanatory variable, the share of students attending independent schools, may be a function of our dependent variable, students' educational achievement. To solve the resulting identification problem, we must find some instrumental variables correlated with the share of students attending independent schools, while they do not have an independent influence on students' grades.

In essence, our approach for handling the endogeneity issue resembles that of Hoxby [12] and Dee [3]. We begin by estimating an equation explaining the share of students attending independent schools. These estimates are then used to construct an instrument for this variable that can be used when estimating the effects of competition on student performance in public schools.

We can formulate an equation explaining the share of independent schools in a municipality in the following way:

$$S_j = \mathbf{R}_j \alpha + \xi_j \tag{2}$$

where S_j is the share of students attending independent schools in municipality j, $\mathbf{R}_j$ is a vector of explanatory variables, α a vector of parameters to be estimated, and ξ_j is an error term. We use j as an index instead of i to emphasize that, unlike in equation (1), the unit of observation is a municipality and not an individual. Since this equation is a reduced form expression, $\mathbf{R}_j$ should include variables expected to influence both the demand and the supply of education in independent schools. Quite obviously, many of the elements of $\mathbf{R}_j$ in equation (2) will also appear in $\mathbf{X}_i$ in equation (1). However, it is the fact that school quality in the municipality may be an explanatory variable in this equation that is the source of the endogeneity problem. In other words, endogeneity is caused by the fact that we would like to include the municipality equivalence of y_i, the dependent variable in equation (1), e.g. average grades in the municipality, as an element in the vector $\mathbf{R}_j$.

While Hoxby [12] and Dee [3] use religious variables as instruments for the share of independent schools, this is not likely to work in the Swedish setting, and probably not in most other European countries either. The religious map of the US reflects the changing patterns of immigration, the expansion of settlements over the continent, and the constitutional ban of any established religion. As a consequence, most regions have a religiously mixed population, and the share of different religions varies across regions. In Europe, by contrast, the principle of "cuius regio, eius religio", i.e. the principle that the Prince decided the religion of the people, and the historical lack of religious freedom have given most regions a relatively homogenous religious composition. Religious minorities, whether historical or the result of recent immigration, are often culturally distinct, and differ from the majority population in many respects with regard to both observable and non-observable socioeconomic characteristics.

Sweden is particularly homogenous. Around 85 percent of the population are members of the Lutheran Church of Sweden, which was not disestablished until the year 2000. The cumulative membership of the five largest other Christian congregations accounts for less than five percent of the population. "Guesstimates" of the number of Muslims range from one to above three percent of the population. The Muslim minority is almost entirely the result of immigration during the last three decades. The number of Jews is only 17000, accounting for 0.2 percent of the population. An additional reason why religious variables are unlikely to serve well as instruments is that only a minority of the independents schools, around 15 percent, are denominational.

The rationale for our approach is that the attitude of the municipalities towards independent schools will influence the likelihood of such schools being established. As discussed above, while the municipalities cannot veto the establishment of independent schools, the National Agency for Education asks for their opinion. There are also informal ways in which a municipality may aid or hinder the establishment of an independent school, e.g. by delaying the necessary permits for the use of buildings by a school. Some municipalities also go out of their way to inform parents about independent as well as municipal schools, while others in effect try to discourage parents from choosing independent schools.

Naturally, it is hard to directly measure this "attitude". However, we may use the municipalities' policies in areas other than schooling as a proxy. In particular, it seems likely that the extent to which municipalities contract out their responsibilities is an indicator of their attitude to the "privatization" of public sector activities. While some Swedish municipalities perform virtually all their tasks in-house, many have contracted out their responsibilities to a considerable extent. At the same time, the extent to which non-school activities are contracted out should not have any independent effect on the educational achievements of school children in the municipality. We use data on the share of municipal activities contracted out in five areas: "infrastructure", i.e. road-maintenance etc., child care, care for the elderly and disabled, social services, i.e. treatment of drug addicts, aid to dysfunctional families, etc., and finally, "business activities".

Since the reforms of school financing came into force in 1992, it seems safe to assume that the grades given in that year have not been affected by any change in the degree of competition from independent schools. Thus, it should be safe to include the average grades in the municipalities for the year 1992, which is the first year for which data are available, as an explanatory variable in equation (2).

Other explanatory variables in equation (2) are the share of immigrants, the share of the population with no higher education, and a measure of average income in the municipality, all of which may affect the demand for independent schools. We would expect the first of these to have a positive effect on the share of students attending independent schools, since some independent schools have a special focus on minority groups. Parents with a higher level of education and a higher income are more likely to make an active choice of school for their children, which should tend to increase the likelihood that they attend an independent school. Thus, we would expect the second of these variables to have a negative sign, and the third to have a positive sign.

We also include a dummy variable indicating whether the municipality is situated in a major urban area, and a measure of the population density. As such a measure, we use ”population distance”, which is calculated by Statistics Sweden, and which is a measure of the hypothetical average distance between inhabitants in the municipality under the assumption that they are evenly distributed. Thus, the value of this variable is higher, the more sparsely populated is the municipality. It is not entirely obvious what signs these variables should have. On the one hand, it may be easier to start an independent school in a densely populated area. On the other hand, the demand for an independent school may be greater if the closest public school is far away. In fact, some independent schools have been started as a direct result of the closing of rural schools.

In addition to the policy variables discussed above, we include a variable supposed to measure the resources the municipality devotes to schooling - the average cost per student. Strictly, this variable may also be endogenous, but we will ignore this complication. It is unclear what sign it should have in a reduced form equation such as (2). Conceivably, the demand for independent schools could be lower if the municipal spending on schools is high. On the other hand, it may be easier to start an independent school when the financial conditions are advantageous.

Finally, two political variables are included in equation (2), namely the share of votes received by the non-socialist parties in the last general election, in 1998, and a variable indicating if the municipal government is non-socialistic. The rationale for including these two variables is that it seems likely that the political views of the inhabitants of a municipality should affect the demand for independent schools. Since the main opposition to independent schools originates from the left on the political spectrum, we would expect the demand for alternatives to the public school system to be larger, the larger is the non-socialist share of the electorate.

The share of students attending independent schools cannot be less than zero, but is, in fact, zero in several municipalities. To take this into account, equation (2) is estimated as a Tobit model.

In essence, the endogeneity of the share of students in independent schools is caused by the fact that independent schools are not established by chance. However, given the size and number of independent schools, self-selection remains a problem, since students are not randomly distributed between independent and public schools. Rather, this distribution is determined by the preference for independent schools. If this preference is related to the students' aptitude, we do not accounting for the fact that self-selection may lead to erroneous conclusions. If, for instance, more able students have a higher propensity to select independent schools, we may fail to find an effect of competition on student results in public schools, or even find an adverse effect.

We address this problem by using Heckman's approach. In other words, we treat y_i of equation (1) as a latent variable that is only observed if the student chooses to go to a public school. We may formulate a selection equation as:

$$w_i = \mathbf{Z}_i \gamma + \zeta_i \tag{3}$$

where $\mathbf{Z}_i$ is a vector of explanatory variables, γ is a parameter vector and ζ_i is an error term. The latent variable y_i of equation (1) is thus only observed if $w_i > 0$. The dependent variable in this model, w_i, may be viewed as the individual's preference for municipal schooling. Note that w_i is also a latent variable. What we observe is instead the binary variable:

$$w_i^* = \begin{cases} 1 \text{ if } w_i > 0 \\ 0 \text{ if } w_i \leq 0 \end{cases} \tag{4}$$

where $w_i^* = 1$ implies that the student attends a municipal school.

