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The Effects of School Competition on Academic Achievement and Grading Standards

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Abstract

Nationwide school choice and fixed per-student governmental funding provide incentives for Dutch schools to perform well. Roughly one third of Dutch pre-university schools are of catholic denomination. Acknowledging this widely available outside option to public and other schools, this paper considers the effect of catholic competition on non-catholic school performance in pre-university education. Employing data from central exit exams, a positive link between competition intensity and academic achievement is found. In addition to raising achievement, higher levels of competition are not associated with a deterioration of grading standards. Finally, (inverse) quantile regression estimates show no evidence of schools at the bottom of the achievement distribution being hurt by competition.

JEL Code: I21.

Keywords: education, competition, Netherlands, IVQR.

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1 Introduction

It is by no means a new discovery that there may be beneficial effects of competition in the market for education. Ever since Friedman (1955), economists have argued that school choice in the form of vouchers would exert competitive pressure on school authorities which in turn would lead them to provide higher school quality. On the downside, increased choice could induce increased sorting by ability. This cream-skimming by the better schools is often thought to leave the least able students amongst themselves. In addition to being stuck in a bad school, they may thus be robbed of any positive peer effects they may have experienced in a mixed-ability school.

There is rather extensive empirical evidence on the effects of school competition in North America, yet this is not the case in Europe. Given the substantial institutional differences between the US and many European countries, further research is in order. This paper fills this gap by considering the Dutch education system which is characterized by centrally devised and graded school exit examinations and fixed per-student funding through the central government. In combination with unrestricted school choice which has been in place ever since the early 20th century, this constitutes a system of nationwide quasi-vouchers. Even though increasing interventions of the central government when it comes to curricula and the size of teaching staff are sometimes criticized (Walford, 2000), this institutional setup clearly complies with conceptions of a competitive school system harbored by proponents of school choice. It thus makes for an interesting subject for studying the implications of school competition.

1.1 The Link between School Quality and Competition

In the United States, each year a substantial share of the population relocates and secondary education is traditionally funded to a considerable degree by means of local property taxes. This makes educational policies and their effects on households' locational decisions a standard example of Tiebout's (1956) 'voting with the feet'. Indeed, research has shown that households take school quality into account when choosing their place of residence and they are willing to pay a premium for it, i.e. school quality is capitalized in house prices.¹

Whether school quality reacts to parents exercising the *exit*-option (or the threat thereof) has been at the center of another strand of research. Predominantly, school quality is measured in terms of academic achievement – i.e. test scores and graduation rates² – and the main explanatory variable is the intensity of competition in the relevant market. One

¹Obviously, in a larger geographical context, there are many other variables such as job availability which influence residential patterns. Within a metro area, however, school quality has been shown to be closely linked to house prices. See Black (1999), Weimer and Wolkoff (2001), Barrow (2002) and Bayer, Ferreira and McMillan (2005). For evidence that these effects can also be found outside the United States, see Cheshire and Sheppard (2003).

²Whether grades and the likes are a good measure of school quality is disputable. While certainly an intriguing issue, the discussion is beyond the focus of this paper.

reasonable indicator of competition would be the number of schools or school districts that make up the choice set within a particular market. Alternatively, the Herfindahl index of concentration, which is closely related to the number of schools or districts can be used (Martinez-Vazquez and Seaman 1985, Hoxby 2000). The percentage of students attending private schools (Hoxby 1994) or the number of private schools is also often employed, as these schools provide an outside option to public schools which may be too similar to actually impose competitive pressure upon one another. Evidently, these measures are all the more powerful when education markets are clearly defined geographically, thus determining a household's choice set.

When employing competition measures, endogeneity issues need to be taken into account. Picture a school district whose schools perform poorly. This district will be especially prone to the initiation of private schooling, as there are more students who are unhappy with the school they presently attend and this will add to the demand for alternatives. Failure to acknowledge this mechanism may lead to an underestimation of the impact of choice on achievement, as one may concurrently observe high degrees of competition and low public school quality. In a similar fashion, the number of school districts may be a function of school quality. Even though the endogeneity of competition has recently been contested by Brasington (2005) and Rothstein (2007), at least testing for endogeneity is necessary.

EMPIRICAL EVIDENCE FOR THE UNITED STATES. Even though school choice continues to be promoted as a means of ensuring that students receive a better education and voucher programs are introduced or extended in the United States, the scientific evidence on the effects of competition are far from being unambiguous. Using data from the UTD Texas School Project, Hanushek and Rivkin (2003) define metropolitan areas as education markets. Competition is measured by a Herfindahl index, which shows no significant connection to school quality. Marlow (1999) on the other hand finds a positive impact on achievement in many of his specifications, when competition is operationalized through the use of a county-wide Herfindahl index. Earlier, Marlow (1997) had already stated positive effects of the number of available schools per student on SAT scores using state-level data.³ Studies by Borland and Howsen (1993) and Zanzig (1997) only find effects up to a certain threshold level of competition. Geller, Sjoquist and Walker (2006) cannot identify a significant positive influence of competition by private schools on test scores in Georgia at all.

