

Does School Competition Improve the Quality of Education?

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Abstract

This paper evaluates the Swedish school reform that was implemented in 1992, at upper secondary school level. The reform implies that independent schools are welcome to compete on the school market and are publicly funded. This reform has led to an increase in the share of students attending independent schools. Several estimations are performed in this paper on what impact this increase of competition has had on students average GPA in public schools. Students from social science and science programs are included. The tests are done with multiple linear regression models and instrumental variable regressions on data collected from 2010. This study covers 93 schools in social science and 76 schools in science programs from 46 different municipalities spread over the country. Previous research has shown a variety of findings. In this paper, no significant results have shown that independent schools would raise the average GPA in public schools; municipalities with no independent schools perform as well as municipalities with a high share of competition. Control variables are used to check for school characteristics. Mainly, it is the number of female students and share of parents with higher education that have the greatest impact. To conclude, this study shows that grades will not be affected if a public school is exposed to competition or not. At the same time, there is no evidence proving that the quality worsens because of competition; that comes from concerns about segregation, where the good students end up in better independent schools and leave low performing students behind.

Keywords: school-choice reform, school competition, public education, educational achievement

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List of Abbreviations

GPA	Grade point average
NAE	The national agency of education
SKL	Swedish Association of Local Authorities and Regions
IND. SCH	Share of independent schools
NOS	Number of students
SOF	Share of female students
SOI	Share of immigrants at a school
EDUP	Share of educated parents
POP	Population in municipality
MA	Municipality in a metropolitan area

1. Introduction

Since the implementation of the Swedish school reform, there has been a remarkable growth of the number of independent schools on the school market. The idea behind introducing the reform was the idea that increased competition would lead to a higher quality of education, increased cost-efficiency and a more diversified school market with schools covering students' needs and interests.

The underlying argument for why privatization should affect the quality of the education is that a monopoly situation may create a lack of incentives for running a good and efficient school. In turn, when it is exposed to competition, schools may be forced to improve their quality. A competitive environment could also give space for new ideas, methods, pedagogy and increased efficiency of running a school. This could in turn also have spill over effects, which would affect the outcome for both public and independent schools.

When evaluating previous research and literature, the evidence and findings on the effect of competition on the school market have varied. How competition has affected the quality of public schools has been tested in a range of different ways, both in Sweden and in other countries. Previous Swedish empirical studies have used several different approaches to measure independent schools impacts on the school market. There has been the subject: if competition has contributed to a higher form of grade inflation (Wikstrom and Wikstrom 2005), or if the free school reform has increased segregation among young people (Ahlin 2003; Böhlmark and Lindahl 2007). This study has a different focus; it will investigate how competition will affect the quality of public schools. The hypothesis builds on previous studies suggesting that competition will enhance the level of education and give incentives to public schools to improve their education. But instead of focusing on students in compulsory school, as in previous studies, this paper will use data on students from upper secondary school. To the author's knowledge, this has never been done before and it is of interest because of the extensive share of students that go to independent schools in comparison to upper school level.

The central contribution of this paper is that I use a data set on upper secondary schools from municipalities spread all over Sweden to empirically analyse the effect that the Swedish school reform has had on the quality of education in upper secondary schools.

1.1 Research Question

The aim to this research is to analyse to what extent competition on the school market has affected average grades on public schools in the Swedish school market. The purpose of this paper is to contribute to the research on the Swedish educational system, concentrating on upper secondary school. This will be done by different empirical methods. To study the relationship between educational quality and competition is of the highest importance since there is a complete lack of empirical findings from upper secondary schools in Sweden. An empirical analysis of competition of upper secondary school is necessary since it is a field of unclear theoretical predictions. Because of the extensive school reform Sweden implemented, it is necessary to evaluate its effect on the school market.

The research question is following:

To what extent has competition on the school market affect the average GPA on upper secondary school level?

1.2 Methods and Data

In this study, the empirical testing is based on two different quantitative, econometric methods applied to test whether an increase of the share of students that go to independent upper secondary schools in a municipality will have a positive effect on average school grades in public schools. A number of multiple linear regressions and IV-regressions are performed to assess the determinants of average grades. School-level data is collected from the database SIRIS, provided by the Swedish national agency for education from the year 2010. Data on the municipality level such as educational level, average income, if there is a conservative majority etc. is collected from Statistics Sweden. The study started with using the 50 largest municipalities in Sweden, but, because of missing data, it ended up with 46 municipalities spread out

over the country. Because of the selection of data, the result will be tested for robustness.

1.3 Limitations

The main limitation of this paper is due to the lack of good data. Primarily, there is the limitation of finding accurate data on how to measure knowledge among the students. First of all, there are no tests that can be considered to measure something as general as knowledge. The closest one can find today would be the national test, which is performed both in compulsory school and upper secondary school. Unfortunately, the results on these tests are not available for all schools on upper secondary school level, and the sample of schools differs from year to year. Another issue is that the teachers from the same school usually correct the national tests; this creates problems with objectivity. Due to the lack of good measurements, average GPA is used in this paper. The measurement still suffers from subjectivity, since the teachers set the grades, but it is the only available data, it covers almost every school in Sweden and is therefore very useful. Another limitation is that the data set only consists of aggregated data. With individual data, a more sophisticated method could have been performed, such as value added specification (Ahlin 2003), but to my knowledge, research has never been done on this level and therefore it is important to fill that gap with the existing data.

1.4 Outline

In the following section, chapter 2, the Swedish school market is shortly explained, with some background information of why Sweden implemented the school reform and how it is designed. In chapter 3, the focus changes to the theoretical framework. Some background on theory of inefficient bureaucracy will be explained and questions such as why competition would improve education will be examined. Findings in previous studies will also be presented. Chapter 4 includes the methodology and the data set. A discussion about the different variables and why they are selected will be presented. There will also be an explanation of the equations used. In chapter 5, the results will be reported. It contains the descriptive statistics, the findings from the OLS and the IV-estimations. This section is completed with a

robustness test. The final chapter of this paper will be a conclusion and some suggestions for future research.

2. The Swedish case

In the early 1990s, Sweden implemented school reforms, changing the outlook of the Swedish school system. Prior to 1991, school funding and decision-making was centralised, but with the new reforms, there was a shift of responsibility from the state to the municipality level. There were three major changes, covering both compulsory school and upper secondary school. The largest difference, and the reason to this paper, was the deregulation of the school market. After 1992, it became possible for independent schools to enter the school market and independent schools were from that time onwards treated as equal to public schools. Before this period, the only existing private schools were boarding schools and a few international schools. After 1992, there has been a remarkable increase of independent schools, which will also be shown later.

Besides for this paradigm shift, there was also a transfer of responsibility from the state to the municipality, with a focus on funding and control. From that point onward, the municipality had to provide a financial voucher per student for independent schools. The voucher is based on the average expenditure per student in public schools and given for each student deciding to enrol in an independent school. This reform changed the financial terms of independent schools and put them on more equal, financial footing as public schools (Ahlin 2003).

Thirdly, it was now possible for the students to chose which school they wanted to attend within the municipality border. The main criterion is that compulsory schools are open for all. The reform had limited impact on compulsory schools since it is subject to availability, students living close to a school are prioritized, and a change of school is only available if there are free spots. In comparison to other countries, independent schools in Sweden cannot reject students for ability, religion or ethnic origin (Sandström, Bergström et al. 2002). According to the school act, independent and public schools need to apply the same rules for selecting students. For upper secondary schools, it is only grades from ninth grade that students are applying with.

For a private actor to operate on the school market and become accepted to take part of the voucher scheme, they have to be approved by the Swedish National Agency for Education. It is also the NAE that is responsible for checking that the independent schools comply with the regulations. It is only the NAE who has the power to make a decision in this question. While the municipality has no formal authority to reject an establishment of independent schools, they do have the right to give the NAE their opinion if they believe an entrance on the school market might harm the quality of public school (Sandström, Bergström et al. 2002).

Except for a few schools (boarding schools, special pedagogy schools, international schools etc.), independent schools are only allowed to get funded by school vouchers. They are not allowed to take any additional tuition fees from their students. Because of the prohibition of tuition fees, an independent schools financial opportunity depends on the school policy of the municipality and on how costly students are in the municipality. Therefore, social characteristics of a municipality may determine the existence of independent schools. There are also no restrictions for ownership structures for independent schools; non-profit organisations or for-profit corporations are all accepted, so it is relatively easy to enter the education market in Sweden (Sahlgren 2010).