Our model can be summarized by equations (1), (2) and (3). While it may be of interest to analyze why independent schools are established in some municipalities but not in others, our main reason for estimating equation (2) is to construct an instrument for the key variable in equation (1), which is our "main equation".

We use a few different specifications of the main equation. In all of these, the explanatory variables are the same. However, we use five different achievement variables as the dependent variable. Measuring educational achievement is difficult. Obviously, we would like a measure that is as encompassing as possible. With this criterion, the "credit value" seems ideal. This value is calculated from the student's final grades in his 16 "best" subjects, and constitutes the basis for acceptance to high school. Thus, this value is roughly equivalent to a grade point average. On the other hand, there is a risk that this measure is not objective since, by necessity, it involves the subjective judgements of teachers. In particular, a possible effect of competition between schools may be to induce teachers to be more generous when grading students. The most objective measure we were able to find was the results on two of the five sub-test in the achievement test in mathematics, sub-tests A and B. Sub-test A tests the students' ability to comprehend mathematical symbols and expressions while sub-test B consists of short algebraic problems. This should limit the scope for subjectivity as far as possible.[5]

The use of our two other achievement variables is motivated by a different concern. It is conceivable that competition increases the average performance but still hurts low-ability students. To explore this possibility, one dichotomous variable indicating

[5]Another advantage of using sub-tests A and B is that we have access to the exact scores of each student, thus giving us an approximately continuous dependent variable. (The maximum scores are 30 and 45, respectively.) For the three other mathematics sub-tests, only the grades, on a four-step scale, are reported. As an informal robustness test, we ran ordered probit regressions on the three other sub-tests, ignoring self selection and endogeneity. Using the robust standard errors, the competition variable was significantly different from zero at the 5-percent level in all cases but one, the oral part of the mathematics test. We also ran ordered probit regressions on grades in mathematics, Swedish and English, again ignoring self selection and endogeneity. This time, the competition variable is significant for the maths grade, but not for the English and Swedish grades. In all cases, the coefficient estimates are positive, however. The results are not reported but can be obtained from the corresponding author.

if the student obtained passing grades in all of the three cardinal subjects (mathematics, Swedish and English),[6] and one variable indicating if he obtained passing grades in all subjects, were used. In these regressions, the econometric specification must be changed since we do not observe y_i of equation (1). The models are estimated as a bivariate probit model with partial observability of one of the variables. Instead of y_i, we observe:

$$y_i^* = \begin{cases} 1 \text{ if } y_i > 0 \\ 0 \text{ if } y_i \leq 0 \end{cases}. \tag{5}$$

Thus, $y_i^* = 1$ implies that the student passes all his classes. However, we only observe y_i^* if $w_i^* = 1$, i.e. if he attends a municipal school.

As discussed above, our key explanatory variable in the main equation is the share of students attending independent schools, which is supposed to be a measure of the degree of competition faced by municipal schools. However, since students are also allowed to choose between different municipal schools, a certain amount of competition will also exist between these. This is hard to measure but, ceteris paribus, the competition between schools, municipal or independent, will be tenser the closer these are located, since students are less likely to make an active choice between schools if the distance between the closest and the second closest school is large. As a proxy for this factor, we use the population distance variable, and a dummy variable indicating if the municipality is located in a major urban area. As we will see below, however, it is difficult to draw any inference from the coefficients of these variables since they will be included in all three equations. These two demographic variables may also capture other factors that affect school choice, the presence of independent schools and student ability. However, no better proxy was available.

[6] A student cannot enter high school until he has passed these three subjects.

The other background variables included in the main equation are sex (female=1), immigrant background, parents' educational level, average municipal income, the municipality's educational spending per child, and the number of students at the school. The first four are included to account for factors likely to influence the students' ability. Obviously, it would be preferable to have access to family income, instead of a municipal average. However, no such data were available. The school spending variable excludes rental costs, since this is difficult to define due to varying accounting practices among municipalities, and because the cost of renting a school building is unlikely to have any effect on educational results. The number of students at the school was included because this has been found to be important in some Swedish studies of student achievements. [18]

Some variables included in the selection equation also figure in the main equation. Those are the variables for sex, immigrant background, parents' educational background, average income in the municipality, population distance, the dummy variable for major urban area and the municipality's educational spending per child. In addition, we include the vote share of the non-socialistic parties in the last general election (1998) and a dummy variable indicating if the municipality has a non-socialist governing majority. It could be expected that the propensity to vote for a non-socialistic party is correlated with the propensity to put your child in an independent school.

It is likely that the error terms are more closely correlated for individuals attending the same school than for individuals in different schools. To allow for this, we estimate robust standard errors, allowing for a cluster effect, using the procedure suggested by Rogers [16].

3.2 Data

The empirical analysis uses four sets of data. One of these is used for the panel data analysis, and is further discussed in section (3.4). The three other data sets are, first, data on around 28 000 youths, second, data on public and independent schools, and third, data on municipalities.

The data on individuals have been assembled by the National Agency for Education and consist of socioeconomic variables, grades and results on the national achievement tests, for all students in the ninth grade in 34 Swedish municipalities for the scholastic year 1997/98. The grades are reported both as a "credit value", which is a summary measure of all grades, roughly equivalent to a grade point average, and as grades in individual subjects. The national achievement tests are given in the subjects English, Swedish and mathematics. The students' grades on each sub-test, as well as on the test as a whole, are reported. For some of the sub-tests, the exact scores are reported, thus providing even more detailed information. The socioeconomic variables include the parents' educational level, the student's sex and information on whether he or either of his parents is an immigrant. Parts of this data set have been provided to the National Agency for Education from Statistics Sweden. This is the case for all data on grades, such as credit value, and most of the socioeconomic background data. Data on test results, however, have been collected by the Agency from schools in the municipalities included in the sample. Unfortunately, there is a considerable number of missing observations in this part of the data set, as will be discussed further below. Since the variable for the student's sex has also been assembled from the test data base, there is also a large number of missing observations for this variable.

The school data base contains variables indicating the type of school, the number of students, etc. The data on municipalities, finally, provide information on population distance, a measure of average income, the municipality's costs for the compulsory school per student and an indicator of whether the municipality is situated in a major urban area. Naturally, a key variable is the share of students attending independent schools. Then, we also have information on a number of political variables. We have data on voting behavior in the 1998 election, the political affiliation of the municipal government and a few policy variables dealing with the degree to which municipal responsibilities have been contracted out. Data on schools were provided by the National Agency for Education while the municipal data are from Statistics Sweden.

/Table 1 about here./

The full data set covers 29335 students in 34 Swedish municipalities. After excluding students attending some "odd" schools, such as hospital schools and a few schools run by the national government or regional governments, the data set consists of 28065 students, 26656 of which attend municipal schools. Descriptive statistics for these are presented in table 1.

