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Competition and Educational Quality: Evidence from the Netherlands

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Abstract: Ample evidence is available for the effect of competition on educational quality as only a few countries allow large scale competition. In the Netherlands free parental choice is present since the beginning of the 20th century, which can be characterized as a full voucher program with 100% funding. Based on panel data for the Netherlands we show that there is a relation between competition and educational outcomes in secondary education, but that it is negative and small. This effect is larger for small and medium sized schools and for schools which do not have a Protestant or Catholic denomination.

Keywords: Competition, Private Schools, Scale, Quality, Secondary Education

JEL: H70, I20

1. Introduction

The literature discusses whether competition between schools increases the quality of educational outcomes. Friedman (1962) claimed already that school choice policies promise to align the incentives of school management with demand. Positive effects on educational outcomes can occur if students choose schools with higher quality levels. This increases the incentives for schools to invest in the quality of the primary process to improve educational outcomes. From a theoretical point of view, a negative effect of competition on quality is also possible. In practice many other characteristics influence school choice. If, for instance, students look more at choices of friends or the attractiveness of sport programs, the link between school choice and quality might be very different. Schools might choose to invest time and money in characteristics appreciated by potential students which are not related to the (direct) quality of education. In this case the effect of competition on educational outcomes might become negative as less time and money is present for the primary process. In addition, measuring and interpreting quality might not be straightforward and costless for students and their parents. Which effect dominates is a matter of empirical analysis.

Unfortunately, empirical analysis of the effect of competition on quality of educational outcomes is scarce due to the absence of real and large scale competition in many countries. A few examples make this clear.

Hoxby (2000) uses the concept of Tiebout choice, parents choose between school districts based on the quality differences of schools, to test this hypothesis. Her result suggests that competition enhances quality for elementary and secondary education. However, Rothstein (2007) shows that her results are sensitive for construction of the competition variables and claims that alternative constructions yield insignificant results. Moreover, Rothstein (2007, p. 2034) finds that Hoxby's specification is subject to selection bias because the sample excludes private school students. In Hoxby (2007) these criticisms are disputed, but the discussion is still unsettled. Even more important is that Tiebout choice is only a weak indicator for the effect of free school choice. Parents have to move to another district to be able to vote with their feet. Fully free choice results in much more competitive pressure as parents can choose other schools in and out of district without having to move house. Unfortunately, only evidence is present for small scale free choice or voucher programs as only a few countries in the world provide fully free choice for parents.

Lavy (forthcoming), for example, analyses the effects of free school choice as an experiment in one of the districts of Tel Aviv (Israel) allowed parents to choose between

public schools both in and out of district. He finds significant positive effects of free school choice on the quality of public schools.

Sandström and Bergström (2005), as a second example, show that the increased parental choice in Sweden since 1992 as a result of a voucher program supports the hypothesis that school results in public schools improve due to competition with independent schools. However, if competition is measured by the commonly used Herfindahl-Hirschman concentration index the results are sometimes negative and sometimes insignificant. Also in Sweden the voucher program is small as only 7% of students were enrolled in an independent school.

Rouse and Barrow (2009, p. 22), after summarizing the literature on voucher programs, conclude that these small-scaled experiments cannot be used to test Friedman's hypotheses and thus that "many questions remain about the potential long-term impacts on academic outcomes and about both the public and private sector responses to a large, permanent, and well-funded voucher program."[1] The Netherlands is one of the only countries in the world where such impacts currently can be measured as it has long experience with free choice, the role of both public and private schools is large and the funding is completely equal between all types of schools.

In the Netherlands the model of free parental choice between different types of schools is present after the historical national school dispute ('schoolstrijd') came to an end in 1917 (Kossmann, 1978).[2] After that period, parental choice and equal opportunities of public and private schools are even guaranteed in the Dutch constitution. Private primary and secondary schools are managed by independent non-profit boards, and abide by practically the same rules as public schools. Many, but not all, private schools have a religious background. Private schools are fully financed by the government at exactly the same level as public schools and for both based on the number of students. The Dutch system could in fact be characterized by a full voucher program with 100% funding. Parents are free to choose any public or private school in the country. Schools are in principle obliged to accept all students. The only exception the law permits is for religious schools to ask that parents agree with their

[1] Rouse and Barrow (2009) conclude that "Keeping these limitations in mind, the best research to date finds relatively small achievement gains for students offered education vouchers, most of which are not statistically different from zero."

[2] A country with a similar system is Belgium, where the system appeared in 1958 after also a prolonged battle between religious and secular political parties (Kossmann, 1978, p. 273).

denomination. In practice, only a few, especially Protestant, schools use this exception. Selection with respect to the a priori quality of students is never allowed. This is an important difference with voucher programs in other countries, where school often can select the students they want. Free choice is used very often as currently 71% of students are at private schools.

After the introduction of free parental choice, a large number of private schools entered the market. However, currently new schools start only very occasionally. The reason for this is that parents can easily start a new school location as long as they proof that the denomination they present (or educational method like Dalton or Montessori they believe in) is not yet present in their surroundings and that enough students are available that want to attend a school with such a denomination. Given the long history, nearly all types of schools are already present.[3] This means that competition in the Netherlands occurs between existing school locations and not with entrants. This is a very important institutional characteristic as we use the number of school locations as an instrument for competition in the market to test for endogeneity problems. This could be important as competition between school locations measured by concentration indices based on market shares (in our case the Herfindahl-Hirschman-Index) might be endogenous with respect to quality as a lower quality might lead to changes in market shares if higher quality school attract students. The number of school locations, however, is not endogenous in the Netherlands as low quality in a market is not a possible reason for getting a permission to start a new school location. The number of school locations in the Netherlands is therefore exogenous with respect to quality. This is a major difference with US markets where entry is very often the result of dissatisfaction with existing school quality (Hoxby, 2000).

Given the long history of competition between schools in the Netherlands, one would expect that effects on quality, if present, are visible. However, the effect of competition on quality has never been systematically analyzed for the Netherlands. In this paper we fill this gap based on data for secondary schools for the period 2002-2006. We use datasets of the Dutch Ministry of Education and the national monitoring agency for education ("Onderwijsinspectie"). We measure school quality by three achievement variables: the average score in the nationwide final exams, the percentage of students that obtain a diploma and the percentage of students finishing on-time. For all three measures we find evidence for

[3] The only exception at present is the start of a few Muslim schools.

a negative effect of competition on quality, which is quite small. This effect is robust for alternative specifications and sensitivity analyses, including endogeneity correcting IV-estimations. It shows that the effect is dominated by small and medium sized schools and by schools which do not have a Protestant or Catholic denomination.

The article is organized as follows. In the second section we discuss the methodology and the available data. In the third section the estimation results are presented. In the fourth section the robustness of the results is discussed. In the fifth section conclusions are drawn.

2. Methodology and Data

Our main methodology is an econometric test of the effect of competition intensity on the educational outcomes of school locations. In the Netherlands a distinction is made between school boards (or competent authorities for public schools), schools, school locations and education types. It is possible that a school board comprises several schools and that a school has several locations, while each location can supply five education types in one or more location. Schools are not obliged to provide all education types and they often choose to provide a subset of the five types.