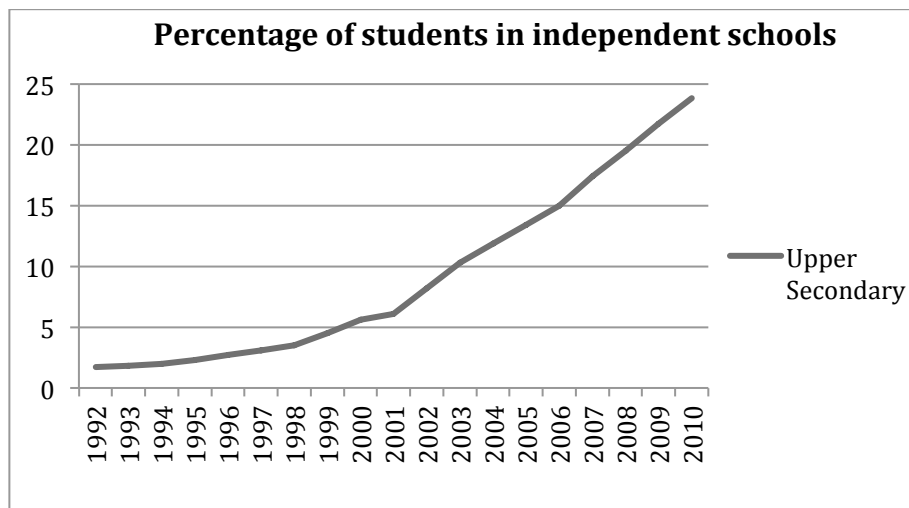
The presence of independent schools has changed the Swedish school market in the last twenty years. Sweden has had a rapid growth of independent schools, especially at the upper secondary school level. The main aim of introducing the school reform was to improve the quality of Swedish education through competition. Sweden has chosen to fund it differently compared to other countries. Unlike other countries with open school markets, Sweden introduced the most completed and extensive reform with full governmental funding. Sweden became one of the most decentralized school systems in the developed world (Lundahl 2002).

There are several reasons why the Swedish case is of interest. First of all, the Swedish government does not make any difference between schools when doling out financial funding to public and independent schools. As long as the school fulfils the needed

requirements, a wide range of different ownerships, both non-profit and profit organisations are receiving the same amount of funding. Different kinds of ownerships have led to an extensive debate about whether private firms should be able to make profits from its operations funded by tax money, a reform only existing in Sweden.

Unlike many other countries, independent schools in Sweden do not aim for a certain specific group of students to their school. In comparison to the USA where a major share of independent schools are of religious character, and therefore Swedish independent schools compete for the same students as public schools.

Figure 1. Students in independent schools



Source: The Swedish National Agency for Education 2012

The enrolment of independent schools differs between municipalities, but it has had a rapid growth since the implementation, as you can see in the graph above. Before the reform, there were only a few independent schools in Sweden. The graph shows the increase of the role independent schools have had in upper secondary schools after the voucher reform. Today, the share of independent schools is over 20 percent. There has also been a major change for compulsory schools but not to the same extent as upper secondary school. In 2010, about 10 percent of all the students on compulsory school level, attended independent schools.

By correlating the vouchers a school receives to the number of students attending the school, it creates a mechanism between schools popularity and how much funding it gets.

3. Theoretical framework

3.1 Cost efficiency and public choice

When Sweden implemented its new school reform, Sweden had recently gone through a financial crisis and the economic situation was not up to the prosperous level Sweden had experienced in the 1980's. One of the reasons for the reform was to run the schools more efficiently than before (Lundahl 2002).

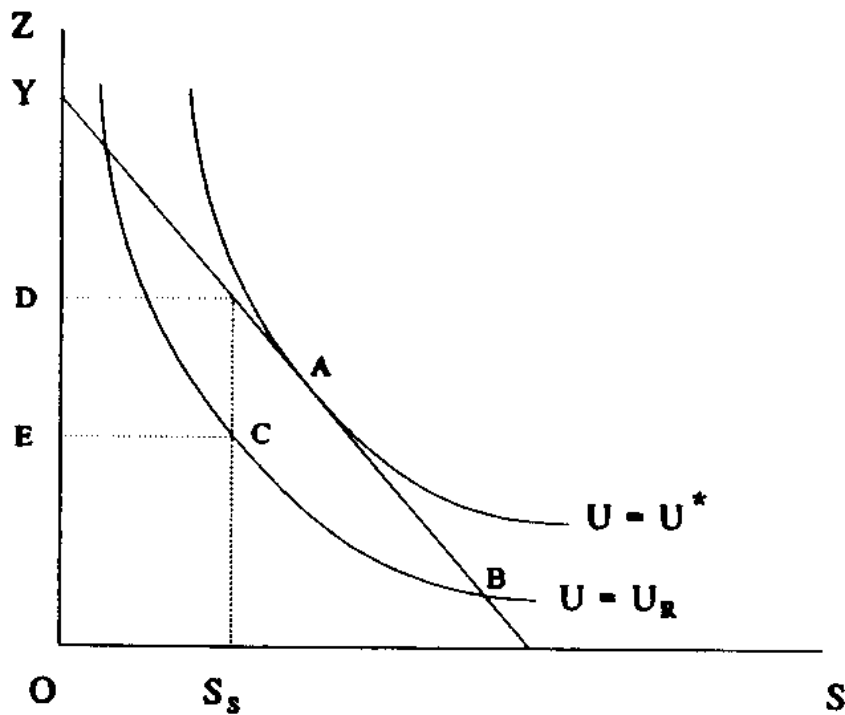
The economic theories of education derive from economic models of production theory and firm behaviour. One of the main areas in production theory, economic efficiency, has a much more vague connection to public schools than regular firms. This question became relevant according to Duncombe, Miner et al. (1997) when they showed evidence of declining student performance, despite an increase of spending on schools and students. Hanushek (1986) was one of the first to investigate how efficient public schools are operated. According to him, production theory is what you need to be studying, to understand the conceptual model of the educational processes and to understand the findings of educational economics.

Duncombe, Miner et al. (1997) analysed the inefficiency of bureaucratic models, with an emphasis on education. The perception that public school bureaucracy does not serve student's interest, but the administration, is one of the problems that have given the attention to the school vouchers programmes and a competitive market. They are guiding us through public choice models and how those causes inefficiency. One of the major differences of executing production analysis between public and private sector derives from the political process, which controls the allocation of public resources. To make a decision in the public sector is more time consuming and it suffers from several principal-agent situations, from voters, politicians and bureaucrats. Niskanen (1975) develops his theory about public choice theory, and the objectives of public managers. He claims that decision makers have the incentive to

maximise the difference between total revenue received and the least cost of production. The excess of expenditures that occur will then be used for non-productive activities, which in turn will generate utility to the bureaucrat. This reasoning has similarities to perfect price-discrimination and will lead to a cost inefficient provision.

Below, an analytic framework is provided, created by Wyckoff (1990), to explain the slack maximizing model, that goes in line with Niskanen's theory. Point A in figure 1 represents the median voter's optimal mix of public goods (S) and private goods (Z), given the budget constraint. According to Wyckoff, the decisive voter has a reversion utility level (U_R), which is a limit for the voter, below this line the voter will either vote against the proposition or leave the community. Hence, the maximizing bureaucrat will try to end up at point B, where the amount of public goods is maximized. The slack-maximizing bureaucrat would instead strive for under-providing public services and select the quantity of public goods so that the gap between the exogenous level of utility U_R and the budget constraint is as large as possible, point C. The two different models explained in this model draw different solutions. While the budget-maximizing bureaucrat will over-provide public services in a cost efficient way, the slack-maximizing bureaucrat will be both allocative inefficient, since it under-provides services, and be cost inefficient.

Figure 2. Bureaucratic inefficiency



Source: Duncombe, Miner et al. (1997) "Figure 1"

Through the framework explained by Wyckoff and what Niskanen estimated, models are evolved to help understand why a public school system, similar to the Swedish system pre-1992, can be perceived as economically inefficient.