The school data base lacks data on one municipality, leaving us with a sample of 33 municipalities and 27996 students, 26587 of which attend municipal schools. As can be seen in Table 1, only a few observations are lacking in the data dealing with the students' grades (credit value, no failing cardinal subject and no failing grade), while almost 13 percent of the observations lack information on test results from sub-test B, and almost as many for sub-test A. It is not likely that the missing observations are random. In fact, the average credit value for the observations missing information on test results is 146, while the mean over all observations is 199. The situation is complicated by the fact that we also miss observations on the students' sex for observations lacking information on test results. Since sex is included as an explanatory variable in all regressions, these observations will have to be omitted in all regressions. Thus, it is essential that we test if our results are robust to different assumptions about the missing observations.

/Table 2 about here/

Equation (2) is estimated using data on all Swedish municipalities. Descriptive statistics for the variables included in that regression are presented in Table 2. In 1998, Sweden had 288 municipalities.[7] Missing observations are not completely overlapping, leaving us with a sample of 280, 177 of which had at least one independent school in 1998. The data on grades are from the year 1992, the year the reforms were instituted. Thus, it seems reasonable that these grades have not been affected by the presence of independent schools. In 1992, grades were given on a five grade scale. The numbers in the table represent averages for all students in each municipality. In Table 3, the correlation between the share of students in independent schools and the five variables describing the degree to which municipal responsibilities have been contracted out is presented. This correlation is positive, and in some cases highly so, between the independent school share and the contracting-out variables.

/Table 3 about here/

3.3 Results

The result from a Tobit estimation of equation (2) is presented in Table 4. Only one of the coefficients of the contracting-out variables, child care, is significantly different from zero at any usual level of significance. The variables on the immigrant share and the share of the population without higher education are also significantly different from zero. In the first case, the sign is positive and in the second case, it is negative, thus indicating that immigrants and people with higher education have a positive

[7] In 1999, one municipality was split into two. Thus, Sweden now has 289 municipalities.

effect on the number of students attending independent schools. The coefficient on the vote share of the non-socialist parties is also positive and significantly different from zero, which confirms our suspicion that voting behavior will influence the likelihood that a student attends an independent school. However, the political affiliation of the municipal government has no significant effect. The urban dummy is significant with a positive sign, which is not surprising, since most independent schools are established in the main urban areas in Sweden.

The most interesting result from this regression is perhaps that the coefficient on average grades in 1992 is negative, and significant at the 10 percent level. The share of students attending independent schools thus seems to be larger where school quality is low. This is in line with Hoxby's [12] results, and indicates that we run the risk of underestimating any positive effects of competition if we do not take endogeneity into account. Our results give no support to the hypothesis that independent schools are more likely to be established in municipalities with "easy customers", i.e. few low-ability students.

/Table 4 about here./

For each of our five result measures, we use four different econometric specifications for the "main" equation, i.e. equation (1). Estimations (I) and (II) in each of the tables ignore self-selection, while models (III) and (IV) are estimated using Heckman's approach, with equation (3) forming the selection part of the model. In the two cases where the dependent variable is dichotomous, the resulting equation is formulated as a probit. Equations (II) and (IV) are estimated using an instrument for the share of students attending independent schools. This instrument is constructed using the estimates of equation (2) presented in Table 4. In all cases, the presented standard errors are from robust estimators allowing for clustering.

We will first discuss which specification should be our preferred model. For each set of four specifications, we would first like to test the hypothesis that the "critical variable", i.e. the share of students attending independent schools is in fact exogenous against the alternative hypothesis that this variable is endogenous, and second, the hypothesis that equations (1) and (3) are independent, against the hypothesis that they are not. For the first of these, we used a Hausman test. Somewhat surprisingly, we could not in any case reject the hypothesis that the share of students attending independent schools is exogenous at any reasonable level of significance. Based on these tests, we should thus prefer the non-IV specifications. The hypothesis that equations (1) and (3) are independent was then only tested for the non-IV specifications, and could at least be rejected at the 5-percent level for the three continuous variables, but not at any usual level of significance for the two dichotomous variables.

In our analysis of the results, we will thus focus on the Heckman models (III) for the continuous variables, and on the univariate probit models (I) for the dichotomous variables. However, the results are similar in all econometric specifications.

We should be cautious in interpreting the results for two of our school result variables, scores on sub-test A, and the dummy variable indicating if the student has no failing grades. (The estimation results for these two variables are deferred to the appendix.) The reasons for this are the following. In the Heckman model with sub-test A as the dependent variable, the estimate for ρ, i.e. the coefficient of correlation between the error terms in the selection equation is -1, which is at the lower bound for that coefficient. Most likely, this indicates that the model is misspecified. In fact, while the distribution of test scores for sub-test B is nicely bell-shaped, the distribution of scores for sub-test A is markedly skewed to the right. As a measure of achievement, our equation (1), the score on sub-test A is in effect censored to the right, thus violating the assumptions behind the Heckman model. This is the result of the design of the mathematics test, where sub-test A is mainly intended to determine which students should get a passing grade, while the other sub-tests are used to determine which of the passing grades a student should get. Thus, we will largely ignore the regressions using sub-test A as the dependent variable, while noting that these results support our conclusions.

The dummy variable indicating if the student has no failing grades was included to test for the possibility that competition harms low ability students, something that may be true even if the average student benefits from competition. The other dichotomous student results variable, which indicates if the student obtains passing grades in the three cardinal subjects, was included for the same reason. However, while the second of these two variables does indeed seem to identify low performing students well, the former does not. A student who does not pass the cardinal subjects cannot attend high school, while a student failing one or a few other subjects may not even get a lower credit value. Recall that the credit value is calculated from the student's 16 highest grades. Thus, in order to get as high a credit value as possible, some students may calculate that they will fail a subject and devote their energy to subjects where they have a chance of receiving a higher grade. Casual empiricism[8] suggests this to be a quite common behavior. While the average credit value of students failing at least one class, but passing the three cardinal subjects, is below average, it is clear that not all students with some failing grades in their report card are under achievers. In fact, around one tenth of the students who fail at least one subject, but pass all three cardinal subjects, has a credit value above the average. In our discussion below of how low ability students are affected by competition, we will focus on the regressions where the dependent variable is an indicator of whether the student passes the three cardinal subjects.

[8] Discussions with students and teachers.

Estimation results for the three remaining achievement variables are presented in tables 5-7. In all regressions, the coefficient on the variable with the share of children attending independent schools is positive. In the preferred econometric specification (model III) for the continuous dependent variables, it is significantly different from zero at the one-percent level. The results thus suggest that competition improves the quality of public schooling. While the size of the coefficient varies between the different econometric specifications, the qualitative results remain the same. The coefficients are positive and significantly different from zero in all cases, including sub-test A.

In the specification with a dichotomous dependent variable, the results are less clear. While the coefficient is positive in all estimated models, it is significant in only one specification, the instrumental variable probit (II). Since this is not our preferred specification, based on the tests performed, we should probably not attribute too much importance to this result.[9] Our failure to get any clear results in these specifications could either be due to the fact that low-ability students benefit less from the increase in quality due to increased competition than the average student, or simply be a result of the lower amount of information contained in a dichotomous variable, as compared to a continuous result variable. However, the main point is that there is no evidence that low-achievers are adversely affected by increased competition from independent schools.