Students finish primary education at the average age of 12 and enroll in one of five levels of secondary education. Sorted at the level of education these are pre-vocational secondary education at three levels ($VMBO_{BA}$, $VMBO_{KA}$ and $VMBO_{GT}$), senior general secondary education (HAVO) or pre-university education (VWO). VMBO with duration of four years is intended as preparation for secondary vocational education. The BA level is the lowest level, aimed at profession oriented learning. The highest VMBO level, GT, is theory based and is necessary for students who want to follow the last two years of HAVO after finishing VMBO. The intermediate level, KA, combines elements from both BA and GT. HAVO with duration of five years is intended as preparation for higher professional education (HBO) and is also necessary for students who want to follow the last two years of VWO after finishing HAVO. VWO with duration of six years is intended to prepare for university. In most schools the final choice between the school types is made after the first two or three years of secondary education, while a first broad streaming (e.g. a combination of HAVO/VWO or VMBO) is based on a nationwide test at the end of primary school and on advice of the primary school teachers.

Our main hypothesis is that locations compete with each other for students and that this competition affects educational quality. Managers have an incentive to attract more students

to increase scale as their salary is often influenced by the size of the location and school. Currently the minimum manager salary of the smallest schools is 101,000 dollar per year, while managers of the largest school can earn up to 255,000 dollar per year (1.47 dollar is 1 euro). Traditionally, board members were unpaid. Increasingly, however, board members also get a salary, which is often coupled to the size of schools (varying from 4,000 dollar for the smallest schools to 17,000 dollar for the biggest schools). As schools are not allowed to ask a contribution from parents and the revenues from the government are fixed per student, the way to increase scale is by increasing the number of students. The question is how this affects the quality of education. As long as quality is a dominant parameter in the choice set of students (and their parents), a positive effect could be expected. Schools with higher achievements are then able to attract more students. A negative effect, however, could occur if other parameters determine the choice set and schools invest in these parameters instead of in quality (see introduction). Which effect dominates is a matter of empirical analysis.

We estimate a panel model using both the cross-section and the time-related variation. For each achievement indicator we estimate the following equation:

$$Q_{i,t} = \beta CI_{i,t} + \gamma S_{i,t} + \lambda P_{i,t} + c_i + d_t + \varepsilon_i, \qquad (1)$$

where $Q_{i,t}$ measures achievement of the location i in year t, $CI_{i,t}$ measures competition intensity, $S_{i,t}$ is a vector of location characteristics, $P_{i,t}$ a vector of socio-economic variables of the neighborhood where the location is located, c_i are time-invariant school fixed effects, d_t are time fixed effects (with 2002 as benchmark) and ε_i is an error term.

Based on administrative data of the national monitoring agency for education we distinguish between three school performance measures as the dependent variable: the average central exam score based on a national exam in the final year that is the same for all Dutch schools, the percentage of graduated students and the percentage of students graduated on-time. All variables are measured at the location level i for each year t and per education type. Data are available for nearly all locations. The total panel includes a maximum of 10,047 observations as we have data for 553 locations, for four (VMBO: 2003-2006) or five years (HAVO and VWO: 2002-2006) and for five education types. In Table 1 the summary statistics are shown for the overall sample and the five education types.

Table 1: Descriptive statistics quality variables, years 2002-2006

	Central exam score	Share on-time graduated	Share graduated
Overall			
- Mean	6.42	0.76	0.94
- Minimum	4.10	0.09	0.07
- Maximum	7.90	1.00	1.00
- Standard deviation	0.33	0.16	0.07
- Observations	10,047	9,183	10,041
VWO			
- Mean	6.41	0.64	0.93
- Observations	2,057	1,945	2,057
HAVO			
- Mean	6.24	0.60	0.90
- Observations	1,973	1,893	1,973
$VMBO_{GT}$			
- Mean	6.35	0.85	0.95
- Observations	2,702	3,022	2,698
$VMBO_{KA}$			
- Mean	6.45	0.86	0.96
- Observations	1,671	1,177	1,670
$VMBO_{BA}$			
- Mean	6.73	0.89	0.95
- Observations	1,644	1,146	1,643

We take as a measure for competition intensity the so-called Herfindahl-Hirschman-Index (HHI). The HHI is based on the share (s_i) of the school locations enrollment in total enrollment within a pre-defined geographic area per education type:[4]

$$HHI = \sum_{i=1}^{n} s_i^{\,2} \qquad (2)$$

School locations within a distance of 10 kilometers are taken into account.[5] The HHI varies between zero and one. A value of (nearly) zero indicates that there are many relatively equal-

sized school locations in the relevant market. A value of one indicates that the school is a monopolist. In the estimations we use a negative HHI (–HHI) as this is easier to interpret (an increase in competition corresponds with an increase of this measure).

In Table 2 descriptive statistics of the HHI indexes are given. On average the HHI has a value of 0.35, indicating that the average location competes with two other locations. An HHI lower than 0.1 reflects a high level of competition and is present for 11% of all locations. An HHI between 0.1 and 0.2, indicating moderately concentrated markets, is present in 26% of all cases. 38% of the school locations have an index between 0.2 and 0.5 and these markets are concentrated. For 26% of the locations markets are highly concentrated with a HHI of 0.5 or more. According to this measure, nearly half of these locations is a monopolist (HHI=1). These figures mean that competition differs a lot per region.

The effect of competition on the quality of education is estimated using the general HHI-index measured at the school location level per education type. As an alternative measure for competition intensity we use in sensitivity analysis the number of competitors in the market and the HHI-index measured at the school level.

The first location characteristic we correct for in the estimations is scale.[6] In our model we include the scale of the board (the number of schools per board), the scale of the school which the location is part of (the total number of students) and the scale of the location at the education type level (the number of students per education type).[7] The second location characteristic is related to the provided type of education. We include dummies with value 1 if one of the five types is provided, with VWO as the benchmark. See Table 3 for descriptive statistics.

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[4] For the market shares (s_i) we take into account students who are in the last two (VMBO and HAVO) and last three (VWO) years. The reason that student numbers of earlier years are disregarded is that students are not yet streamed finally and precisely to education types.

[5] In US-literature the HHI is mostly based on a municipality or a district. In the Netherlands competition takes place within a certain geographic area as municipalities are much closer to each other. The distances between school locations are calculated using a standard route planner. The average distance Dutch students travel according to Statistics Netherlands is 10 kilometers.

[6] The effects of scale are not influenced by the correlation with competition. Estimations without competition variables or scale variable do not lead to other conclusions, while the correlation between competition intensity and the scale of schools, locations and boards is only 0.05, -0.06 and 0.00.

[7] We tested for multi-collinearity between these variables and did not find any indication for this. We excluded the scale of the location summed over education types as this variable has a very high correlation with scale per education type.

Table 2a: Share of school locations by level of competition

	HHI	Locations	Share of all locations
High level of competition	< 0.1	1,067	0.11
	0.1 to 0.2	2,579	0.26
Low level of competition	0.2 to 0.5	3,806	0.38
	0.5 to 1.0	1,495	0.15
Monopoly	1.0	1,100	0.11
Total		10,047	1.00

Table 2b: Descriptive statistics competition variables

	Average	Max	Min	St.dev.	N
HHI at location level	0.35	1.00	0.04	0.28	10,047
- 21 biggest cities	0.15	0.83	0.04	0.09	3,282
- Top 25% population density[1]	0.18	1.00	0.04	0.13	2,511
- Bottom 25% pop. density[1]	0.56	1.00	0.04	0.31	2.502
- 1st quintile scale schools[2]	0.33	1.00	0.04	0.27	1,814
- 2nd quintile scale schools[2]	0,31	1.00	0.04	0.27	2,084
- 3rd quintile scale schools[2]	0.35	1.00	0.05	0.27	1,970
- 4th quintile scale schools[2]	0.41	1.00	0.05	0.29	2,049
- 5th quintile scale schools[2]	0.38	1.00	0.05	0.27	2,130
- Public	0.36	1.00	0.04	0.28	2,895
- Catholic	0.39	1.00	0.05	0.29	1,858
- Protestant	0.35	1.00	0.05	0.27	1,664
- Neutral	0.34	1.00	0.05	0.27	1,731
- Other	0.32	1.00	0.04	0.26	1,945
HHI at school level	0.39	1.00	0.05	0.28	10,048
Number of competitors	5.46	35	0	5.55	10,047