3.2 Competition and quality

The theoretical argument for school choice and competition in the school market is that freedom of choice will lead to an enhanced match between what students need and what is offered and an increased parental choice. It also tells us that competition will result in better quality and a more efficient usage of resources. According to Hoxby (2000), school choice generates incentives that schools have to be more productive because it gives households more information on the principal-agent problem existing between the parents and the people running the school, and schools need to provide good education in order to not be rejected. Though it will most likely take years before any effects can be traced to a school reform like the one in Sweden. It can be misleading to focus on short-term effects because they depend solely on

students actively making a decision after the implementation of the reform. The effect of competition where unsuccessful schools actually exit and more successful schools expand, may take years. The modern case for using vouchers and how an increase in educational choice creates a better school started with Friedman (1955).

Eberts et al. (1990) stated:

"increased freedom by parents and students to choose the school that best meets their educational needs would in this view, not only provide a better match of supply and demand, but would also discipline teachers and administrators to be more responsive to the needs of students and thus provide a more efficient and effective educational program".

3.3 Empirical research on public schools

Over the years public schools have been accused of not offering a sufficient education. There have been a number of different researchers arguing that independent schools create spill-over effects on public schools and increase the educational quality both in independent and public schools (Friedman 1955; Friedman and Friedman 1981). This can be seen as a result of that the worst schools will go out of business.

There have been several American researchers looking for evidence of school choice improving the quality of education (Borland and Howsen 1992). Hoxby (1994) examined the mechanism between increased competition and quality of education. She studied the effects of inter-school competition on public schools by using exogenous variation in the availability and costs of private school alternatives to public schools. She found that greater competitiveness significantly improves the quality of public schools, measured by educational attainment, graduation rates and teacher wages.

Dee (1998) went one step further and examined how competition affected the quality of public schools in 18 different states in America. Dee realized that empirical strategies which rely exclusively on ordinary least-squares (OLS) could result in misleading findings because of omitted variable bias. A central empirical issue has

been that the key variable, number of students attending private schools, may have been endogenously determined. Dee states that there is evidence that the equilibrium demand for private schools is significantly affected by several dimensions of socioeconomic status. Those socioeconomic characteristics also correlate with the level of student achievement. If the empirical model does not account for the socioeconomic priors of students and their communities, a partial correlation between competition and the quality of public schools could create misleading inferences.

A second specification issue Dee was concerned about was that the demand for private schools is not an independent determinant of the quality of local public schools. Several researchers have drawn the conclusion that an increase of the quality of public schools should reduce the demand for private schools (Downes and Greenstein 1996). According to Dee, the existence of omitted variable bias might underestimate the effect of competition from private schools on public school achievements. Therefore, Dee performed a method with two-stage least-square regressions, and found that competition from private schools does have a positive impact on high-school graduation rates. As a measurement for competition and popularity for private schools, Dee used population concentration of Catholics. This is one way to deal with the endogeneity problem that could have occurred. In the USA, a large proportion of private school enrolment is in catholic schools, and, therefore, the population concentration of Catholics and private schools is highly correlated.

When Hoxby performed her experiment about competition and the quality of public schools, she also used religious concentration as an instrument for measuring the existence of private schools. Back in 1994, religious private schools accounted for 87% of the U.S. private enrolment, and Catholic schools alone accounted for 80% of private school enrolment. Using religion as an exogenous measure for competition to public school is relevant because of its correlation with private schools, but is uncorrelated with other factors affecting the demand for private schools, such as public schools with poor quality. Hoxby also found evidence that greater private school competition raises the quality of public schools measured in wages, high school graduation rates and educational attainment.

There are other researchers investigating the interrelationship between independent and public schools as a consequence of a new voucher system (Epple and Romano 1998). There have not always been unanimous results in this question. Sander (1999) found that there were no improvement of the quality in the public school sector in the districts of Illinois, but at the same time he could not prove that there would be a decrease in the quality either. Borland and Howsen (1992) expected that increased concentration on the market and competition between the students and the voucher that comes with it, should improve the quality. However, according to their findings, competition has led to decreases in student achievement.

In Sweden, Sandström, Bergström et al. (2002) provided one of the first studies in the field by doing an empirical analyses on what impacts the Swedish school reform has had on public schools. They used a data set of 28 000 students in ninth grade from both public and independent schools in the scholastic year 1997/98. In this case, it also suffered from identification problems that the student demand for private schools is related to the quality of public schools and the students that choose independent schools are not a random sample but can be calculated with background variables. Instead of using two staged least square regression, Sandström, Bergström et al. (2002) chose to approach it differently. They used sample selection models to simultaneously model student's choice of schools and their educational achievements. An attempt to estimate the share of students attending independent schools was also performed. Instead of using variables such as religion as an instrument, they used a number of political variables to create an instrument. With help of interviews with representatives from the four largest Swedish school corporations, Böhlmark and Lindahl (2008) concluded that municipal characteristics are important when opening up a new school. They found that it is mainly the attitudes towards privatization among local politicians and voters that matter. According to them, local authorities have the power to limit the expansion of independent schools if they have a hostile attitude towards them. Except for the political variables, some characteristics of the municipality were also used such as, if it belongs to an urban area, the average income etc.

Sandström and Bergström used five different measurements of educational achievement as dependent variable in their models. This is a consequence of the

difficulties in measuring educational achievements. The first one used was a student's credit value, which is calculated from the student's final grades and is used for applying to high school. This measurement is lacking in objectivity since it may give teachers incentives to give higher grades to attract students. Therefore, two sub-tests from the achievement test in mathematics are used to limit the subjectivity. The two last variables are used for other reasons. There has been concern that competition will increase the average performance but at the same time hurt the low-ability students. So the first variable used, therefore, measures if the student passed the three cardinal subjects: mathematics, Swedish and English. The second measures if the student has passed in all subjects. Their results confirmed what Dee and Hoxby found in their papers: that competition will improve the results in public schools. Both the higher test results and grades are significant in statistical terms.

Ahlin (2003) performed a similar study with two research questions. The first one was if a higher degree of school competition improves student performance, and the second was if higher-performing students gain at the expense of more disadvantaged students, one of the main objections to school choice. It has been argued that students who actively are making a decision of which school they want to enrol, also tend to be more motivated students or have parents that are more engaged in their children's education. Low-achieving students will then be left behind in schools with lower education quality and cannot compete about the other students. This also means that low-achieving students will end up in classes with lower performing peer groups. Ahlin did not find uniform evidence that competition has enhanced the performance on English and Swedish tests, but at the same time it did not show that competition has had a negative effect on the results. Böhlmark and Lindahl (2008) also found varying results with positive effects on short-term outcomes but no effect in the long-run.

Criticism has arisen towards papers studying this mechanism. Newmark (1995) re-specified the model used by Couch, Shughart Ii et al. (1993) and the relationship proving that the educational achievement in public schools is higher in the counties in the US where a larger share of the school-aged children were enrolling in private schools, was not statistically significant anymore. Newmark questioned the robustness

of their empirical findings, and when he changed their model specifications, their results were no longer statistically significant.

Swedish findings have also been questioned. Wibe (2002) redid the empirical testing originally made by Sandström, Bergström et al. (2002). Wibe criticized them for choosing variables, not based on relevance for adding a positive effect on the results. Including other variables or excluding a few of the existing ones would change their findings, and even prove the opposite, independent schools have a negative impact on their tests. He also accuses them of using a dataset that does not represent all the schools

In conclusion, it has been difficult to draw any unanimous analysis from previous research. It is a field where the theories of competition predict different outcomes. Therefore, it is of importance to perform an empirical research on the consequences of quality after introducing the school reform for upper secondary school in Sweden.

4. Data and methodology

To empirically test the hypothesis, a quantitative, econometric, cross sectional method has been used. In a number of different regressions, average GPA has been used as a dependent variable. Measuring academic achievement is considered to be rather difficult and, in this paper, average GPA is used, assumed to reflect and indicate to some extent the knowledge of students in schools. Even though it is not a perfect measurement, there are other parameters besides knowledge that are considered when grades are given; it is the best existing measurement. Relative grades on a municipal level will also be used as a dependent variable to investigate if there is a gap in grades between public and independent schools depending on competition. As an independent variable, the share of students attending independent schools in a municipality will be used. The model is estimated by Ordinary Least Squares (OLS) and by an IV-model (instrumental variable estimation), and checked for robustness. Data is collected from three different databases, SIRIS (NAE), Statistics Sweden and SKL.