/Table 5-7 about here./

It is comforting to note that in all cases, the instrumental variable estimates are larger in magnitude than the comparable non-IV estimate. Thus, we are likely to err on the side of caution in claiming to find a positive effect of competition.

[9] In addition, this result is not robust to slight alterations of the model, such as minor changes in the list of explanatory variables. The coefficient is still positive, but not significant, if we exclude the population distance variable and the dummy for major urban areas.

Our rejection of the OLS model against the Heckman specification, and the fact that the estimated coefficients in the latter are larger in magnitude, implies that we are likely to underestimate the positive effects of competition if ignoring self-selection.

The estimation results on the other coefficients offer few surprises. Girls have significantly better school results than boys (except for the test scores on sub-test A, where boys score significantly higher). A higher educational level of parents has a positive influence on school achievements, while children with an immigrant background have significantly worse results. These coefficients are highly significant in all cases, usually at the one-percent level. The coefficient on the income variable is positive, and significant in one case (sub-test B).

For the two demographic variables, the dummy for a major urban area and the population distance variable, only the latter is significantly different from zero, and only when the dependent variable is continuous. These variables were included to proxy for a possible effect of competition between different municipal schools. Our hypothesis was that competition between different municipal schools would be more intense, ceteris paribus, the closer they were located. Since the population distance variable is larger the more sparsely populated is the municipality, this variable should have a negative sign to support our hypothesis. This is the opposite to our findings. However, while we find no evidence of a positive effect of competition between municipal schools, concluding that such an effect does not exist is probably premature. As pointed out above, our demographic variables are probably poor proxies for "intra-municipal" competition, and may also be correlated with unobserved factors that are important for school choice and educational achievement.[10]

[10] One point of criticism of our results has focused on the inclusion of these two demographic variables. To test if our results are robust to specification with regard to these two variables, we tested to exclude them, to include the logarithm or the square of the population density variable, and all combinations thereof. In all regressions, the qualitative results were the same as in the main regressions. For the credit value and sub-test B, the changes in the estimated coefficients were in the second significant digit. (Results available from the corresponding author.)

The school-cost variable is not significant, and the sign is sometimes negative. While this result is consistent with the findings of Hanushek [8] and others that the link is weak, if not nonexistent, between resources spent on education, and educational outcome, we would not like to draw any conclusions from this result. Since this is not the focus of the study, we have not taken the potential endogeneity of this variable into account.

The estimated coefficients on the number of students attending ninth grade in the school is positive, and significant in two cases. (Credit value and the no failing grade in the cardinal subject variable.) Thus, we find weak evidence that students in larger schools achieve better results.

In the selection equation, we find that five coefficients are significant for both the credit value and sub-test B. The results are quantitatively the same as in an ordinary probit estimation of the likelihood that a student will attend a municipal school. Immigrant background and parents with a higher educational background reduce the probability that a student will attend a municipal school. Population distance is also negative and significant, indicating that people in sparsely populated areas are more likely to attend an independent school.

The two "political variables" are both significant, with opposite signs. Taken at face value, a larger vote-share for the non-socialist parties increases the likelihood of a student attending an independent school. However, given this vote-share, this probability is reduced if the municipality has a non-socialist governing majority. This may seem surprising, but a reasonable hypothesis is that the need to opt out of the public school system may be reduced if the governing majority is of the same political affiliation as the parent. The estimation results are consistent with the estimates of equation (2).[11]

[11] The population distance variable has opposite effects in the selection equation and in equation

The robustness of our results may mainly be challenged for two reasons. First, there is a large number of missing data, and second, data are only from a selection of Swedish municipalities.

To address the last of these issues, we tested to drop each municipality, one at a time, two at a time, and three at a time, for all possible combinations of the 33 municipalities, using credit value and sub-test B as dependent variables. We estimated the models using the preferred Heckman specification. When only one municipality was dropped, the coefficient on the independent school share remained positive and significant in all cases when we used the Heckman specification, in all cases but two at the 1- or 5-percent level.[12] When two municipalities were dropped, the estimated coefficient failed to be significant in 9 cases out of the 528 possible combinations, when sub-test B is the dependent variable, and in 13 cases when the credit value is the dependent variable. However, in no case did the estimates fail to be significant for both sub-test B and the credit value for the same combination of dropped municipalities. In most cases where the Heckman estimates did not result in a coefficient significantly different from zero, the coefficients were positive and significant when the models were estimated using OLS. (In all cases for sub-test B, and in all but 5 cases for the credit value.)

When three municipalities were dropped, we got 5456 different possible combinations. In all but six, the coefficient on the independent school share is significantly different from zero at least at the 10-percent level, for at least one of the two dependent variables. It failed to be significant for one of the variables in 493 cases. (173 and 326 for sub-test B and the credit value, respectively.) Even though the coefficient

(2), but is only significant in the former.

[12] In the Heckman estimation with the credit value as the dependent variable, the coefficient is significant at the 10-percent level when Gothenburg or Uppsala was dropped. We also estimated an OLS for comparison. In the OLS, the parameter estimate is significant in all but one case for sub-test B, and in all but six cases for the credit value.

is negative in a few cases, it is not negative and significant in one single case when we use Heckman's method, and in exactly one case when using OLS. In most cases, the change in the parameter estimates is in the second significant digit.

To test whether the large number of missing observations for test results, and for the dummy variable for the student's sex, has any serious consequences for our results, we replaced the missing values under a few different assumptions. First, the sex-dummy was replaced by 0.5 which is close to the average in the sample, as is hardly surprising. We then replaced the missing values for the credit value and the student's grade in mathematics with zero. We thus made the assumption that all students for which data were missing were extreme low ability students. Finally, we regressed the test results from sub-tests A and B, respectively, on the credit value and the mathematics grade, and also on each of these separately, and replaced the missing values for these tests with the predicted values. The values of the coefficients fell slightly, between 7 and 12 % for sub-test B, and between 11 and 18 % for sub-test A, but were still significant at the 5- and 1-percent level, respectively. As an additional test, we replaced all missing data for the test scores and for the credit value with zero, and ran the regressions on these three variables. This assumption is clearly extreme, since many students with missing data on the test scores have above average grades in mathematics. However, under this assumption, the coefficients in the regressions with sub-test A and the credit value as dependent variables are smaller in value, about half the size for sub-test A, and 13 % for the credit value, but were still significant at the 1- and 5-percent levels of significance, respectively. For sub-test B, the value of the coefficient is higher, but the estimate is no longer significant.[13]

[13] We also tested various other assumptions about the missing values for the sex and parental education variables: That all missing are boys/girls, that all missing have only the lowest/intermediate/highest level of education. None of these permutations of the model affected

Our conclusion is that the results are robust with regard to changes in the selection of municipalities in the sample. Only under extreme assumptions about the missing values do the qualitative results change. Thus, our results also seem to be robust in this respect.