1. Per location. 2. With respect to number of students.

No socio-economic data on characteristics of the student population are available at the location level. Therefore we use data that is available for the zip code where the location is located.[8] We include the following socio-economic characteristics: the number of non-western foreigners per 100 inhabitants (foreigners), the average income per inhabitant in 1,000 euro (income) and population density. The only demographic information available at the location level for the whole period is gender (the share of girls). The data for the socio-

[8] Zip codes in the Netherlands are alphanumeric, consisting of four digits (followed by two letters). These four digit zip codes are geographic areas of towns or municipalities and the Netherlands has more than 4,000 of such areas. The average size of this area is 10.3 squared kilometres.

economic characteristics for each zip code are obtained from Statistics Netherlands. See Table 3 for descriptive statistics. Note that we also include school and year fixed effects to correct for not-observed heterogeneity.

Table 3: Descriptive statistics other variables

	Average	Max	Min	St.dev.	N
Scale location (students)	219	1,553	10	164	10,047
Scale school (students)	1,713	10,492	25	1,494	10,047
Scale board (schools)	13	74	1	19	10,047
Education level (share):					
- VWO	0.20	1.00	0.00	0.40	10,047
- HAVO	0.20	1.00	0.00	0.40	10,047
- $VMBO_{GT}$	0.27	1.00	0.00	0.44	10,047
- $VMBO_{KA}$	0.17	1.00	0.00	0.37	10,047
- $VMBO_{BA}$	0.16	1.00	0.00	0.37	10,047
Girls (share)	0.49	1.00	0.00	0.09	10,047
Foreigners (share)	0.10	0.80	0.00	0.11	10,047
Income (*1000)	13.0	29.0	8.0	2.4	10,047
Population density[1]	4,027	26,046	46	3,033	10,047
Year 2002	0.09	1.00	0.00	0.28	10,047
Year 2003	0.21	1.00	0.00	0.41	10,047
Year 2004	0.23	1.00	0.00	0.42	10,047
Year 2005	0.24	1.00	0.00	0.42	10,047
Year 2006	0.23	1.00	0.00	0.42	10,047

1. Inhabitants/km^2

3. Results

Table 4 presents the estimations results based on OLS. For all three achievement indicators a significant negative relationship is found between quality and competition. These results suggest that more competition decreases the quality of education. However, the effects are not large. If competition increases from monopoly (HHI=1) to full competition (HHI=0) the average central exam score decreases with 0.05. With the same change, the percentage of graduated students decreases with 1.1%-point and the percentage on-time graduated students decreases with 1.7%-point. A smaller change in competition intensity is more probable, especially because in the Netherlands competition takes place between existing school locations and not with entrants. Assume, for example, that a dominant firm with 60% market share looses students to four other schools with 10% market share each with the ex-post

result that all schools have equal market shares (resulting in a HHI decrease from 0.40 to 0.20). In this case the average central exam scores decrease with 0.01, while the percentage of graduated and on-time graduated students decreases with respectively 0.2 and 0.3%-point. This means that, although we find a significant relationship between competition and quality, the effects are rather small.

Table 4: Estimation results OLS model

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
Competition (-HHI)	-0.049	(0.019)***	-0.017	(0.007)**	-0.011	(0.004)**
Scale location (*1000)	0.091	(0.027)***	0.009	(0.011)	-0.007	(0.006)
Scale school (*1000)	0.021	(0.005)***	-0.001	(0.002)	0.000	(0.001)
Scale board (schools)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)
HAVO	-0.143	(0.008)***	-0.033	(0.003)***	-0.030	(0.002)***
$VMBO_{GT}$	0.042	(0.013)***	0.214	(0.005)***	0.015	(0.003)***
$VMBO_{KA}$	0.109	(0.010)***	0.199	(0.004)***	0.026	(0.002)***
$VMBO_{BA}$	0.390	(0.010)***	0.234	(0.004)***	0.024	(0.002)***
Girls	0.017	(0.039)	0.031	(0.017)*	0.036	(0.009)***
Foreigners	-0.240	(0.054)***	0.005	(0.021)	-0.007	(0.012)
Income (*1000)	1.437	(2.316)	-1.765	(0.914)*	-0.582	(0.537)
Population density (*1000)	0.001	(0.002)	-0.001	(0.001)	-0.001	(0.000)***
Year 2003	0.008	(0.010)	0.024	(0.003)***	0.003	(0.002)
Year 2004	-0.019	(0.010)*	0.046	(0.003)***	0.006	(0.002)***
Year 2005	-0.061	(0.010)***	0.063	(0.003)***	0.004	(0.002)*
Year 2006	-0.047	(0.011)***	0.073	(0.003)***	0.003	(0.002)
Constant	6.30	(0.048)***	0.60	(0.019)***	0.92	(0.011)***
R^2 (within)	0.30		0.63		0.11	
Observations	10,047		9,183		10,041	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request.

Scale effects are found only for the central exam score if the scale of location and school increases. These effects are small and positive. If the scale of the location is increased with 1,000 students the central exam score rises with 0.09. This effect is 0.02 if the scale of the school increases with the same number.

For time effects, the exam score declines over time but the percentage of on-time graduated students increases over time. Thus, there are fewer students with delay, but the price is a lower exam score.

Turning to the socio-economic characteristics, we find significant negative results on the central exam score if a school is located in a neighborhood with a high percentage of non-western foreigners. The share of graduated students is lower when the population density

increases. It should be noted, however, that we include detailed fixed effects (per school), which might interact with these variables. Indeed, models without fixed effects show highly significant coefficients for foreigners, income and population density for all three quality measures. We find no indication that the gender effect is important for the central exam score, but the share of (on-time) graduated is higher with a larger share for girls.

4. The robustness analysis

It could be argued that the effect of competition is not homogeneous. First, a difference could be present between urban and rural areas. As competition is generally higher in urban areas, it could be possible that our main results are in fact driven by differences between urban and rural areas. To test this, we include an additional effect for the 21 biggest cities and for the locations located in areas with a relative low (bottom 25%) and high (top 25%) population density. The HHI is indeed much lower in the 21 big cities with an average value of 0.15 (Table 2b). This is comparable to the level of 0.18 for the locations located in the 25% locations with the highest population density. The bottom 25% locations have an HHI of 0.56. Still, we do not find support for the heterogeneity hypothesis (Table 5, models 1 and 2).[9] None of the coefficients are significant for a separate competition intensity effect for big cities and areas with a low or high population density.

A second type of possible heterogeneity is related to the scale of school locations. It could be argued that smaller school locations have a higher need to attract additional students and thus compete more fiercely. One reason for this is that small schools profit more from scale economies in costs and reputational effects if their scale increases. A second reason is that small schools can loose their permit if the scale drops below a certain level. Finally, the wage level of managers is often coupled to the scale of schools, providing incentives to scale up, especially for managers of smaller schools. To test this we include, first, an additional variable measuring the multiplicative effect of HHI and the scale of schools and, second,

[9] Full estimation results for the models presented in Table 5 and 6 are in Appendix B.