Most prominent in the public discourse are probably two studies by Hoxby (1994, 2000). In the more recent paper she develops an index of competition based on the number of school districts in a metropolitan area. The use of streams as an instrumental variable for the number of districts leads her to the conclusion of a positive influence of choice on achievement. The earlier study also finds a positive effect, measuring competition as the percentage of students in the market attending private schools. Here, the instruments are the shares of the population associated with various religious denominations. An approach

³Schools per student or per capita is not a reasonable concept of competition when local education markets are studied. Simply imagine a local education market which harbors few students or is sparsely populated but has only one school. This would imply high levels of competition when in fact the school is a local monopolist.

similar to Hoxby (1994) is used by Dee (1998), Jepsen (1999) and Sander (1999). Even though all three studies allow for endogeneity of competition, only Dee finds a significant positive link to levels of achievement. This lack of consensus in the literature is best summarized in an extensive survey of studies on school choice by Belfield and Levin (2002), who state that a mere third of the 25 empirical studies considered in their survey find significantly positive effects of levels of competition on academic achievement.

EMPIRICAL EVIDENCE FOR OTHER COUNTRIES. Possibly due to the assumption that Tiebout-sorting is less prevalent in Europe, a large portion of the literature is concerned with North America. Moreover, in a European context, education isn't typically funded via local taxes, pointing to lower levels of Tiebout-style competition. However, there are countries such as the Netherlands, which allow for school choice without changing residential location, i.e. these countries do not set up mandatory catchment areas. When the institutional feature of nationwide school choice is combined with fixed per-student governmental funding, the setup corresponds to an unrestricted nationwide system of school vouchers. A voucher system compares favorably to traditional Tiebout competition, as it enables low-income families who otherwise wouldn't be able to afford living in a good school district to exercise the *exit*-option. It provides a level playing field when it comes to making educational choices, at least on a financial level.

Åhlin (2003) as well as Sandström and Bergström (2005) state that the abolition of catchment areas in Sweden and the installation of a voucher scheme in 1992 led to positive effects on achievement. Beneficial effects are also found by Bradley, Johnes and Millington (1999) for the United Kingdom. They define competition as the number of schools in the education market. Using urban density as a proxy for school competition, Gibbons and Silva (2006) find that students in densely populated areas in the UK fare better academically. When it comes to the Netherlands, the research on school choice has been largely descriptive (Patrinos 2000, De Vijlder 2000, Ritzen et al. 1997, and Dronkers 1995). Levin (2004) and Dronkers (2004) examine the effect of attending a catholic school on academic performance. Both studies conclude that catholic schools generate superior educational outcomes. Clearly, this does not say anything about the impact of levels of competition on achievement. We should, however, take these results as ample evidence that the real outside option to attending a non-catholic school in the Netherlands is transferring to a catholic school rather than choosing another non-catholic one.

Given that the US evidence – which is inconclusive in any event – may not apply to education systems in other countries and the rather thin literature on school choice in Europe, this paper adds an important piece to the school choice puzzle. The remainder of the paper is organized as follows: section 2 explains in further detail the motivation for choosing the Netherlands as an object of examination. Data sources are described in section 3, along with the general empirical strategy. Section 4 contains the main empirical results. Beneficial effects of competition on academic achievement are found and neither various robustness checks nor the 2SLS estimations suggest any differently. Section 5 uses quantile regression (QR) and inverse/instrumental variable quantile regression methods (IVQR) in order to determine whether anyone is hurt by school competition, despite the positive effects that mean regression suggests. Section 6 concludes.

2 The Dutch Education System

In this section, a brief overview of the different types of schools in the Netherlands, the organization of school leaving examinations and centralized funding is given.

2.1 Types of secondary schools

Dutch compulsory education encompasses twelve school years and starts with primary education (*Basisschool*) at age five. Primary education lasts eight years and is in most cases completed with the taking of the *CITO* (*Central Institute for Test Development*) End of Primary School Test, a standardized test supposed to help parents determine the type of secondary education most suitable for their child.

Today, there are three types (*opleidingen*) of institutions in secondary education (*Voortgezet Onderwijs, VO*) among which parents may choose:

- (i) Pre-vocational or middle level secondary education (*Voorbereidend middelbaar beroepsonderwijs, VMBO*) lasts four school years.
- (ii) Senior or higher general secondary education (*Hoger Algemeen Voortgezet Onderwijs, HAVO*) amounts to five years of schooling.
- (iii) Pre-university education (*Voorbereidend Wetenschappelijk Onderwijs, VWO*) encompasses six years of schooling and offers a choice of either the “*Atheneum*”, where neither Greek nor Latin is compulsory, or the “*Gymnasium*” which has obligatory Greek and Latin lessons. The goal of *VWO* education is to enable students to take up a university education; it is thus the highest form of secondary education in the Dutch education landscape.