3.4 Panel data analysis

In the three regressions described above, we allow for the error terms to be more closely correlated within observational units (schools) than across such units. In effect, we assume an error component model. An alternative specification would be to use a panel data setting. However, since our data on individuals are from one time period only, the estimation of fixed effect models is not tractable. To check if non-observable heterogeneity is important in accounting for student results, we use a separate data set on municipal grade averages and background variables. Data are available for the years 1992 and 1994-1997 for all 288 municipalities that existed in 1997. Since two of these were created in 1995 through some changes of administrative boundaries, the panel is unbalanced.

We estimate one-way and two-way models, using both fixed effects and a random effects specification. In table 2, we also present estimation results from an OLS and a between model. Since this data base contains aggregate data, the variables are slightly different from the three previous models. It should also be noted that the dependent variable is an average for all students, i.e. for students in both municipal and independent schools. The variable indicating the share of students in independent schools is the same as before, however. Apart from this variable, we include variables for the shares of the population with immigrant background and with no higher education. In addition, the municipality's spending on education, excluding rental

our conclusions.

costs, are included. This variable is also defined as before.

/ Table 2 about here./

The preferred model is the two-way random effects model. In the two-way setting, we cannot reject the random effects model against the fixed effects model on the five percent level in a Hausman-test, while we may reject the one-way specification against the two-way specification. However, the coefficients on the variable for the independent school share are close in all regressions, and significant in all specifications except the two-way fixed effect specification and the between model. The results from the panel data models thus confirm earlier results, and seem to validate the error component setting assumed in the sample selection models.

Since the panel data models are specified as simple linear models, the coefficients are easily interpreted. To get a idea of the economic significance of increased competition, we may compare the "resource coefficient", i.e. educational spending per student, with the impact of a larger percentage of students in independent schools. Such an analysis must obviously be taken with several grains of salt, but gives some idea of the scale of the effect. Taken literally, the preferred model implies that an increase in the share of students attending independent schools by one percentage point would be equivalent to an increase in spending by about SEK 2000,[14] which corresponds to an increase in spending by over 5 percent, computed from the sample average.

4 Concluding remarks

The role of independent schools had been hotly debated long before Friedman and Friedman [6] proposed school vouchers as a means of improving the quality of schooling. In the Netherlands, the "schoolstrijd", in which advocates and opponents of

[14] SEK 1 $\approx$ EUR 0.11 $\approx$ USD 0.097, as of March 2002.

state support to independent schools clashed, was a central issue of political conflict during several decades around the turn of the century, leading up to the constitutional compromise of 1917. [13] In France, the role of Catholic schools was a highly divisive issue from the revolution of 1789 and onwards. [4] The establishment of secular schools was a central element of the anticlerical reforms under the Third Republic. [1] In recent years, this debate has taken a new turn. Historically, much of the debate has focused on ideological issues, e.g. whether it is right to use public funds to support religious schools, or if public schools should be used as a means of imposing greater national cohesion. In today's debate, however, efficiency motives have been introduced as an argument for school choice. It is claimed that increased competition between schools would be beneficial to educational quality.

A number of empirical studies have shown this argument to be valid. The present study confirms the finding that greater competition improves the standards of public schools. The wide scope of reform of the system for financing primary education makes the Swedish experience particularly interesting. Sweden has left a system with virtually no parental influence over school choice, and an almost complete dominance of public schools. A voucher system, where parents are allowed to choose any school approved by the National Agency for Education, has been put in its place. Independent schools receive funding on close to equal terms with public (municipal) schools.

A widespread concern among opponents of school choice is that competition will hurt the public schools. The present study shows this fear to be without foundation.

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			By municip.			By individual (all)			By individual (municipal school only)		
Variable	Min	Max	Valid obs.	Mean	St. dev.	Valid obs.	Mean	St. dev.	Valid obs.	Mean	St. dev.
Full sample			34			28065			26656		
Credit value	0	320				27456	199.1	65.24	26075	199.6	62.83
Sub-test A	0	30				25000	19.95	6.934	23734	19.82	6.941
Sub-test B	0	45				24543	21.57	9.266	23293	21.37	9.233
No failing Coeur subj.	0	1				26867	0.9167	0.2763	25726	0.9155	0.2782
No failing grade	0	1				27219	0.7799	0.4143	26075	0.7804	0.414
Indep. school share	0	10.2	33	2.412	3.108	27996	5.221	3.433	26587	5.079	3.431
Woman	0	1				26079	0.4983	0.5000	24695	0.4969	0.5000
Immigrant backgr.	0	1				27111	0.2084	0.4062	25923	0.2048	0.4035
Parents' educ. backgr.	1	3				26087	2.381	0.6696	24758	2.367	0.6715
Income (muni. 100 SEK)	816.1	1197	33	952.1	90.34	27972	1013	100.9	26587	1010	100.4
Urban dummy	0	1	33	0.2121	0.4151	27996	0.51075	0.4999	26587	0.4989	0.5000
Population distance	17	1077	33	222.6	224.5	27996	94.30	107.3	26587	96.46	108.5
No. of students in school	1	226	33	105.4	30.46	27972	116.5	41.72	26587	119.3	39.17
School cost	34600	54900	33	42310	4791	27996	44420	5109	26587	44300	5091
Non-socialist municip. gov.	0	1	33	0.2121	0.4151	27996	0.08901	0.2848	26587	0.09253	0.2898
Non-socialist vote share	0.2359	0.5397	33	0.4040	0.08924	27996	0.4611	0.07012	26587	0.4592	0.07078

Table 1 – Descriptive statistics, variables in equations (1) and (3).

For variables defined at the municipal level, descriptive statistics are presented both unweighted and weighted by the number of students in the sample from each municipality. For all variables, descriptive statistics are presented both for the entire sample, and for the sub-sample of students attending municipal schools.

Variable	Min	Max	Valid obs.	Mean	St. dev.
Indep. school share	0	14.6	288	1.610	3.108
Average grades 92	2.98	3.51	285	3.194	0.08717
Contracting (infrastructure)	0	50	288	7.830	9.369
Contracting (child care)	0	29	288	5.257	5.129
Contracting (elderly and disabled)	0	84	288	8.396	9.196
Contracting (social services)	0	55	288	17.17	10.45
Contracting (business)	0	81	287	12.26	15.04
School cost	29200	58900	284	41385	4601
Share with immigr. backgr.	0	9	288	2.191	1.390
Share without higher educ.	7	39	288	26.91	5.592
Income (municip., 100s of SEK.)	741	1755	288	956.2	121.4
Non-socialist municip. gov. (dummy)	0	1	288	0.3194	0.4671
Non-socialist vote share	0.1897	0.8412	288	0.4367	0.1095
Urban dummy	0	1	288	0.1319	0.3390
Population distance	17	2045	288	276.4	267.1

Table 2 – Descriptive statistics, variables in equation (2)

Descriptive statistics for variables used in estimating the model for the independent school share. Note that these data cover all of Sweden’s 288 municipalities.

	Indep. sch. sh.	Cont.(infr.)	Contr.(chi.)	Contr.(eld.)	Contr.(soc.)
Independent school share	-				
Contracting (infrastructure)	0.144	-			
Contracting (child care)	0.435	0.113	-		
Contracting (elderly and disabled)	0.385	0.138	0.384	-	
Contracting (social services)	0.129	0.074	0.083	0.208	-
Contracting (business)	0.151	0.386	0.221	0.303	0.088

Table 3 – Correlation between contracting out, and the independent school share

The table displays the correlation between the degree to which municipalities have contracted out their responsibilities and the independent school share.