Table 5: Estimation results competition variables alternative specifications

Nr.	Model	Competition variables	Central exam score		Share on-time graduated		Share graduated	
			Coef	St.error	Coef	St.error	Coef	St.error
0	OLS (Table 4)	-HHI	-0.049	(0.019)***	-0.017	(0.007)**	-0.011	(0.004)**
1	Separate effect for 21 biggest cities	-HHI	-0.050	(0.019)***	-0.017	(0.007)**	-0.011	(0.004)**
		-HHI * 21 biggest cities	-0.102	(0.066)	0.041	(0.027)	-0.023	(0.015)
2	Separate effect for bottom and top 25% with respect to. population density	-HHI	-0.055	(0.022)**	-0.016	(0.008)*	-0.015	(0.005)***
		-HHI * Bottom 25% population density	0.010	(0.019)	-0.002	(0.007)	0.006	(0.004)
		-HHI * Top 25% population density	-0.041	(0.046)	0.008	(0.019)	-0.001	(0.011)
3	Multiplicative effect with scale school	-HHI	-0.152	(0.026)***	-0.035	(0.009)***	-0.015	(0.006)**
		-HHI * Scale school (*1000 students)	0.048	(0.008)***	0.009	(0.003)***	0.002	(0.002)
4	Effect per scale class schools with respect to the. number of students (1st quintile are smallest schools, 5th quintile are largest schools)	-HHI * Schools 1st quintile (students)	-0.182	(0.030)***	-0.038	(0.011)***	-0.023	(0.007)***
		-HHI * Schools 2nd quintile (students)	-0.058	(0.031)*	-0.046	(0.011)***	-0.013	(0.007)*
		-HHI * Schools 3rd quintile (students)	-0.139	(0.036)***	0.001	(0.014)	-0.022	(0.008)***
		-HHI * Schools 4th quintile (students)	-0.041	(0.029)	0.000	(0.011)	0.004	(0.007)
		-HHI * Schools 5th quintile (students)	0.038	(0.028)	-0.002	(0.011)	-0.011	(0.006)*
5	Effect per denomination	-HHI	-0.091	(0.025)***	-0.022	(0.009)**	-0.014	(0.006)**
		-HHI * Catholic	0.090	(0.036)**	0.017	(0.013)	0.010	(0.008)
		-HHI * Protestant	0.090	(0.025)***	0.012	(0.009)	0.005	(0.006)
		-HHI * Neutral	0.054	(0.033)	0.004	(0.012)	0.007	(0.008)
		-HHI * Other	-0.019	(0.020)	-0.007	(0.007)	-0.005	(0.005)
6	Effect trend	-HHI	-0.070	(0.030)**	-0.041	(0.011)***	-0.011	(0.007)
		-HHI * Trend	0.006	(0.007)	0.007	(0.002)***	0.000	(0.002)

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request, results for other variables available on request.

Table 6: Estimation results competition variables sensitivity analysis

			Central exam score		Share on-time graduated		Share graduated	
Nr.	Model	Competition variables	Coef	St.error	Coef	St.error	Coef	St.error
0	OLS (Table 4)	-HHI	-0.049	(0.019)***	-0.017	(0.007)**	-0.011	(0.004)**
7	IV	-HHI instrumented by number of competitors	-0.048	(0.020)**	-0.020	(0.007)***	-0.010	(0.005)**
8	Alternative competition variable	Number of competitors	-0.012	(0.001)***	-0.003	(0.001)***	-0.002	(0.000)***
9	Alternative competition variable	-HHI at school level	-0.064	(0.019)***	-0.018	(0.007)**	-0.014	(0.004)***
10	Quadratic effect competition	HHI	-0.262	(0.071)***	-0.079	(0.027)***	-0.035	(0.016)***
		HHI^2	0.175	(0.056)***	0.051	(0.022)**	0.020	(0.013)
11	Separate effect for high HHI	HHI	-0.080	(0.031)***	-0.025	(0.012)**	-0.013	(0.007)*
		HHI between 0.8 and 1.0	0.026	(0.021)	0.006	(0.008)	0.002	(0.005)
12	No fixed effects per school	-HHI	-0.106	(0.013)***	-0.031	(0.005)***	-0.013	(0.003)***

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request, results for other variables available on request.

replace the HHI by HHI's in scale quintiles.[10] We find indeed evidence for a relation between the effect of competition intensity and scale (Table 5, models 3 and 4). The coefficient for HHI is with -0.15 now three times as high for the effect on central exam score, but decreases if the scale of schools becomes larger. At the average scale (1,713 students) the effect is -0.069. The effect becomes zero for schools with a scale of about 3,000 students. For the share of on-time graduated students comparable effects are found. For the share of graduated students, however, the multiplicative effect is insignificant. In the specification with quintiles, it is clear that the effect is dominated by the first three quintiles. This means that the negative effect of competition on quality is dominated by small and medium sized schools.

A third type of possible heterogeneity is related to the denomination of schools. Students are in principle free to choose any school in the Netherlands. Certain private schools, however, have a special relationship with a subgroup of the inhabitants. Catholic schools, for instance, will be more attractive for students with a Catholic background. This might influence the real competition intensity schools feel. To test this, we include additional parameters for the HHI variable per type of private school. We distinguish between Catholic (18% of total), Protestant (17%), Neutral (17%) and Other (19%) private schools. This last group is the combination of several small denominations such as Orthodox Protestant, Anthroposophist and Islamic. We find evidence for a denominational effect for the central exam score (Table 5, model 5). Effects are zero for Protestant and Catholic schools, while the effects for other private and public schools are now higher (-0.09) than in the basic model.

A final type of possible heterogeneity is related to time. Newspapers and popular journals publish increasingly reliable information on the quality of schools and the quality variables of all schools are since 2004 also available on the internet. Furthermore, it might take time before enough students and their parents make use of this information and students and their parents might need time to get used to using this information properly. It could be argued, therefore, that the competition effect on quality changes over time as information on quality becomes better available for students and their parents. We test this by including an additional variable multiplying the HHI with a time trend. Only the estimations with the share of on-time graduated students results in a significant coefficient (Table 5, model 6). Here we

[10] School locations are divided in five equal groups with respect to school size. These groups have cut-off points at respectively 360, 1,075, 1,765 and 2,507 students. We include also dummies for scale classes to prevent that possible non-linear scale effects are included in coefficients for multiplicative effects.

find evidence that the effect was larger at the beginning of our time frame. After six years, which lies outside our sample, the effect becomes zero.

To analyze the robustness of the estimations we test for endogeneity. One could argue that there is also an effect of quality on competition. This is the case if low quality performance of schools invokes an increase in competition as it gives more possibilities for other schools to compete on quality. If this is the case, our OLS-estimations might be biased. An alternative for OLS is IV-estimation where the HHI is replaced by an instrument (as applied for instance by Sandström and Bergström (2005) and Hoxby (2000, 2007)). We use the number of competitors in the market as an instrument.[11] While market shares, and thus the HHI, might be endogenous to quality, this is not possible in the Netherlands for the number of competitors. As the introduction shows, entry of school locations is (nearly) non-existent. More important is that a low quality in a certain market can never be a reason to start a new school location. If this would be the reason for certain parties to start a new school location, permission is not granted. Only when denominations (or specific educational methods) are not present in the relevant market, such permission is granted. The number of school locations is, therefore, exogenous by law. This is a major difference with US markets where entry is very often the result of dissatisfaction of existing school quality (Hoxby, 2000). Table 6 present the results for the IV-estimator based on 2SLS estimation (model 7). We find that the reported negative effect of competition on quality is robust for endogeneity as all coefficients for the competition variables are not significantly different from the OLS-estimates.