Cross sectional regressions have been chosen for a number of reasons. First of all, the requirements for students might change over time, as the school plan is revised. Second, grades are not an absolute measurement; at several time periods there has been a different grading system, and to weight old grades to new would be a complicated process. There is also a risk that grade inflation may affect the results if a longitudinal regression would be used. Finally, to collect data on all schools separately, year after year would be time consuming and not within the limited time of this paper. Thus, averaged GPA grades from 2010 will be used.

To approach the problem with endogeneity, an estimation of the share of students attending independent schools was done. There will be a similar approach as Dee (1998) used with an instrumental variable model.

4.1 Dependent Variable

The hypothesis of this project is that competition from independent schools on the Swedish school market, will affect the grades of students in public upper secondary schools, in the way that it enhances students grades. To test this can be difficult since it requires both information on students GPA and an objective assessment of the students. Since there is no satisfying, centralised control of knowledge in Sweden, a situation has arisen where there is a lack of data and good measurement for knowledge. In compulsory secondary school, students perform a national test in the three core subjects: math, Swedish and English. The results are collected by the Swedish National Agency for Education and can be used for analysis by researchers and authorities. In upper secondary school, on the other hand, similar tests are performed but it is only a sample of all the tests that is collected. Another weakness is that it is the teachers in the same school that are correcting the national test and that could cause a problem with objectivity (Vlachos 2010). It has been shown that average independent schools give higher grades on the national test than public schools, especially when it is the students own teachers correcting the tests (Skolverket 2009; Tyrefors-Hinnerich and Vlachos 2012). What is suggested is that the national test should be corrected by a centralized organization and not by the school. This was tested in 2009, and they found a deviant result from the original corrections made by the schools (Skolinspektionen 2010:2). Several schools have used their own interpretation of the national criteria when it comes to setting grades, and they do not correspond to the criteria (Skolinspektionen 2010:1). Skolverket (2009) published a report, where they requested an additional measurement to simplify the analysis and to be able to draw more precise conclusions between actual knowledge and the grades students are given. Today, no such thing exists. This is one of the major limitations when studying knowledge on an upper secondary school-level.

To perform a research question like this, a measurement that is based on a national-wide test that is corrected by a centralized group of people and with a clear criteria of what is demanded, would be the best. No such data exists. Therefore, the measurement available today that can give us an idea of knowledge-level among students is average GPA, even though it is far from perfect.

4.2 Independent variable

The share of students attending independent schools will be the key-explanatory variable in this report as a measurement for competition. However, just like knowledge and academic achievements, it can be problematic to measure competition for several reasons. In this paper I will treat every municipality as its own school market and competition will only be measured within that market. It seems to be a logic reasoning, since it is the local authorities that are financially responsible for schools. To continue, another assumption is that competition only exists between public schools and independent schools, hence higher rates of independent schools lead to higher competition and there is no competition between public schools. There could also be students choosing a school from a neighbouring area, and that competition is created between schools from different municipalities. Control variables will be used to try to counter these effects.

Regardless of competition, there are other factors within a municipality that can affect level of grades in a municipality. Not least the characteristics of the population. Therefore, information about student background is of interest, such as the amount of students with foreign backgrounds, the share of female students in a school, and the average income in a municipality. This information will be considered as control variables.

4.3 Control Variables

It has been proven that parental support, attention and attitude towards schoolwork matters for academic achievement. Skolverket (1999) found a strong, positive correlation between students average GPA and the level of education of their parents. In this project, parental educational level will be used as a percentage of the students who have parents that continued to study after upper secondary school. The parent needs at least 30 credits from university or similar.

The share of the students that are female will also be used. It has been shown that females tend to have on average higher GPA than males and that will be controlled for. The last variable on school level that will be used is the percentage of students with an immigrant background. In this case, that means that the student was born

abroad or that both of the student's parents come from another country. Skolverket found that students with immigrant backgrounds perform worse in school, even when they took social background and gender into account.

4.4 Data set

My empirical analysis will contain two different sets of data, first, data on public and independent schools, and second, data on municipalities. The data on schools has been collected from the database SIRIS, on the National Agency for Education webpage. It consists of average grades of students that went to public upper secondary schools. Students are selected from science and social science programmes in upper secondary schools. These are the two programmes that are most similar between schools and are therefore simplest to compare. How independent schools are closer to offer what students demand or how satisfied students are with their school will not be a part of this paper, but could still be a significant reason of the existence of independent schools.

I started out by collecting data from the fifty largest municipalities in Sweden, to get an even spread sample over the entire country. Unfortunately, there is missing data on some municipalities, which leaves me with a sample of totally 46 municipalities. When comparing students from social science programmes, 93 public schools are included and in the science programme, I worked with 78 schools.

To collect data on municipality level, Statistics Sweden and SKL has been used.

4.5 Estimation Equation

Traditional statistical method to be used in these situations is ordinary least square-method (OLS), where average GPA or the relative grades is the dependent variable and share of students attending independent schools is the explanatory model. The main equation will look as follows:

$$y_i = \alpha_1 F_i + Z_i \alpha_2 + \varepsilon_i$$

where:

- y_i is a measure of knowledge
- F is the share of students attending independent schools,
- α_1 is a parameter to be estimated,
- Z_i is a vector of other explanatory variables on school level,
- α_2 is a parameter to be estimated
- ε_i is an error term

To run this equation and achieve correct, unbiased estimates requires that the error term is uncorrelated with the share of students in independent schools. This means that F is considered to be an exogenous variable, and that the causal relation goes from share of students to average GPA's.

It is not always the case to find a clear causal relation, if it is the other way around, the average GPA's that affect the share of students in independent schools, then F can be considered to be an endogenous variable. A variable that is determined by the model itself, and therefore might give incorrect estimations of the variables (Angrist, Krueger et al. 2001). As mentioned earlier, an independent school will receive financial funding per student, based on the average cost per student in a municipality. Except for that funding, independent schools are not allowed to charge any tuition fees from their students. This means that independent schools do not have any impact on the amount of funding they will get per student. What they can control, to some extent, is their costs; by operating their school more efficiently and by attracting higher ability students, who need fewer resources. In municipalities with socially disadvantaged students or students with limited knowledge of Swedish could result in additional costs for the school. To make profits, independent schools could make the decision to not enter the school market in municipalities where the cost is higher. In other words, grades in a municipality might signal the level of the students. Thus, the key explanatory variable in my main equation can be a function of the dependent variable, academic achievements. There is a risk that this model suffers from endogeneity; therefore, a model will also be estimated with instrumental variables that will try to solve the potential endogeneity problem.

4.6 Instrumental variable

To estimate the causal relationship between the share of students attending independent schools and the average grades and to deal with the endogeneity problem, the method of instrumental variables (IV) will be used. What needs to be solved is to find different variables that are correlated with the share of students attending independent schools, but at the same time are not correlated with the average GPA.

My approach of dealing with this problem is similar to what Dee (1998) and Sander (1999) did. First of all, I created an equation that will explain the share of students in independent schools:

$$F_j = \beta H_j + \varepsilon_j$$

where:

- F_j is the share of students in independent schools living in municipality j
- H is a vector of explanatory variables
- β is a parameter to be estimated
- ε_j is an error term

Several factors that will be used as control variables in equation 1 will also appear in equation 2 but not all of them.

To estimate the instruments for the share of independent schools, a wide range of different methods have been used. Most likely the instruments will vary depending on how the school market looks like in a country. Dee (1998) used religious variables as instruments for explaining the share of independent schools, a logic reasoning since the major part of independent schools in the United States of America is connected to religion. Unlike the US, Swedish independent schools have nothing to do with religion. As Sandström, Bergström et al. (2002) point out, Sweden is a particularly homogenous country where around 85 per cent are members of the Lutheran Church of Sweden.

My approach to estimate the share of independent schools builds on municipalities' attitude towards them, both with a political perspective and by countering the characteristics of the population in a municipality. As I have mentioned, there are informal ways for a municipality to hinder the establishment of independent schools, which is why it is included. I have used a dummy variable if there is a conservative majority in the municipality to estimate the attitude toward independent schools. That is, the equation is built on the assumption that right-wing voters have a more positive view of privatization and that affects the introduction of independent schools.