Independent school share	
Valid obs:	280
Left-censored obs:	103
Uncensored obs:	177
Average grades 92	-4.518 *
	(2.443)
Contracting (infrastructure)	0.02579
	(0.01990)
Contracting (child care)	0.1315 ***
	(0.0428)
Contracting (elderly and disabled)	-0.005913
	(0.02513)
Contracting (social services)	0.01101
	(0.01814)
Contracting (business)	-0.009423
	(0.01248)
School cost	3.73E-05
	(4.74E-05)
Share with immigr. backgr.	0.3868 ***
	(0.1443)
Share without higher educ.	-0.1338 ***
	(0.04585)
Income (municip., 100s of SEK)	0.0003759
	(0.00249)
Non-socialist municip. gov. (dummy)	-0.6807
	(0.5038)
Non-socialist vote share	6.688 **
	(2.69)
Urban dummy	1.764 **
	(0.6853)
Population distance	-0.0007302
	(0.001036)
Constant	12.37
	(8.187)
Standard error:	2.610
	(0.1451)
Pseudo R2:	0.1184

Table 4 – Explaining the share of independent schools

The table presents results from a Tobit-estimation of equation (2), explaining the share of students attending independent schools in Sweden's 288 municipalities.

Main equation	Dependent variable : Credit value I	II	III	IV
Uncensored obs.	22961	22961	22961	22961
Censored obs.	-	-	1098	1098
Indep. school share	0.5381 *	1.493 **	1.461 ***	3.286 ***
	(0.2849)	(0.6773)	(0.5379)	(0.9745)
Woman	19.89 ***	19.90 ***	19.96 ***	19.99 ***
	(0.9012)	(0.9018)	(0.9522)	(0.952)
School cost	-0.0003269	-0.0003391	-0.0003355	-0.000317
	(0.0002117)	(0.0002065)	(0.0003082)	(0.0002972)
Immigrant backgr.	-7.098 ***	-7.311 ***	-4.134 **	-4.556 **
	(1.49)	(1.491)	(1.919)	(1.932)
Parents' educ. backgr.	29.18 ***	29.13 ***	31.15 ***	31.12 ***
	(0.752)	(0.7424)	(0.9427)	(0.9461)
Income (municip., 100s of SEK)	0.009453	0.005358	0.01389	0.005293
	(0.009754)	(0.01012)	(0.01587)	(0.01612)
Urban dummy	1.839	0.4814	1.515	-0.7564
	(2.410)	(2.709)	(3.735)	(4.073)
Population distance	0.01434 *	0.02121 **	0.01434 *	0.02784 ***
	(0.007834)	(0.008180)	(0.008355)	(0.009086)
No. of students in school	0.04687 **	0.04262 **	0.04309 **	0.03277 *
	(0.01833)	(0.01854)	(0.01691)	(0.01718)
Constant	122.4 ***	124.0 ***	113.9 ***	116.1 ***
	(10.69)	(10.73)	(16.59)	(16.60)
Selection equation	Selected: Students attending municipal schools			
Woman			-0.1241 **	-0.1238 **
			(0.05266)	(0.05421)
School cost			-0.0000338	-0.0000281
			(0.0000285)	(0.0000246)
Immigrant backgr.			-0.1549 **	-0.1555 **
			(0.07849)	(0.0775)
Parents educ. backgr.			-0.3714 ***	-0.3692 ***
			(0.04171)	(0.04101)
Income (municip., 100s of SEK)			0.003311	0.002515
			(0.002644)	(0.002206)
Nod-socialist municip. gov. (dummy)			1.634 **	1.41 **
			(0.8273)	(0.6839)
Non-socialist vote share			-9.899 *	-8.244 *
			(5.537)	(4.503)
Urban dummy			-0.1736	-0.1408
			(0.2539)	(0.2272)
Population distance			-0.001746 **	-0.001471 **
			(0.0008738)	(0.0007029)
Constant			5.753 ***	5.467 ***
			(1.268)	(1.144)
ρ			-0.9534	-0.9525
			(0.02689)	(0.02841)
σ			54.77	54.76
			(0.7653)	(0.7624)
λ			-52.22	-52.16
			(1.571)	(1.653)

Table 5 – Explaining student results. Credit value.

The table presents results from estimations of the main equation (1), with the credit value as the dependent variable. Estimations (I) and (II) ignore self-selection, while models (III) and (IV) are estimated using Heckman's approach, with equation (3) forming the selection part of the model. Equations (II) and (IV) are estimated using an instrument for the share of students attending independent schools. This instrument is constructed using the estimates of equation (2) presented in Table 4. The presented standard errors are from robust estimators allowing for clustering. The preferred specification is model (III).

Main equation	I	II	III	IV
	Dependent variable : Sub-test B			
Uncensored obs.	21815	21815	21815	21815
Censored obs.	-	-	1098	1098
Indep. school share	0.1396 **	0.2795 **	0.1767 ***	0.2996 *
	(0.05489)	(0.1335)	(0.05950)	(0.1582)
Woman	0.393 ***	0.3971 ***	0.4020 ***	0.4001 ***
	(0.1373)	(0.1375)	(0.1373)	(0.1371)
School cost	0.0000107	0.0000148	0.0000105	0.0000152
	(0.0000378)	(0.0000377)	(0.0000384)	(0.0000379)
Immigrant backgr.	-3.185 ***	-3.214 ***	-3.087 ***	-3.187 ***
	(0.2151)	(0.2196)	(0.2262)	(0.2399)
Parents' educ. backgr.	4.255 ***	4.252 ***	4.327 ***	4.273 ***
	(0.1074)	(0.1081)	(0.1168)	(0.1403)
Income (municip., 100s of SEK)	0.004990 ***	0.00432 **	0.005129 ***	0.004313 **
	(0.001755)	(0.001824)	(0.001793)	(0.001832)
Urban dummy	-0.7592	-0.9171 *	-0.7817	-0.9331 *
	(0.4717)	(0.5413)	(0.4825)	(0.5523)
Population distance	0.002197	0.003256 **	0.002235 *	0.003338 **
	(0.001381)	(0.001532)	(0.001351)	(0.001535)
No. of students in school	0.003042	0.002333	0.003225	0.002328
	(0.00359)	(0.003736)	(0.003573)	(0.003744)
Constant	5.421 ***	5.482 ***	5.077 **	5.382 ***
	(1.942)	(1.941)	(1.965)	(1.973)
Selection equation	Selected: Students attending municipal schools			
Woman			-0.03646	-0.03386
			(0.04310)	(0.04343)
School cost			-0.0000504	-0.0000501
			(0.0000384)	(0.0000386)
Immigrant backgr.			-0.3142 ***	-0.3074 ***
			(0.1010)	(0.1035)
Parents educ. backgr.			-0.2731 ***	-0.2761 ***
			(0.05880)	(0.05995)
Income (municip., 100s of SEK)			0.005068	0.004989
			(0.003114)	(0.003098)
Non-socialist municip. gov. (dummy)			2.382 ***	2.355 ***
			(0.8483)	(0.8439)
Non-socialist vote share			-14.2 **	-14.1 **
			(5.948)	(5.936)
Urban dummy			-0.2849	-0.2857
			(0.3667)	(0.3684)
Population distance			-0.00227 **	-0.002282 **
			(0.001066)	(0.001078)
Constant			6.591 ***	6.617 ***
			(1.65)	(1.676)
ρ			-0.2252	-0.06626
			(0.09317)	(0.2497)
σ			8.520	8.493
			(0.06087)	(0.05504)
λ			-1.918	-0.5627
			(0.8009)	(2.122)

Table 6 – Explaining student results. Sub-test B.