Next, we test alternative assumptions for the competition variable. First, competition is measured by the number of school locations in the market. Second, competition is measured at the level of the school instead of the school location to reflect the case that competition takes place at school instead of location level. In both cases we find again a negative effect of competition on quality (Table 6, models 8 and 9). Third, we investigate whether there is a non-linear effect between competition and quality by including a quadratic term for the HHI variable as in Aghion et al. (2005). Although the coefficients for quadratic effects are significant for the central exam score and the share of on-time graduated students, the negative effect is still present

[11] To be precise, we use (1/(number of competitors+1)) as an instrument to get a measure between 0 and 1 that is comparable with the HHI variable, which makes comparison of coefficients with our OLS-estimates easier. Alternative specifications with for example just the number of competitors or (1/(number of competitors+3)) all result in negative and significant coefficients.

in nearly all cases (Table 6, model 10). Only when the HHI decreases in the range of 1.0 (monopoly) to 0.8 a very small increase in quality (0.01) is observed. Estimations with a separate effect for this HHI range, however, shows that this is the result of overshooting given the quadratic specification (Table 6, model 11). Although all three coefficients for the separate effects are negative, they are never significant. Finally, we estimated models without fixed effects for schools and find that coefficients are significant and negative, but much higher for the central exam score and the share on-time graduated (Table 6, model 12). This means that panel estimations are important as fixed effects can correct for not-observed heterogeneity.

Summarizing, the found negative relationship between competition and quality for the Dutch secondary schools is rather robust, but is higher for small and medium sized schools and for schools which are not Catholic or Protestant.

5. Conclusions

In the literature an interesting debate on the effect of competition between schools takes place. It is argued that competition enhances quality. However, if quality plays a minor role in the choices made by students and their parent the opposite effect could be possible. The empirical tests of the hypothesis that competition improves quality are based on countries where only a low level of competition is present. Tiebout choice, small scale voucher programs and experiments do not necessarily shed light on the long-term effects of fully free parental choice. In the Netherlands free parental choice has been the leading principle since the beginning of the previous century, which could be characterized as a full voucher program with 100% funding. Nevertheless, a systematic analysis of the effect of this free parental choice on educational achievements did not take place and this paper fills this gap for secondary education. Our conclusion is that there is a robust negative relation between competition and the quality of educational outcomes, but that the effect is small. This effect is robust for alternative specifications and sensitivity analyses, including endogeneity correcting IV-estimations. It shows that the effect is dominated by small and medium sized schools and by schools which do not have a Protestant or Catholic denomination.

These findings contradict with especially Hoxby (2007) and Lavy (forthcoming). Given the fact that only our analysis is based on fully free choice, which has been available on a large scale and for a long time, it could be argued that our results give a better approximation of the long term effects. However, the results are consistent if in Israel and the US quality of

educational outcomes plays a much larger role in school choice compared with the Netherlands.

In future research there are several avenues to explore. First, future research should use broader measures of quality. It could be that competition has a positive effect on other quality aspects than educational outcomes. Lavy (forthcoming) provides first evidence for such effects as behavioral outcomes improved after the introduction of free choice in Tel Aviv. Second, it is interesting to investigate the effects of competition on quality for primary schools as well, where distance is a more important feature of school choice. Third, if data are available for more years, it is possible to investigate whether the found relationship still holds in a larger time span. The effect of public discussion and increasing transparency using internet might diminish the negative effects after some years if the role of quality in choosing schools increases.

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Appendix A. List of variables

Competition (-HHI)	Minus Herfindahl-Hirschman-Index at location level (sum of market shares of locations within radius of 10km)
Competition (# competitors)	Number of competitors at location level within radius of 10 km.
Competition (-HHI school level)	Minus Herfindahl-Hirschman-Index at school level (sum of market shares of schools within radius of 10km)
Biggest 21 cities	Dummy with value 1 if location is situated in one of the 21 biggest cities (these cities have more than 118,000 inhabitants) and zero otherwise
Population density	Number of inhabitants per square kilometer
Bottom 25% pop. density	Dummy with value 1 if location is situated in a postcode area with a low population density (75% of areas have higher density) and zero otherwise
Top 25% pop. density	Dummy with value 1 if location is situated in a postcode area with a high population density (75% of areas have lower density) and zero otherwise
Scale location	Number of students per location
Scale school	Number of students of the school where the location is part of
Scale board	Number of schools per board where the location is part of
HAVO	Dummy with value 1 if location provides education at HAVO level and zero otherwise
$VMBO_{GT}$	Dummy with value 1 if location provides education at $VMBO_{GT}$ level and zero otherwise
$VMBO_{KA}$	Dummy with value 1 if location provides education at $VMBO_{KA}$ level and zero otherwise
$VMBO_{BA}$	Dummy with value 1 if location provides education at $VMBO_{BA}$ level and zero otherwise
Girls	Share of girls at location
Foreigners	Share of non-western foreigners at postcode level
Income	Income per inhabitant in euro at postcode level
Catholic	Dummy with value 1 if location has a Catholic denomination and zero otherwise
Protestant	Dummy with value 1 if location has a Protestant denomination and zero otherwise
Neutral	Dummy with value 1 if location has a Neutral denomination and zero otherwise
Other	Dummy with value 1 if location has another denomination than public, Catholic, Protestant and Neutral and zero otherwise

Appendix B. Estimation results sensitivity analysis

Not for publication (might be made available at website)

Tables give detailed results for estimations presented in Table 5 and 6. The number of the estimated models in Table 5 and 6 equals the number of the table headings in this Appendix (e.g. details for model 1 in Table 5 are in Table B1).

Table B1: Estimation results with separate effect competition variable for biggest 21 cities

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
Competition (-HHI)	-0.050	(0.019)***	-0.017	(0.007)**	-0.011	(0.004)**
-HHI * Biggest 21 cities	-0.102	(0.066)	0.041	(0.027)	-0.023	(0.015)
Scale location (*1000)	0.089	(0.028)***	0.010	(0.011)	-0.008	(0.006)
Scale school (*1000)	0.021	(0.005)***	-0.001	(0.002)	0.000	(0.001)
Scale board (schools)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)
HAVO	-0.143	(0.008)***	-0.033	(0.003)***	-0.030	(0.002)***
$VMBO_{GT}$	0.043	(0.013)***	0.213	(0.005)***	0.016	(0.003)***
$VMBO_{KA}$	0.108	(0.010)***	0.199	(0.004)***	0.026	(0.002)***
$VMBO_{BA}$	0.390	(0.011)***	0.235	(0.004)***	0.023	(0.002)***
Girls	0.017	(0.039)	0.032	(0.017)*	0.036	(0.009)***
Foreigners	-0.250	(0.054)***	0.008	(0.021)	-0.010	(0.013)
Income (*1000)	1.275	(2.320)	-1.705	(0.916)*	-0.628	(0.538)
Population density (*1000)	0.001	(0.002)	-0.001	(0.001)	-0.001	(0.000)***
Year 2003	0.008	(0.010)	0.024	(0.003)***	0.003	(0.002)
Year 2004	-0.019	(0.010)*	0.045	(0.003)***	0.006	(0.002)***
Year 2005	-0.060	(0.010)***	0.064	(0.003)***	0.004	(0.002)*
Year 2006	-0.046	(0.011)***	0.073	(0.003)***	0.003	(0.002)
Constant	6.292	(0.048)***	0.603	(0.019)***	0.917	(0.011)***
R^2 (within)	0.30		0.63		0.11	
Observations	10,026		9,163		10,020	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request.