Besides the municipality, the market needs to be large enough to make profits. Therefore, I have used a dummy variable if the municipality is situated in a major urban area. The hypothesis is that with a school district in a major urban area, there are greater possibilities for starting a competitive business.

5. Results

Below, the descriptive statistics are seen for all the variables used in the regressions, both on a school level and for municipalities. The statistics on a school level are divided between social science and science programmes.

To clarify, I will explain the abbreviations again:

NOS- number of students

SOF- share of females

SOI- share of immigrants

SEP- share of educated parents

AVE. GPA- average GPA (grade point average)

IND SCH- share of students attending independent school

POP- population in a municipality

AI- average income

MA- metropolitan area

CONS- conservative majority

EDUP- share of educated parents

5.1 Descriptive Statistics

The first table shows different variables on the school level. Every public upper secondary school that offers social science from the 46 largest municipalities is included. Data is collected from the database SIRIS on the NAE's webpage. These variables will later be used as control variables in the different regressions performed. The statistics are counted for all the students attending a specific program, such as social science, in a school that year, except for the average GPA, which only includes the students graduating that year.

Table 1. Variables on school level, social science program, year 2010

Var	N	Mean	Median	Std	Min	Max
NOS	93	302,26	294	162,45	33	798
SOF	93	61,39	63	9,24	35	88
SOI	93	26,22	21	20,06	4	95
EDUP	93	57,82	59	14,00	23	88
AVE. GPA	93	14,67	14,7	1,19	12,40	17,8
IND SCH	93	0,33	0,37	0,22	0	0,69

Source: Authors calculations, based on data from SIRIS database and Statistics Sweden

As seen in Table 1, there are large variations in all the variables. There is a substantial variation in the percentage of independent schools in different school districts. The share of independent schools varies between 0 and 69 percent, with a mean value of 33 percent. The dependent variable, Average GPA, varies between 12.40 and 17.80, with a standard deviation of 1,19 credit points. As further seen in Table 1, there are also rather large variations in the different control variables used. For descriptive statistics on the different variables separated per school and region, see appendix.

In table 2, the same variables are observed, but now collected on schools offering science program.

Table 2. Variables on school level, science program, year 2010

Var	N	Mean	Median	Std	Min	Max
NOS	79	229,77	188	126,44	64	527
SOF	79	44,90	45	8,94	16	61
SOI	79	29,54	25	18,98	5	95
EDUP	79	72,75	72	10,31	39	94
AVE. GPA	79	16,03	16,1	1,03	13,4	17,8
IND SCH	79	0,24	0,21	0,20	0	0,75

Source: Authors calculations, based on data from SIRIS database and Statistics Sweden

As seen in Table 2, a similar result is shown as in Table 1. Worth mentioning is that there are not as many public schools with science programmes as with social science programmes. There is a larger gap in the share of students attending independent schools, where it varies between 0 and 75 percent. Average GPA, that later will be used as a dependent variable, varies between 13,4 and 17,8. On average, parents of students attending science programmes are more educated than parents to students attending social science programmes. At the same time, there are more girls attending social science compared to science, which is more male dominated.

In table 3, the focus is now on descriptive statistics on the 46 largest municipalities. Parts of this information will be used as instrumental variables, in order to explain why some municipalities have a higher rate of independent schools than others, in the two-stage least square regression.

Table 3. Variables on municipality level, year 2010

Var	N	Mean	Median	Std. Dev	Min	Max
POP	46	115434,30	81820	137537,66	42542	864324
SOI	46	0,20	0,18	0,10	0,06	0,53
AI	46	272,45	261,75	37,27	227,9	430,1
MA	46	0,28	0	0,46	0	1
CONS M	46	0,33	0	0,47	0	1
EDUP	46	0,47	0,46	0,10	0,33	0,81

Source: Authors calculations, based on data from SIRIS database, Statistics Sweden, and SKL (Sveriges kommuner och landsting)

As seen in table 3, there are descriptive statistics of the municipalities where some of them are used for creating an instrumental variable model. There are also relatively large variations in the variables. There is a large variation in size between the municipalities, where Stockholm is the largest with 860 000 and Trelleborg is the smallest with 42 542. There is a dummy variable measuring political affiliation in this table, which takes the value of one if the municipality has a conservative majority. There is a dummy variable for a municipality that is included in a metropolitan area,

according to SKL. In major urban areas, it is more likely that students compete for the spots in a school because of the population density of students.

There is a rather large difference in average cost per student between districts. How this would affect the likelihood of the existence of independent schools is unclear. On the one hand, it could increase the amount of independent schools since the school voucher is based on the average cost per student in a municipality. On the other hand, that could imply that there are extra costs or more expensive students that would deter independent schools.

In table 4, a pairwise correlation matrix shows the correlation between the variables.

Table 4. Correlations

	GPA	Ind. sch	NOS	SOF	SOI	EDUP	POP
Ind.Sch	0,027 93						
NOS	0,299** 93	0,069 93					
SOF	0,183 93	-0,089 93	-0,118 93				
SOI	-,413** 93	,204* 93	-,369** 93	-0,098 93			
EDUP	,579** 93	0,077 93	,509** 93	0,054 93	-,744** 93		
POP	0,153 93	,622** 93	0,175 93	-0,175 93	,220* 93	0,126 93	
MA	0,004 93	,233* 93	0,091 93	-,299** 93	,355** 93	-0,019 93	,592** 93

** Correlation is significant at the 0.01 level.

* Correlation is significant at the 0.05 level.

Source: Authors calculations, based on data from SIRIS database, Statistics Sweden, and SKL (Sveriges kommuner och landsting)

As seen in Table 4, the average GPA is positively correlated with the number of students at a school, the share of highly educated parents, and negatively correlated with the amount of immigrants. It follows with what previous research has found. The first assessment of the data set suggests that schools with a large amount of students, a high ratio of academic parents and a low share of immigrants will generate the highest grades. Observing the share of independent school in a municipality, it shows that there is no significant correlation with average GPA. Thus, the first analysis of the data seems to not support the findings that previous researchers found: that independent schools have a positive effect on knowledge among students.

To ensure that the variables are legitimate, different statistical tests have been run. First, the variables were tested for multicollinearity. The variance inflation factor test did not show any indications of multicollinearity in either the OLS or the IV-model. After testing for skewness and kurtosis, I can conclude that the data is bell-shaped and I cannot reject the null hypothesis of normal distribution for the average GPA. When observing the data and its residuals, for heteroscedasticity, I cannot reject the null hypothesis of homoscedasticity either.

5.2 OLS-Model

The first model is an OLS multiple regression on school level data, where average GPA of a school is the dependent variable, the share of students attending independent schools is the explanatory variable, and school characteristics as a vector of control variables that also might affect the grades. The results are shown below.

Table 5. OLS-regression. Dependent variable: Average GPA, Social science

Var	B	Std. Error	Sig.
(Constant)	10,271	1,082	0
IND. SCH	-0,125	0,507	0,806
NOS	0	0,001	0,709
SOF	0,021	0,011	0,073
SOI	0,004	8,00E-03	0,607
EDUP	0,052	0,012	0
R square	0,361		

Source: Authors calculations, based on data from SIRIS database, Statistics Sweden, and SKL (Sveriges kommuner och landsting)

As seen in table 5, in the OLS regression, it is indicated that two specific variables are statistically significant determinants of the average GPA. Those are the share of female students attending the school and the share of educated parents. This suggests that a higher share of girls in a school will generate a higher GPA. It also shows that if there are higher shares of the students with parents who have studied at least one year at university, it will generate a higher GPA. Regarding the share of independent schools, it has, according to this method, a negative relation to the average GPA. Important to notice is that this finding is not significant and therefore it is impossible to either reject or accept the hypothesis. Thus, so far it is not proven that competition improves the grades or quality of public schooling. The R square value shows that 38 percent of the average GPA is explained by this model.

Similarly, the OLS multiple regression is made in table 6 as in table 5, but in this case, data from students in the science programme is used instead.

Table 6. OLS-regression. Dependent variable: Average GPA, Science

Var	B	Std. Error	Sig.
(Constant)	11,542	1,083	0
IND. SCH	-0,005	0,416	0,991
NOS	0,001	0,001	0,201
SOF	0,021	0,009	0,018
SOI	-0,014	0,006	0,025
EDUP	0,051	0,013	0
R Square	0,594		

Source: Authors calculations, based on data from SIRIS database, Statistics Sweden, and SKL (Sveriges kommuner och landsting)

As seen in table 6, there is one more significant variable in comparison to table 5, and that is the share of immigrants. This variable shows a negative relation to the average GPA. The share of independent schools has changed signs compared to table 5, which would suggest that increased competition would improve the quality of public schools. However, no conclusions can be drawn from this, since the variable is still not statistically significant.