The table presents results from estimations of the main equation (1), with the scores on sub-test B as the dependent variable. Estimations (I) and (II) ignore self-selection, while models (III) and (IV) are estimated using Heckman's approach, with equation (3) forming the selection part of the model. Equations (II) and (IV) are estimated using an instrument for the share of students attending independent schools. This instrument is constructed using the estimates of equation (2) presented in Table 4. The presented standard errors are from robust estimators allowing for clustering. The preferred specification is model (III).

Main equation	Dependent variable : No failing grade in cardinal subjects I	 II	 III	 IV
Uncensored obs.	22930	22930	22930	22930
Censored obs.	-	-	1098	1098
Indep. school share	0.01215	0.04745 **	0.0009692	0.04133
	(0.008987)	(0.02228)	(0.01747)	(0.03595)
Woman	0.1869 ***	0.1871 ***	0.1801 ***	0.1857 ***
	(0.03039)	(0.03046)	(0.03194)	(0.03158)
School cost	3.94e-06	2.42e-06	4.16e-06	2.36e-06
	(7.42e-06)	(7.26e-06)	(7.47e-06)	(7.23e-06)
Immigrant backgr.	-0.3174 ***	-0.3252 ***	-0.3360 ***	-0.3319 ***
	(0.04857)	(0.04910)	(0.05175)	(0.05213)
Parents' educ. backgr.	0.5048 ***	0.5031 ***	0.4730 ***	0.4953 ***
	(0.02345)	(0.02343)	(0.05592)	(0.04341)
Income (municip., 100s of SEK)	0.0002725	0.0001522	0.0002372	0.0001505
	(0.0003551)	(0.0003583)	(0.000368)	(0.0003567)
Urban dummy	-0.05760	-0.1140	-0.04966	-0.1078
	(0.08134)	(0.08833)	(0.08157)	(0.09135)
Population distance	0.0003766	0.0006337 **	0.0003703	0.0006094 **
	(0.0002554)	(0.000287)	(0.000254)	(0.0003082)
No. of students in school	0.002437 ***	0.002303 ***	0.002359 ***	0.002305 ***
	(0.0006161)	(0.0006209)	(0.0006131)	(0.0006195)
Constant	-0.3800	-0.3100	-0.2739	-0.2774
	(0.3768)	(0.3719)	(0.4288)	(0.4059)
Selection equation	Selected: Students attending municipal schools			
Woman			-0.03000	-0.03286
			(0.04178)	(0.04214)
School cost			-0.0000461	-0.0000472
			(0.0000385)	(0.0000385)
Immigrant backgr.			-0.2931 ***	-0.2986 ***
			(0.2931)	(0.1012)
Parents educ. backgr.			-0.2840 ***	-0.2855 ***
			(0.05942)	(0.05941)
Income (municip., 100s of SEK)			0.004876	0.004909
			(0.003106)	(0.003106)
Non-socialist municip. gov. (dummy)			2.299 ***	2.324 ***
			(0.8694)	(0.8562)
Non-socialist vote share			-14.13 **	-14.09 **
			(5.941)	(5.949)
Urban dummy			-0.3245	-0.3071
			(0.376)	(0.3755)
Population distance			-0.002393 **	-0.002346 **
			(0.001069)	(0.001069)
Constant			6.641 ***	6.632 ***
			(1.638)	(1.652)
ρ			0.4157	0.1583
			(0.4017)	(0.5854)

Table 7 – Explaining student results. No failing grade in the cardinal subjects.

The table presents results from estimations of the main equation (1), with a dummy variable indicating if the student has passing grades in the three cardinal subjects (mathematics, Swedish and English) as the dependent variable. Estimations (I) and (II) ignore self-selection and are estimated as probit models, since the dependent variable is dichotomous, while models (III) and (IV) are estimated as bivariate probit models with partial observability and with equation (3) forming the selection part of the model. Equations (II) and (IV) are estimated using an instrument for the share of students attending independent schools. This instrument is constructed using the estimates of equation (2) presented in Table 4. The presented standard errors are from robust estimators allowing for clustering. The preferred specification is model (I).

		One-way		Two-way		
	OLS	FE	RE	FE	RE	Between
R^2	0.2481	0.7515		0.7632		0.3305
Adjusted R^2	0.2460	0.6880		0.7015		0.3210
Indep. school share	0.0041 ***	0.0037 **	0.0041 ***	0.0019	0.0037 **	0.0038
	(0.0014)	(0.0017)	(0.0015)	(0.0020)	(0.0016)	(0.0028)
Municip. school spending	$2.1 \cdot 10^{-6}$ ***	$3.4 \cdot 10^{-6}$ ***	$2.8 \cdot 10^{-6}$ ***	$1.4 \cdot 10^{-6}$ **	$1.6 \cdot 10^{-6}$ ***	$1.9 \cdot 10^{-6}$ **
	($5.0 \cdot 10^{-7}$)	($5.7 \cdot 10^{-7}$)	($5.1 \cdot 10^{-7}$)	($7.0 \cdot 10^{-7}$)	($6.2 \cdot 10^{-7}$)	($1.1 \cdot 10^{-6}$)
Share without higher educ.	-0.0064 ***	-0.0026 ***	-0.0046 ***	$7.2 \cdot 10^{-4}$	-0.0060 ***	-0.0070 ***
	($3.7 \cdot 10^{-4}$)	($6.7 \cdot 10^{-4}$)	($4.8 \cdot 10^{-4}$)	0.002	($7.6 \cdot 10^{-4}$)	($7.2 \cdot 10^{-4}$)
Share with immigr. backgr.	-0.0058 ***	-0.0085 ***	-0.0076 ***	-0.0013	-0.0033	-0.0051 **
	(0.0015)	(0.0029)	(0.0021)	(0.0033)	(0.0025)	(0.0030)
Constant	3.3 ***	N/A	3.2 ***	3.1 ***	3.3 ***	3.3 ***
	(0.024)		(0.028)	(0.078)	(0.035)	(0.049)

Table 8 – Results from panel data models.

One, two and three asterisks indicate that the coefficient estimates are significantly different from zero at the 10-, 5- and 1-percent levels. The figures within parenthesis are standard errors. The one-way random effects model can be rejected against the fixed effects specification in a Hausman test at any usual level of significance. The two-way random effects specification cannot be rejected at the 5-percent level against the fixed effects specification, however,. The models are estimated on data from all 288 Swedish municipalities for the years 1992 and 1994-1997.