Table B2: Estimation results with separate effect competition variable for top and bottom 25% population density

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
Competition (-HHI)	-0.055	(0.022)**	-0.016	(0.008)*	-0.015	(0.005)***
-HHI * Bottom 25% pop. density	0.010	(0.019)	-0.002	(0.007)	0.006	(0.004)
-HHI * Top 25% pop. density	-0.041	(0.047)	0.008	(0.019)	-0.001	(0.011)
Scale location (*1000)	0.089	(0.028)***	0.009	(0.011)	-0.008	(0.006)
Scale school (*1000)	0.021	(0.005)***	-0.001	(0.002)	0.000	(0.001)
Scale board (schools)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)
HAVO	-0.143	(0.008)***	-0.033	(0.003)***	-0.030	(0.002)***
$VMBO_{GT}$	0.042	(0.013)***	0.213	(0.005)***	0.015	(0.003)***
$VMBO_{KA}$	0.108	(0.010)***	0.199	(0.004)***	0.026	(0.002)***
$VMBO_{BA}$	0.390	(0.010)***	0.235	(0.004)***	0.024	(0.002)***
Girls	0.019	(0.039)	0.031	(0.017)*	0.036	(0.009)***
Foreigners	-0.242	(0.054)***	0.005	(0.021)	-0.008	(0.012)
Income (*1000)	1.471	(2.336)	-1.772	(0.923)*	-0.655	(0.542)
Population density (*1000)	0.000	(0.002)	-0.001	(0.001)	-0.001	(0.001)***
Year 2003	0.008	(0.010)	0.024	(0.003)***	0.003	(0.002)
Year 2004	-0.019	(0.010)*	0.046	(0.003)***	0.006	(0.002)***
Year 2005	-0.061	(0.010)***	0.063	(0.003)***	0.004	(0.002)*
Year 2006	-0.046	(0.011)***	0.073	(0.003)***	0.003	(0.002)
Constant	6.296	(0.048)***	0.602	(0.019)***	0.918	(0.011)***
R^2 (within)	0.30		0.63		0.11	
Observations	10,047		9,183		10,041	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request.

Table B3: Estimation results with multiplicative effect HHI and scale schools

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
-HHI	-0.152	(0.026)***	-0.035	(0.009)***	-0.015	(0.006)**
-HHI*Scale school (*1000)	0.048	(0.008)***	0.009	(0.003)***	0.002	(0.002)
Scale location (*1000)	0.095	(0.027)***	0.010	(0.011)	-0.007	(0.006)
Scale school (*1000)	0.037	(0.006)***	0.002	(0.002)	0.001	(0.001)
Scale board (schools)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)
HAVO	-0.143	(0.008)***	-0.033	(0.003)***	-0.030	(0.002)***
$VMBO_{GT}$	0.045	(0.013)***	0.214	(0.005)***	0.015	(0.003)***
$VMBO_{KA}$	0.112	(0.010)***	0.199	(0.004)***	0.026	(0.002)***
$VMBO_{BA}$	0.393	(0.010)***	0.235	(0.004)***	0.024	(0.002)***
Girls	0.005	(0.039)	0.028	(0.017)*	0.035	(0.009)***
Foreigners	-0.250	(0.054)***	0.003	(0.021)	-0.008	(0.012)
Income (*1000)	1.648	(2.313)	-1.652	(0.915)*	-0.575	(0.537)
Population density (*1000)	0.001	(0.002)	-0.001	(0.001)	-0.001	(0.000)***
Year 2003	0.008	(0.010)	0.024	(0.003)***	0.003	(0.002)
Year 2004	-0.019	(0.010)*	0.046	(0.003)***	0.006	(0.002)***
Year 2005	-0.061	(0.010)***	0.064	(0.003)***	0.004	(0.002)*
Year 2006	-0.047	(0.010)***	0.073	(0.003)***	0.003	(0.002)
Constant	6.262	(0.048)***	0.596	(0.019)***	0.916	(0.011)***
R^2 (within)	0.30		0.63		0.11	
Observations	10,047		9,183		10,041	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request.

Table B4: Estimation results with separate effect competition variable for quintiles schools with respect to the number of students (1st quintile are smallest schools, 5th quintile are largest schools).

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
-HHI*1st quintile	-0.182	(0.030)***	-0.038	(0.011)***	-0.023	(0.007)***
-HHI*2nd quintile	-0.058	(0.031)*	-0.046	(0.011)***	-0.013	(0.007)*
-HHI*3rd quintile	-0.139	(0.036)***	0.001	(0.014)	-0.022	(0.008)***
-HHI*4th quintile	-0.041	(0.029)	0.000	(0.011)	0.004	(0.007)
-HHI*5th quintile	0.038	(0.028)	-0.002	(0.011)	-0.011	(0.006)*
Scale location (*1000)	0.093	(0.028)***	0.014	(0.011)	-0.007	(0.006)
Dummy 2nd quintile	0.049	(0.018)***	-0.009	(0.007)	-0.001	(0.004)
Dummy 3rd quintile	0.001	(0.024)	0.006	(0.009)	-0.002	(0.006)
Dummy 4th quintile	0.040	(0.027)	-0.003	(0.010)	0.006	(0.006)
Dummy 5th quintile	0.014	(0.034)	-0.018	(0.013)	-0.007	(0.008)
Scale school (*1000)	0.040	(0.007)***	0.005	(0.003)	0.002	(0.002)
Scale board (schools)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)
HAVO	-0.143	(0.008)***	-0.033	(0.003)***	-0.030	(0.002)***
$VMBO_{GT}$	0.055	(0.022)**	0.211	(0.008)***	0.014	(0.005)***
$VMBO_{KA}$	0.111	(0.010)***	0.200	(0.004)***	0.026	(0.002)***
$VMBO_{BA}$	0.392	(0.010)***	0.236	(0.004)***	0.024	(0.002)***
Girls	-0.003	(0.040)	0.020	(0.017)	0.033	(0.009)***
Foreigners	-0.254	(0.054)***	0.002	(0.021)	-0.009	(0.012)
Income (*1000)	1.634	(2.314)	-1.502	(0.915)	-0.584	(0.538)
Population density (*1000)	0.001	(0.002)	-0.001	(0.001)	-0.001	(0.000)***
Year 2003	0.007	(0.010)	0.024	(0.003)***	0.003	(0.002)
Year 2004	-0.019	(0.010)*	0.045	(0.003)***	0.006	(0.002)***
Year 2005	-0.062	(0.010)***	0.064	(0.003)***	0.004	(0.002)*
Year 2006	-0.047	(0.010)***	0.074	(0.003)***	0.003	(0.002)
Constant	6.235	(0.054)***	0.598	(0.021)***	0.916	(0.013)***
R^2 (within)	0.30		0.63		0.11	
Observations	10,047		9,183		10,041	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request.