The regression results from these two models found that the share of female students attending a school has a significant, positive impact on grades. In the same way, schools with highly educated parents also have a positive impact on the school. Whether the share of immigrants has an influence on the grades differed in its significance in the two models. In the science programme, it is statistically proven to lower the average GPA. However, the most important finding in this model is that the share of students attending independent schools has no significant impact on the quality of public school.

5.3 IV-Model

5.3.1 Estimation of instrumental variable

In this step, the Instrumental Variable-model has been used to study what impact different variables have had on the share of students that enrol in independent schools on a municipality level. In the regression, the dependent variable is the share of students in independent schools. The explaining variables are the share of immigrants, average income in a municipality, and the share of the population with higher education. Two dummy variables are used: one if the municipality belongs to a metropolitan area and the other if there is a conservative majority in the municipality. These are the variables that are used as instrumental predictors for the share of students attending independent schools in a later stage.

Table 7. IV-estimation. Estimation of the instrument variables for municipalities. Dependent variable: Share of students in independent schools, social science program

Var	B	Std. Error	Sig.
(Constant)	0,59	0,271	0,032
SIM	-0,052	0,337	0,878
AI	-0,003	0,001	0,009
EDUP	0,009	0,003	0,004
MA	0,181	0,08	0,025
CONS	-0,029	0,051	0,572
R square	0,177		

Source: Authors calculations, based on data from SIRIS database, Statistics Sweden, and SKL (Sveriges kommuner och landsting)

The variables in table 7 explain 18 percent of the share of the students attending independent schools. There are three different variables that are statistically significant: average income, the education level of the population and if the municipality is in a metropolitan area. Educational level and metropolitan area both have a positive coefficient, while average income has a small, negative coefficient.

This indicates that people with higher education have a positive effect on the share of students attending independent schools. Whether the municipality is situated in a metropolitan area will also increase the number of students attending independent schools. This is not surprising since independent schools are common in metropolitan areas, and the more densely people are living, *ceteris paribus*, competition will increase. To avoid multicollinearity, other measurements such as population and population per square kilometre are excluded. However, if the municipality has a conservative majority seems to not have a significant effect on the share of students attending independent schools. Hence, it seems that it does not matter if it is a right-wing or a left-wing municipality when it comes to the share of students attending independent schools on an upper secondary school level. The reasoning behind including the share of immigrants in a municipality was that a high share would imply a more diverse population and a larger demand for independent schools that would fulfil the population's needs. The results show that there is not a statistically significant connection.

Since the assumption is made that upper secondary schools only compete for students enrolling in specific programmes, there is a difference in the amount of students that attend social science programmes in independent schools compared to students attending science programmes. Therefore, two different tables are presented. Below, in table 8, the instrument variables are estimated but with the share of students in independent schools enrolling in science programmes as a dependent variable.

Table 8. IV-Estimation. Estimation of the instrument variables for municipalities
Dependent variable: Share of students in independent schools

Var	B	Std. Error	Sig.
(Constant)	0,277	0,304	0,365
SOI	0,174	0,35	0,622
AI	-0,001	0,001	0,188
EDUP	0,005	0,003	0,071
MA	0,111	0,081	0,171
CONS	0,016	0,055	0,775
R square	0,138		

Source: Authors calculations, based on data from SIRIS database, Statistics Sweden, and SKL (Sveriges kommuner och landsting)

As seen in table 8, two coefficients have changed from a negative sign to a positive in comparison to table 7, the variable for share of immigrants in a municipality and the dummy variable for conservative majority, but none of these variables are statistically significant. In general, the result in table 8 is weaker than in the previous table. In this table, it is only the level of education that is statistically significant. A higher educational level in a municipality will increase the share of students attending an independent school. It is also a slightly lower R square value in this model.

5.3.2 Instrumental variable regression

In this section, estimation has been performed to measure the impact the share of independent schools has on the average GPA. To solve for the endogeneity problem, a two-stage least square regression has been used where municipality variables such as: share of immigrants, average income, level of education, if it is in a metropolitan area and if there is a conservative majority have been used to predict the share of independent schools

Table 9. IV-Regression Estimation with the IV-model. Average GPA from social science programs is used as a dependent variable

Var	B	Std. Error	Sig.
(Constant)	12,166	3,855	0,002
IND.SCH	-1,695	1,832	0,357
SOF	-0,011	0,045	0,807
SOI	0,011	0,017	0,504
EDUP	0,06	0,026	0,022
R square	0,139		

Source: Authors calculations, based on data from SIRIS database, Statistics Sweden, and SKL (Sveriges kommuner och landsting)

As seen in table 9, there is only one significant variable: the share of highly educated parents. It has a positive coefficient, which means that a higher share of educated parents will also increase the average GPA. The other variables are all insignificant and any conclusions about whether competition on the school market has increased the grades cannot be significantly drawn.

Table 10. IV-Regression Estimation with the IV-model: Average GPA from science programs is used as a dependent variable

Var	B	Std. Error	Sig.
(Constant)	17,844	9,208	0,056
IND. SCH	0,013	4,494	0,998
SOF	-0,044	0,093	0,635
SOI	-0,033	0,046	0,471
EDUP	0,016	0,068	0,817
R square	0,207		

Source: Authors calculations, based on data from SIRIS database, Statistics Sweden, and SKL (Sveriges kommuner och landsting)

The same regression is made, but with students attending science program. In this regression, the results are even more insignificant, and no variable can be statistically proven to affect the average GPA.

As shown above, performing an IV-regression did not improve the results of estimating to what extent the share of students attending independent schools would improve the average GPA. At the same time, running a two-stage linear regression gave a weaker result on the determinants that were significant in the OLS-model. According to Ahlin (2003), endogeneity of an independent schools location is not a problem in the Swedish market. The result in this section could, therefore, be a case of weak instrumental variables. The existence of independent schools on an upper secondary level is so extensive that it seems to be a randomised selection in terms of where they are located. In total, only 7 municipalities out of 46 do not offer an alternative to public schools, and in some municipalities it is considered to be an overcrowded market (Kallin 2008). Thus, it would be interesting to study the upper secondary school market, but there are difficulties to make a good estimate of variables that explain the supply of schools.

5.4 Robustness

Two additional tests have been performed to check the robustness of the results. Since the data used in this paper is only a selection of schools and municipalities, there is a risk that the findings may be challenged. To make sure that the results would hold, two robustness tests have been performed. In the first test, each school with social science program was eliminated in succession. The new estimation was then used in an OLS-model. The OLS-model was used because it showed the most significant results in the testing. The same explanatory variable and control variables were used and average GPA was used as the dependent variable. In the second test a similar method was used, but this time each municipality has been successively excluded.

The tests proved that the share of students attending independent schools does not significantly affect the quality of public schools. The coefficient remained negative, but still statistically insignificant. As before, the only two variables with a significant

coefficient were the share of female students and the share of highly educated parents. The share of female students shifted between a 5 and 10 percent significance level and the share of highly educated parents remained at a constant 1 percent significance level. In appendix, a sample of the changes in the variables used in the robustness tests is shown.

6. Conclusion

This paper has analysed the effects of competition on the school market and other control variables, on students average GPA. The hypothesis is that higher competition in the school market (higher share of students attending independent schools) would improve the quality of education in public schools. Competition would force public schools to put more effort into the level education they provide, so that they would continue to attract students. This was tested with the help of a number of multiple linear regression models, where average GPA was the dependent variable and the share of students attending independent schools in a municipality was the independent variable. This was also performed with an instrumental variable model, where the share of students attending an independent school was estimated, in an attempt to solve the endogeneity problem that might exist between the dependent and the independent variable. This paper contributes to the research in this field by being the first to investigate what impact the market mechanism has on student performance in upper secondary school. This is of interest because independent schools have a larger share of the school market in upper secondary school than in compulsory school.