Appendix

Main equation	Dependent variable : Sub-test A I	II	III	IV
Indep. school share	0.1266 ***	0.2512 ***	0.2031 **	0.2159 **
	(0.03907)	(0.09434)	(0.08219)	(0.09616)
Woman	-1.199 ***	-1.196 ***	-1.113 ***	-1.202 ***
	(0.1016)	(0.1018)	(0.1095)	(0.1018)
School cost	0.0000213	0.0000253	0.0000216	0.0000248
	(0.0000299)	(0.0000305)	(0.0000409)	(0.0000307)
Immigrant backgr.	-1.901 ***	-1.927 ***	-1.427 ***	-1.974 ***
	(0.1541)	(0.1603)	(0.2389)	(0.1616)
Parents educ. backgr.	3.215 ***	3.212 ***	3.46 ***	3.176 ***
	(0.08764)	(0.08765)	(0.1161)	(0.09384)
Income (municip., 100s of SEK)	0.002690 **	0.002092	0.003419	0.002101
	(0.001332)	(0.001409)	(0.002137)	(0.001412)
Urban dummy	-0.8369 **	-0.9781 **	-0.7541	-0.9495 **
	(0.3545)	(0.4066)	(0.4962)	(0.4077)
Population distance	0.0001591	0.001111	-0.0005636	0.0009651
	(0.00116)	(0.001256)	(0.001205)	(0.001273)
No. of students in school	0.007740 ***	0.007112 **	5.96e-08	0.007142 **
	(0.002743)	(0.002886)	(1.19e-07)	(0.002865)
Constant	8.448 ***	8.486 ***	8.151 ***	8.654 ***
	(1.401)	(1.382)	(2.181)	(1.410)
Selection equation	Selected: Students attending municipal schools			
Woman			0.1649 ***	-0.03225
			(0.0167)	(0.0428)
School cost			-0.0000138 **	-0.0000485
			(5.80e-06)	(0.0000388)
Immigrant backgr.			0.2113 ***	-0.3006 ***
			(0.03633)	(0.1017)
Parents educ. backgr.			-0.5123 ***	-0.2812 ***
			(0.01521)	(0.06076)
Income (municip., 100s of SEK)			0.001646 *	0.004941
			(0.0009588)	(0.003110)
Nod-socialist municip. gov. (dummy)			0.8313 **	2.333 ***
			(0.3303)	(0.8490)
Non-socialist vote share			-6.048 **	-14.21 **
			(2.403)	(5.993)
Urban dummy			-0.1909 *	-0.3103
			(0.1024)	(0.372)
Population distance			-0.00105 **	-0.002381 **
			(0.0004972)	(0.001084)
Constant			4.529 ***	6.689 ***
			(0.4795)	(1.674)
ρ			-1 ***	0.1545
			(4.93e-12)	(0.09568)
σ			6.753	6.339
			(0.1133)	(0.049)
λ			-6.753 ***	0.9797
			(0.1133)	(0.6099)

Table A1 – Explaining student results. Sub-test A.

The table presents results from estimation of the main equation (1), with the scores on sub-test A as the dependent variable. Estimation (I) and (II) ignore self-selection, while models (III) and (IV) are estimated using Heckman's approach, with equation (3) forming the selection part of the model. Equations (II) and (IV) are estimated using an instrument for the share of students attending independent schools. This instrument is constructed using the estimates of equation (2) presented in Table 4. The presented standard errors are from robust estimators allowing for clustering. The preferred specification is model (III). Not that the estimated value of ρ, i.e. the correlation between the random terms of the selection and main equations is –1, which is at the bound for that parameter. This indicates that the model may be miss-specified.

Main equation	Dependent variable : No failing grade (all subjects) I	II	III	IV
Uncensored obs.	22961	22961	22961	22961
Censored obs.	-	-	1098	1098
Indep. school share	0.003633	0.007838	0.008454	0.01397
	(0.008975)	(0.01906)	(0.01018)	(0.02183)
Woman	0.2332 ***	0.2333 ***	0.2329 ***	0.2336 ***
	(0.0253)	(0.02528)	(0.02551)	(0.02531)
School cost	-7.68e-07	-7.03e-07	-8.16e-07	-6.19e-07
	(6.33e-06)	(6.30e-06)	(6.39e-06)	(6.30e-06)
Immigrant backgr.	-0.2032 ***	-0.204 ***	-0.1870 ***	-0.1943 ***
	(0.04193)	(0.04154)	(0.04499)	(0.04758)
Parents educ. backgr.	0.4652 ***	0.4651 ***	0.4732 ***	0.4712 ***
	(0.01901)	(0.01881)	(0.01910)	(0.02041)
Income (municip., 100s of SEK)	-0.0003944	-0.0004127	-0.0003664	-0.0004082
	(0.000328)	(0.0003335)	(0.0003296)	(0.0003342)
Urban dummy	0.09566	0.09010	0.09134	0.08423
	(0.07125)	(0.0745)	(0.07237)	(0.07448)
Population distance	0.0005848 **	0.0006169 **	0.0005887 **	0.0006411 **
	(0.0002836)	(0.000302)	(0.0002804)	(0.000302)
No. of students in school	0.001235 **	0.001212 **	0.001248 **	0.001205 **
	(0.0005841)	(0.0005929)	(0.0005804)	(0.0005928)
Constant	-0.06658	-0.06386	-0.1146	-0.09685
	(0.3574)	(0.3593)	(0.3597)	(0.3618)
Selection equation	Selected: Students attending municipal schools			
Woman			-0.04003	-0.03797
			(0.04242)	(0.04336)
School cost			-0.0000469	-0.0000471
			(0.0000381)	(0.0000384)
Immigrant backgr.			-0.3008 ***	-0.3002 ***
			(0.1008)	(0.1013)
Parents educ. backgr.			-0.2891 ***	-0.2882 ***
			(0.05836)	(0.05848)
Income (municip., 100s of SEK)			0.004846	0.004857
			(0.003085)	(0.003123)
Nod-socialist municip. gov. (dummy)			2.335 ***	2.332 ***
			(0.8367)	(0.8384)
Non-socialist vote share			-13.94 **	-13.95 **
			(5.934)	(5.985)
Urban dummy			-0.2902	-0.2926
			(0.3634)	(0.3651)
Population distance			-0.002297 **	-0.002302 **
			(0.00106)	(0.001066)
Constant			6.607 ***	6.610 ***
			(1.656)	(1.657)
athrho			-0.3851	-0.2278
			(0.4591)	(0.4764)
ρ			-0.3671	-0.224
			(0.3973)	(0.4525)

Table A2 – Explaining student results. No failing grade (all subjects).

The table presents results from estimation of the main equation (1), with a dummy variable indicating if the student have passing grades in all subjects as the dependent variable. Estimation (I) and (II) ignore self-selection and are estimated as probit models, since the dependent variable is dichotomous, while models (III) and (IV) are estimated as bivariate probit models with partial observability and with equation (3) forming the selection part of the model. Equations (II) and (IV) are estimated using an instrument for the share of students attending independent schools. This instrument is constructed using the estimates of equation (2) presented in Table 4. The presented standard errors are from robust estimators allowing for clustering. The preferred specification is model (I).