Table B5: Estimation results with separate effect competition variable for denominations

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
-HHI	-0.091	(0.025)***	-0.022	(0.009)**	-0.014	(0.006)**
-HHI * Catholic	0.090	(0.036)**	0.017	(0.013)	0.010	(0.008)
-HHI * Protestant	0.090	(0.025)***	0.012	(0.009)	0.005	(0.006)
-HHI * Neutral	0.054	(0.033)	0.004	(0.012)	0.007	(0.008)
-HHI * Other	-0.019	(0.020)	-0.007	(0.007)	-0.005	(0.005)
Scale location (*1000)	0.094	(0.027)***	0.009	(0.011)	-0.007	(0.006)
Scale school (*1000)	0.019	(0.005)***	-0.001	(0.002)	0.000	(0.001)
Scale board (schools)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)
HAVO	-0.143	(0.008)***	-0.033	(0.003)***	-0.030	(0.002)***
$VMBO_{GT}$	0.031	(0.013)**	0.211	(0.005)***	0.014	(0.003)***
$VMBO_{KA}$	0.109	(0.010)***	0.199	(0.004)***	0.026	(0.002)***
$VMBO_{BA}$	0.391	(0.010)***	0.235	(0.004)***	0.024	(0.002)***
Girls	0.014	(0.039)	0.029	(0.017)*	0.036	(0.009)***
Foreigners	-0.234	(0.054)***	0.006	(0.021)	-0.007	(0.012)
Income (*1000)	1.684	(2.320)	-1.686	(0.918)*	-0.541	(0.538)
Population density (*1000)	0.001	(0.002)	-0.001	(0.001)	-0.001	(0.000)***
Year 2003	0.008	(0.010)	0.024	(0.003)***	0.003	(0.002)
Year 2004	-0.019	(0.010)*	0.046	(0.003)***	0.006	(0.002)***
Year 2005	-0.061	(0.010)***	0.064	(0.003)***	0.004	(0.002)*
Year 2006	-0.046	(0.011)***	0.073	(0.003)***	0.003	(0.002)
Constant	6.294	(0.048)***	0.603	(0.019)***	0.917	(0.011)***
R^2 (within)	0.30		0.63		0.11	
Observations	10,047		9,183		10,041	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request.

Table B6: Estimation results with competition variable times trend

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
-HHI	-0.070	(0.030)**	-0.041	(0.011)***	-0.011	(0.007)
-HHI * Trend	0.006	(0.007)	0.007	(0.002)***	0.000	(0.002)
Scale location (*1000)	0.090	(0.027)***	0.009	(0.011)	-0.007	(0.006)
Scale school (*1000)	0.021	(0.005)***	-0.001	(0.002)	0.000	(0.001)
Scale board (schools)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)
HAVO	-0.143	(0.008)***	-0.033	(0.003)***	-0.030	(0.002)***
$VMBO_{GT}$	0.042	(0.013)***	0.214	(0.005)***	0.015	(0.003)***
$VMBO_{KA}$	0.109	(0.010)***	0.199	(0.004)***	0.026	(0.002)***
$VMBO_{BA}$	0.391	(0.010)***	0.235	(0.004)***	0.024	(0.002)***
Girls	0.017	(0.039)	0.031	(0.017)*	0.036	(0.009)***
Foreigners	-0.243	(0.054)***	0.001	(0.021)	-0.007	(0.012)
Income (*1000)	1.503	(2.318)	-1.619	(0.915)*	-0.582	(0.538)
Population density (*1000)	0.001	(0.002)	-0.001	(0.001)	-0.001	(0.000)***
Year 2003	0.010	(0.010)	0.027	(0.003)***	0.003	(0.002)
Year 2004	-0.015	(0.011)	0.050	(0.004)***	0.006	(0.003)**
Year 2005	-0.055	(0.013)***	0.071	(0.004)***	0.004	(0.003)
Year 2006	-0.038	(0.014)***	0.083	(0.005)***	0.003	(0.003)
Constant	6.290	(0.048)***	0.595	(0.019)***	0.917	(0.011)***
R^2 (within)	0.30		0.63		0.11	
Observations	10,047		9,183		10,041	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request.

Table B7: Estimation results IV 2SLS model

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
Competition (-HHI)	-0.048	(0.020)**	-0.020	(0.007)***	-0.010	(0.005)**
Scale location (*1000)	0.091	(0.027)***	0.009	(0.011)	-0.007	(0.006)
Scale school (*1000)	0.021	(0.005)***	-0.001	(0.002)	0.000	(0.001)
Scale board (schools)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)
HAVO	-0.143	(0.008)***	-0.033	(0.003)***	-0.030	(0.002)***
$VMBO_{GT}$	0.042	(0.013)***	0.214	(0.005)***	0.015	(0.003)***
$VMBO_{KA}$	0.109	(0.010)***	0.199	(0.004)***	0.026	(0.002)***
$VMBO_{BA}$	0.390	(0.010)***	0.234	(0.004)***	0.024	(0.002)***
Girls	0.017	(0.039)	0.031	(0.017)*	0.036	(0.009)***
Foreigners	-0.241	(0.054)***	0.006	(0.021)	-0.008	(0.012)
Income (*1000)	1.413	(2.323)	-1.679	(0.916)*	-0.597	(0.539)
Population density (*1000)	0.001	(0.002)	-0.001	(0.001)	-0.001	(0.000)***
Year 2003	0.008	(0.010)	0.024	(0.003)***	0.003	(0.002)
Year 2004	-0.019	(0.010)*	0.046	(0.003)***	0.006	(0.002)***
Year 2005	-0.061	(0.010)***	0.064	(0.003)***	0.004	(0.002)*
Year 2006	-0.047	(0.011)***	0.073	(0.003)***	0.003	(0.002)
Constant	6.296	(0.048)***	0.600	(0.019)***	0.918	(0.011)***
R^2 (within)	0.30		0.63		0.11	
Observations	10,047		9,183		10,041	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request, instrument is number of competitors.

Table B8: Estimation results with number of competitors as competition variable

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
Competition (# competitors)	-0.012	(0.001)***	-0.003	(0.001)***	-0.002	(0.000)***
Scale location (*1000)	0.082	(0.027)***	0.008	(0.011)	-0.009	(0.006)
Scale school (*1000)	0.022	(0.005)***	-0.001	(0.002)	0.001	(0.001)
Scale board (schools)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)
HAVO	-0.149	(0.008)***	-0.034	(0.003)***	-0.031	(0.002)***
$VMBO_{GT}$	0.062	(0.013)***	0.219	(0.005)***	0.019	(0.003)***
$VMBO_{KA}$	0.101	(0.010)***	0.197	(0.004)***	0.025	(0.002)***
$VMBO_{BA}$	0.384	(0.010)***	0.234	(0.004)***	0.023	(0.002)***
Girls	0.007	(0.039)	0.027	(0.017)	0.034	(0.009)***
Foreigners	-0.169	(0.054)***	0.018	(0.021)	0.004	(0.013)
Income (*1000)	6.485	(2.365)***	-0.683	(0.933)	0.222	(0.549)
Population density (*1000)	0.004	(0.002)**	-0.001	(0.001)	-0.001	(0.000)
Year 2003	0.010	(0.010)	0.024	(0.003)***	0.004	(0.002)
Year 2004	-0.014	(0.010)	0.046	(0.003)***	0.007	(0.002)***
Year 2005	-0.057	(0.010)***	0.064	(0.003)***	0.005	(0.002)**
Year 2006	-0.043	(0.010)***	0.074	(0.003)***	0.004	(0.002)
Constant	6.289	(0.045)***	0.607	(0.018)***	0.918	(0.010)***
R^2 (within)	0.30		0.63		0.11	
Observations	10,048		9,184		10,042	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request.