My results do not support the hypothesis that independent schools have improved the quality of public education on upper secondary school level, through competitive pressure. That is, that the results I have found, do not support previous findings in Sweden (Sandström, Bergström et al. 2002; Tegle 2010) that an increase of school competition in a school district have statistically a positive significant impact on students grades. On the other hand, like Sander (1999), my findings do not support that allowing independent schools on the school market will decrease the grades in public schools. There is a risk that more disadvantaged students could be left behind in schools that do not perform well enough competitively, and they will not take part in those peer group effects that might arouse in highly competitive schools (Ahlin 2003; Hsieh and Urquiola 2003; Sund 2009). It could be that it takes a long time for the competition mechanism to affect the school market. It will most likely take years for successful school to expand and open up new school. At the same time, it takes time for unsuccessful schools to exit the market. Before changes will occur, the spill

over effects independent schools could have on public schools might strike us with its absence.

Because of the lack of good, objective measurement to compare with, average GPA has been used as a dependent variable. In a better world, there would be more available measurements, so a more extensive comparison could be performed without suffering from subjectivity and aggregated data, and more precise conclusions could be drawn. One of the shortcomings might be that I only used aggregated data, which may have generated too general of conclusions. There could also be an improvement in the estimation strategy, which could give a different result. In the instrumental variable model, it was difficult to find good estimates to explain the existence of independent schools. As in the US, several researchers have used religion as a proxy for independent schools (Hoxby 1994; Dee 1998), and it has been a good proxy. In Sweden, independent schools compete for the same students, so in general, no specific group such as religious affiliation, is attracted to a certain school, except if the school has a good reputation. Therefore, it is hard to predict which factors matters when independent schools start up.

In conclusion, this study has shown that the share of students attending independent schools is not an important determinant of the quality in public schools. Thus, there is an insignificant difference between municipalities with high rate of competition and municipalities with low rate of competition. These results differ from previous research where competition had a positive effect on the quality in compulsory school (Sandström, Bergström et al. 2002; Tegle 2010).

For future research it would be interesting to focus more on upper secondary school level, since the school reform has had a greater impact on that market in comparison to compulsory school. To do research that investigates the connection between competition and school quality more closely. Due to the lack of good data in this paper, using a more extensive data set with variables on individual level would be good to complement my findings. Also, if possible, using several different measurements for the quality of education, and using results from different tests may give more significant results.

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Appendix

Description of Data

Table 11. Schools used in regressions, social science program

School	NOS	SOF	SOI	EDUP	Ave. GPA
Blackebergs gymnasium	554	59	13	78	16,7
Bromma gymnasium	536	35	12	68	12,8
Brännkyrka gymnasium	274	71	54	41	13,5
Farsta gymnasium	132	50	61	42	15,2
Frans Schartaus gymnasium	507	54	43	55	14,5
Kungsholmens gy/Sthlms Musikgy	345	66	24	83	17,1
Kärntorps gymnasium	339	47	15	73	16,6
Norra Real	367	67	9	85	17,1
Ross Tensta gymnasium	234	55	92	28	12,7
Spånga gymnasium	74	55	35	43	14,3
Södra Latins gymnasium	479	75	9	80	17,8
Thorildsplans gymnasium	339	49	39	57	13,7
Östra Reals gymnasium	568	60	16	75	16,1
Burgårdens utbildningscentrum	40	70	85	30	12,4
Hvitfeldtska gymnasiet	532	56	23	70	15,1
Katrinelundsgymnasiet	264	45	46	48	12,9
Polhemsgymnasiet	379	59	26	65	16,2
Schillerska gymnasiet	418	65	21	68	15,3
Heleneholms gymnasium	140	63	24	70	12,7
Malmö Borgarskola	559	55	36	66	16
Malmö Latinska skolan	318	67	70	39	13,7
Pauligymnasium	113	71	65	48	12,4
S:t Petri skola	369	73	16	73	15,5
Bolandgymnasiet	70	76	14	66	15,7
Celsiuskolan	347	41	27	52	14,9
Fyrisskolan	529	58	24	59	14
Katedralskolan	347	67	12	76	16,7
Anders Ljungstedts gymnasium	111	56	30	45	13,8
Folkungaskolan gymnasiet	567	66	17	67	14,6
Katedralskolan	490	62	15	68	15,2
Carlförsska gymnasiet	326	64	29	56	13,8
Rudbeckianska gymnasiet	457	68	23	70	14,8
Karolinska skolan	578	69	29	66	16,2
Risbergskolan	206	57	22	54	13,7
Nicolaiskolan	134	57	38	48	14,2
Olympias skolan	88	74	17	59	14
De Geergymnasiet	144	65	60	34	14,2
Hagagymnasiet	116	70	21	49	16,2
Kungsgårdsgymnasiet	94	71	30	43	14,9
Erik Dahlbergsgymnasiet	275	52	21	59	13,5
Per Brahegymnasiet	449	71	14	62	13,5
Dragonskolan	129	57	11	71	15
Östra Gymnasiet	114	55	17	68	12,9
Gymnasieskolan Spyken	374	64	8	85	16,1
Katedralskolan	440	55	15	81	17,1
Polhemsskolan	798	56	19	66	13,8
Bäckängsgymnasiet	470	69	21	60	15,2
Sven Eriksonsgymnasiet	222	53	24	53	13,7
Huddingegymnasiet	165	68	53	35	14,9
Östra gymnasiet	335	68	29	44	14,1
Rekarnegymnasiet	318	64	32	57	14,9
S:t Eskils gymnasium	115	72	23	54	15,7
Sundsvalls Gymnasium	523	54	8	57	13,6
Borgarskolan	277	68	10	56	14,4
Vasaskolan	264	65	17	55	15,9

Sannarpsgymnasiet	385	68	21	57	14,7
Sturegymnasiet	216	88	14	63	14,9
Nacka gymnasium	756	56	10	75	16,5
Colin Leclairgymnasiet	122	39	86	23	13,5
Sundstagymnasiet	383	58	11	66	14,3
Tingvallagymnasiet	275	64	21	57	13,9
S:t Botvids gymnasium	78	64	95	26	15,2
Tullinge gymnasium	165	36	39	47	14,2
Tumba gymnasium	137	71	61	36	12,6
Katedralskolan	311	63	16	67	14,8
Kungsmadskolan	33	61	55	39	14,8
Christian 4:s Gymnasium	127	76	13	59	14,3
Söderportgymnasiet	358	63	21	62	13,8
Österänggymnasiet	94	69	18	64	13,7
Fredrika Bremergy Erika	319	50	32	39	12,7
Aranäsgymnasiet	355	68	5	64	14,3
Elof Lindälvs gymnasium	354	54	4	56	14,4
Luleå gymnasieskola	269	62	13	67	15,5
Kaplanskolan	170	69	7	55	15,6
SAM-gymnasiet	306	63	57	44	13,5
Rudbecksskolan	561	66	13	69	15,1
af Chapmangymnasiet	249	61	11	66	15,4
Fässbergsgymnasiet	109	48	22	60	14
Peder Skrivares skola	298	60	13	61	15,3
Richard Steffengymnasiet	375	60	5	54	15,7
Rodengymnasiet	260	58	10	48	15,3
Lugnetgymnasiet	205	62	9	71	14
Magnus Åbergsgymnasiet	263	69	30	49	14,2
Nolaskolan	369	73	8	53	14,9
Uddevalle gymnasieskola	441	64	14	60	14,7
Nyköpings gymnasium	293	63	20	42	13,1
Gymnasium Skövde Västerhöjd	294	68	21	58	14,9
Linnéskolan	183	63	20	49	15,4
Hagagymnasiet	217	56	20	40	13,3
Gångsätra gymnasium	448	45	9	75	15
Hersby gymnasium	210	57	9	88	16,5
Tyresö gymnasium	165	50	19	63	14,4
Söderslättgymnasiet	205	65	22	45	14,5

Source: Authors calculations, based on data from SIRIS database

Table 12. Schools used in regressions, science program

School	NOS	SOF	SOI	EDUP	Ave. GPA
Blackebergs gymnasium	473	36	19	84	17,5
Bromma gymnasium	176	25	22	79	15,2
Brännkyrka gymnasium	97	54	71	57	14,9
Farsta gymnasium	77	39	43	70	15,4
Kungsholmens gy/Sthlms Musikgy	341	61	35	87	17,7
Kärretorps gymnasium	370	44	29	80	16,6
Norra Real	414	43	24	84	17,8
Ross Tensta gymnasium	119	48	92	46	13,9
SpÅnga gymnasium	181	53	25	71	15,1
S:t Eriks gymnasium	152	54	78	57	13,8
Södra Latins gymnasium	189	61	17	88	17,6
Thorildsplans gymnasium	246	20	41	70	14,5
Östra Reals gymnasium	362	43	45	70	16
Hvitfeldtska gymnasiet	527	48	34	76	16,4