Table B9: Estimation results with HHI at school level

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
Competition (-HHI)	-0.064	(0.019)***	-0.018	(0.007)**	-0.014	(0.004)***
Scale location (*1000)	0.092	(0.027)***	0.009	(0.011)	-0.007	(0.006)
Scale school (*1000)	0.021	(0.005)***	-0.001	(0.002)	0.000	(0.001)
Scale board (schools)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)
HAVO	-0.144	(0.008)***	-0.033	(0.003)***	-0.030	(0.002)***
$VMBO_{GT}$	0.041	(0.013)***	0.213	(0.005)***	0.015	(0.003)***
$VMBO_{KA}$	0.108	(0.010)***	0.198	(0.004)***	0.026	(0.002)***
$VMBO_{BA}$	0.389	(0.010)***	0.234	(0.004)***	0.024	(0.002)***
Girls	0.018	(0.039)	0.032	(0.017)*	0.036	(0.009)***
Foreigners	-0.232	(0.054)***	0.005	(0.021)	-0.006	(0.012)
Income (*1000)	1.892	(2.320)	-1.747	(0.915)*	-0.502	(0.538)
Population density (*1000)	0.001	(0.002)	-0.001	(0.001)	-0.001	(0.000)***
Year 2003	0.008	(0.010)	0.024	(0.003)***	0.003	(0.002)
Year 2004	-0.019	(0.010)*	0.045	(0.003)***	0.006	(0.002)***
Year 2005	-0.061	(0.010)***	0.063	(0.003)***	0.004	(0.002)*
Year 2006	-0.047	(0.011)***	0.073	(0.003)***	0.003	(0.002)
Constant	6.280	(0.048)***	0.602	(0.019)***	0.914	(0.011)***
R^2 (within)	0.30		0.62		0.19	
Observations	10,047		9,183		10,041	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request.

Table B10: Estimation results with competition variable squared

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
-HHI	-0.262	(0.071)***	-0.079	(0.027)***	-0.035	(0.016)**
$-HHI^2$	0.175	(0.056)***	0.051	(0.022)**	0.020	(0.013)
Scale location (*1000)	0.089	(0.027)***	0.008	(0.011)	-0.008	(0.006)
Scale school (*1000)	0.021	(0.005)***	-0.001	(0.002)	0.000	(0.001)
Scale board (schools)	0.001	(0.001)	0.000	(0.000)	0.000	(0.000)
HAVO	-0.143	(0.008)***	-0.033	(0.003)***	-0.030	(0.002)***
$VMBO_{GT}$	0.045	(0.013)***	0.214	(0.005)***	0.016	(0.003)***
$VMBO_{KA}$	0.106	(0.01)***	0.198	(0.004)***	0.026	(0.002)***
$VMBO_{BA}$	0.387	(0.011)***	0.234	(0.004)***	0.023	(0.002)***
Girls	0.016	(0.039)	0.030	(0.017)*	0.036	(0.009)***
Foreigners	-0.212	(0.054)***	0.013	(0.021)	-0.004	(0.013)
Income (*1000)	2.847	(2.359)	-1.332	(0.932)	-0.422	(0.547)
Population density (*1000)	0.002	(0.002)	-0.001	(0.001)	-0.001	(0.000)**
Year 2003	0.008	(0.010)	0.024	(0.003)***	0.003	(0.002)
Year 2004	-0.018	(0.010)*	0.046	(0.003)***	0.007	(0.002)***
Year 2005	-0.060	(0.010)***	0.064	(0.003)***	0.004	(0.002)*
Year 2006	-0.046	(0.011)***	0.074	(0.003)***	0.003	(0.002)
Constant	6.231	(0.052)***	0.583	(0.020)***	0.910	(0.012)***
R2 (within)	0.30		0.63		0.11	
Observations	10,047		9,183		10,041	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request.

Table B11: Estimation results with separate competition variable for high HHI

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
-HHI	-0.080	(0.031)***	-0.025	(0.012)**	-0.013	(0.007)*
-HHI (0.8<HHI<1.0)	0.026	(0.021)	0.006	(0.008)	0.002	(0.005)
Scale location (*1000)	0.091	(0.027)***	0.009	(0.011)	-0.007	(0.006)
Scale school (*1000)	0.021	(0.005)***	-0.001	(0.002)	0.000	(0.001)
Scale board (schools)	0.001	(0.001)	0.000	(0)	0.000	(0)
$VMBO_{GT}$	-0.143	(0.008)***	-0.033	(0.003)***	-0.030	(0.002)***
$VMBO_{KA}$	0.042	(0.013)***	0.214	(0.005)***	0.015	(0.003)***
$VMBO_{BA}$	0.108	(0.01)***	0.198	(0.004)***	0.026	(0.002)***
VMBOBA	0.389	(0.011)***	0.234	(0.004)***	0.024	(0.002)***
Girls	0.016	(0.039)	0.030	(0.017)*	0.036	(0.009)***
Foreigners	-0.232	(0.054)***	0.007	(0.021)	-0.007	(0.013)
Income (*1000)	1.802	(2.334)	-1.664	(0.923)*	-0.554	(0.541)
Population density (*1000)	0.001	(0.002)	-0.001	(0.001)	-0.001	(0)***
Year 2003	0.008	(0.01)	0.024	(0.003)***	0.003	(0.002)
Year 2004	-0.019	(0.01)*	0.046	(0.003)***	0.006	(0.002)***
Year 2005	-0.061	(0.01)***	0.064	(0.003)***	0.004	(0.002)*
Year 2006	-0.046	(0.011)***	0.073	(0.003)***	0.003	(0.002)
Constant	6.281	(0.049)***	0.599	(0.019)***	0.916	(0.011)***
R^2 (within)	0.30		0.63		0.11	
Observations	10,047		9,183		10,041	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request.

Table B12: Estimation results without fixed effects per school

	Central exam score		Share on-time graduated		Share graduated	
	Coef	St.error	Coef	St.error	Coef	St.error
Competition (-HHI)	-0.106	(0.013)***	-0.031	(0.005)***	-0.013	(0.003)***
Scale location (*1000)	0.254	(0.021)***	0.082	(0.008)***	0.023	(0.005)***
Scale school (*1000)	-0.005	(0.002)**	0.000	(0.001)	0.000	(0.001)
Scale board (schools)	0.001	(0.000)***	0.000	(0.000)***	0.000	(0.000)***
HAVO	-0.164	(0.009)***	-0.037	(0.003)***	-0.032	(0.002)***
$VMBO_{GT}$	-0.019	(0.010)*	0.220	(0.004)***	0.016	(0.002)***
$VMBO_{KA}$	0.098	(0.011)***	0.205	(0.004)***	0.028	(0.002)***
$VMBO_{BA}$	0.370	(0.011)***	0.240	(0.004)***	0.024	(0.002)***
Girls	-0.044	(0.033)	0.031	(0.015)**	0.025	(0.007)***
Foreigners	-0.595	(0.034)***	-0.130	(0.013)***	-0.121	(0.007)***
Income (*1000)	-4.140	(1.379)***	-3.090	(0.519)***	-1.541	(0.300)***
Population density (*1000)	-0.005	(0.001)***	-0.004	(0.000)***	-0.002	(0.000)***
Year 2003	0.003	(0.012)	0.025	(0.004)***	0.002	(0.003)
Year 2004	-0.026	(0.012)**	0.046	(0.004)***	0.006	(0.003)**
Year 2005	-0.065	(0.012)***	0.064	(0.004)***	0.005	(0.003)*
Year 2006	-0.047	(0.012)***	0.074	(0.004)***	0.004	(0.003)
Constant	6.473	(0.031)***	0.616	(0.012)***	0.944	(0.007)***
R^2 (within)	0.30		0.62		0.19	
Observations	10,047		9,183		10,041	

Notes: Standard errors in brackets, */**/*** means significance at 10%/5%/1%, models are estimated with school fixed effects which are available upon request.