Katrinelundsgymnasiet	185	45	41	69	14,2
Polhemsgymnasiet	430	47	29	75	17,4
Heleneholms gymnasium	87	38	30	74	15,4
Malmö Borgarskola	329	43	56	70	16,5
Malmö Latinskola	109	46	67	49	13,6
Pauligymnasium	143	43	68	54	13,9
S:t Petri skola	412	50	35	77	16,1
Celsiuskolan	104	42	24	80	15,4
Fyrisskolan	243	35	29	72	15,3
Katedralskolan	213	48	29	79	17,6
Lundellska skolan	174	40	10	89	17,6
Rosendalsgymnasiet	427	38	17	89	16,6
Berzeliuskolan	354	38	21	81	16,2
Katedralskolan	327	46	13	85	16,9
Hässlö gymnasiet	104	16	14	70	16,5
Rudbeckianska gymnasiet	443	44	33	74	16,1
Karolinska skolan	497	57	38	67	15,8
Risbergsskolan	79	58	19	72	15,7
Filbornaskolan	89	37	22	72	15,7
Olympiaskolan	67	42	25	78	16,9
Tycho Braheskolan	64	50	33	67	14,8
Ebersteinska gymnasiet	143	41	35	73	15,8
Hagagymnasiet	95	41	28	66	16,6
Erik Dahlbergsgymnasiet	340	41	22	77	16,5
Per Brahegymnasiet	94	60	17	77	16,7
Östra Gymnasiet	91	34	16	68	15,7
Gymnasieskolan Spyken	360	54	7	94	17,6
Katedralskolan	504	46	17	92	17,2
Polhemsskolan	360	43	22	80	15,8
Bäckängsgymnasiet	268	49	25	69	16,8
Huddingegymnasiet	143	45	65	56	15,7
Sjödalsgymnasiet	188	40	33	72	15,8
Östra gymnasiet	152	53	32	59	14
Rinmangymnasiet	220	51	43	69	15,9
Sundsvalls Gymnasium	133	55	16	70	15,2
Vasaskolan	229	45	25	69	16,6
Nacka gymnasium	415	43	15	82	17,7
Naturvetargymnasiet	129	50	95	64	15,3
Älvkullelegymnasiet	295	43	19	80	14,9
Tullinge gymnasium	151	25	19	77	15,5
Tumba gymnasium	66	59	76	39	13,4
Katedralskolan	320	48	23	74	16,2
Österänggymnasiet	277	44	23	78	15,4
Fredrika Bremergymnasiet	244	38	35	58	15,3
Elof Lindälvs gymnasium	163	41	9	81	16,8
Luleå gymnasieskola	268	52	9	80	16,8
Balderskolan	197	51	12	69	16,2

NT-gymnasiet	262	34	40	77	16,7
Rudbecksskolan	510	38	22	84	16,3
Åva gymnasium	181	39	15	82	16,5
Ehrensvärdska gymnasiet	203	50	10	79	16,7
Fässbergsgymnasiet	146	40	31	80	16,5
Peder Skrivares skola	168	50	15	65	16,1
Christopher Polhemgymnasiet	219	47	5	71	16,9
Haraldsbogymnasiet	171	48	14	80	16,9
Nils Ericsonsgymnasiet	181	52	31	70	15,7
Nolaskolan	161	59	17	68	17,2
Uddevalla gymnasieskola	218	52	17	66	16
Nyköpings gymnasium	126	44	19	67	16,1
Gymnasium Skövde Västerhöjd	257	60	17	71	16,6
Hässleholms Tekniska skola	151	50	28	63	16,5
Soltorgsgymnasiet	147	44	26	64	16,2
Hersby gymnasium	412	37	8	89	16,3
Tyresö gymnasium	74	28	20	74	15,5
Söderslättsgymnasiet	116	51	33	62	15,7

Source: Authors calculations, based on data from SIRIS database

Table 13. Municipalities used in regressions

Municipality	AI	MA	CONS	EDUP	SOI
Stockholm	312,1	1	1	58	0,29
Göteborg	261,3	1	0	47	0,3
Malmö	227,9	1	0	46	0,41
Uppsala	262,2	0	1	55	0,21
Linköping	259,5	0	1	54	0,17
Västerås	274,1	0	1	48	0,24
Örebro	251,5	0	0	46	0,2
Helsingborg	262,3	0	0	42	0,26
Norrköping	248,7	0	0	40	0,2
Jönköping	262,9	0	1	50	0,18
Umeå	251,9	0	0	59	0,12
Lund	259,4	0	0	69	0,21
Borås	257,8	0	0	44	0,25
Huddinge	288,8	1	0	45	0,34
Eskilstuna	241,5	0	0	43	0,27
Sundsvall	273,6	0	0	43	0,1
Gävle	268,6	0	0	44	0,14
Halmstad	257,1	0	0	50	0,19
Nacka	365,1	1	1	64	0,23
Södertälje	246,2	1	0	37	0,44
Karlstad	253,3	0	0	54	0,13

Botkyrka	243,1	1	0	38	0,53
Växjö	259,3	0	1	50	0,19
Kristianstad	249,6	0	0	46	0,18
Haninge	269,4	1	0	33	0,29
Kungsbacka	326,6	1	1	54	0,08
Luleå	265,4	0	0	55	0,11
Skellefteå	262,6	0	0	46	0,07
Järfälla	298,7	0	1	44	0,32
Sollentuna	362,5	1	1	66	0,26
Karlskrona	265,4	0	0	48	0,13
Mölnadal	301,5	1	0	49	0,18
Varberg	268,6	0	1	49	0,11
Gotland	236,1	0	0	39	0,06
Norrköping	260,7	0	1	34	0,12
Falun	266,1	0	0	50	0,1
Trollhättan	255,1	0	0	34	0,23
Örnsköldsvik	269,4	0	0	44	0,07
Uddevalla	256,5	0	0	41	0,15
Nyköping	270,6	0	0	39	0,14
Skövde	260,2	0	1	46	0,16
Hässleholm	242,6	0	0	44	0,15
Borlänge	252,7	0	0	37	0,17
Lidingö	430,1	1	1	81	0,18
Tyresö	321	1	1	43	0,19
Trelleborg	253,2	0	0	36	0,18

Source: Authors calculations, based on data from Statistics Sweden, and SKL (Sveriges kommuner och landsting)

Test of Robustness

Table 14. Sample of OLS-regression with one school excluded in succession

IND. SCH	NOS	SOF	SOI	EDUP
-0,168	0	0,021*	0,004	0,051***
-0,014	0	0,014	0,003	0,051***
-0,092	0	0,022*	0,004	0,051***
-0,178	0	0,023**	0,003	0,051***
-0,126	0	0,021*	0,004	0,052***
-0,141	0	0,02*	0,003	0,048***
-0,195	0	0,024**	0,004	0,05***
-0,163	0	0,02*	0,004	0,049***
-0,118	0	0,02*	0,005	0,052***
-0,173	0	0,021*	0,005	0,052***
-0,216	0	0,017	0,004	0,05***
-0,098	0	0,019*	0,005	0,052***
-0,149	0	0,02*	0,004	0,051***
-0,048	0	0,022**	0,006	0,052***
-0,118	0	0,02*	0,004	0,052***
-0,047	0	0,019*	0,004	0,051***
-0,225	0	0,021*	0,004	0,051***
-0,131	0	0,02*	0,004	0,052***
-0,059	0	0,02*	0,006	0,057***
-0,131	0	0,021*	0,003	0,051***
-0,122	0	0,021*	0,005	0,052***
-0,116	0	0,024**	0,008	0,055***

*Note: All the variables are used as when the OLS-regression was performed. * significant at 10%, ** significant at 5% and *** significant at 1%*

Source: Authors calculations, based on data from SIRIS database, Statistics Sweden, and SKL (Sveriges kommuner och landsting)