Most Dutch schools offer more than one of these *opleidingen*, and often one school will provide access to all three kinds of secondary education. The analysis in this paper is restricted to the pre-university branch, because it is assumed that parents and students in higher branches make more use of the freedom to choose.⁴

2.2 Mandatory School Leaving Exams

Dutch students end their secondary schooling careers with the taking of central examinations. These central exams (*centraal examen*) account for half the final grade. The

⁴Denessen, Slegers and Smit (2005) find that with higher socioeconomic status, proximity as a reason for a particular school choice becomes less important. Since the share of students from a lower status background is lower in *VWO* than in other branches, this implies that in *VWO* more so than in other branches parents will not just pick the school that is geographically most convenient.

other half is determined via decentralised testing (*schoolexamen*). The *centraal examen* are centrally arranged and graded by the testing agency *CITO*.⁵ All students of the same *opleiding* are faced with identical questions and grading is done by *CITO* within 4 weeks' time. An official body, appointed by the Ministry of Education, *CEVO* (*Centrale examencommissie vaststelling opgaven*) establishes the norms for the central exams.⁶

2.3 School Choice and Centralized Funding

The demand side of the Dutch secondary education system is characterized by parents enjoying unrestricted nationwide school choice. There are no catchment areas whatsoever and schools can neither charge tuition nor easily decline students based on criteria such as ability, thus leaving (at least theoretically) little room for cream-skimming.

Market entry barriers on the supply side are also low, as everyone in the Netherlands is granted the right to set up a school, if he or she so desires. The Dutch government is obliged to take care of school funding as soon as the number of enrolled students rises above a certain number, regardless of denomination or other philosophies and views held by the founders. A fixed annual transfer from the central government is then being triggered by every student enrolled in a particular institution of secondary education. Furthermore, if a school's enrolment drops below a certain level, it can be shut down. As a consequence of this institutional setup, 70% of Dutch secondary schools are non-public schools.

Even though Walford (2000) criticizes increasing interventions of the central government when it comes to curricula and the size of teaching staff, it is still obvious that this education system complies with conceptions of a competitive school system harbored by proponents of school choice. Hence, it makes for an interesting subject of studying the implications of school choice.

3 Empirical Strategy and Data Sources

This section describes the general estimation approach used in testing the idea that schools which are exposed to higher levels of competition respond by providing superior school quality. It discusses various measures of school quality as well as competition. Furthermore, the possible endogeneity of the competition variable is addressed.

⁵For further information, go to: http://www.cito.nl/com_assess_ex/nat_final_ex/eind_fr.html

⁶In some subjects, no centralized testing occurs (e.g. physical education and arts). The analysis in this paper is limited to subjects where standardized central exams are given.

3.1 Estimation approach

The data used in this paper comprises information on the graduating classes of 2002 and 2003.⁷ The fact that the competition variable hardly varies from one year to another means that the focus of this paper is on cross-sectional analysis of the data. The impact of competition on educational achievement is estimated using the following baseline estimation equation:

$$G_{ij} = \alpha C_{ij} + \mathbf{X}_i \boldsymbol{\beta} + \mathbf{Z}_j \boldsymbol{\delta} + \varepsilon_{ij}, \quad (1)$$

where i denotes the individual *VWO*-school and j education markets (in the context of this paper, this will typically be a municipality), G_{ij} is the average *centraal examen* grade at school-level, C_{ij} is the level of competition faced by school i in market j , \mathbf{X}_i is a vector of control variables at the school level and \mathbf{Z}_j is a vector of control variables at the local geographic (municipality) level. To allow for the possible correlation of ε_{ij} within geographic areas considered, the model allows for clustering of the standard errors at the municipality level.

3.2 Measuring Competition and Achievement

Two important questions have to be addressed before estimating the baseline equation:

- (i) Which outcome measure is to be employed?
- (ii) How should competition be measured?

Many measures come to mind when (i) is considered. This work uses school-level average grades in the central exit examinations. Even though quality of education involves so many more components than grades, they may well constitute one of the best available measures of educational output as they are considerably easier to grasp and measure than other aspects. These grades are determined by means of a central exam and central grading, administered by an independent institute (CITO). This practice renders them as close as one can get to an impartial measure of school quality, as long as one is willing to accept that the central exam tests the skills that should be conveyed by a Dutch secondary school. Since exams are mandatory, there is no worry about selection-bias, either, as would be the case with voluntary tests such as the American SAT (Scholastic Aptitude Test). Another variable that has often been used as an outcome are graduation rates. While this variable is available, in the Dutch setting it seems inappropriate, as half of the final grade and thus the graduation rate is determined via decentralized testing. In essence, this makes graduation rates (and standards) a choice variable for the individual school.⁸

⁷Even though data on grades and some controls are available prior to 2001, due to a different system of standardization, these exam outcomes cannot be compared to post-2000 grades. For the class of 2001, some of the school level controls could not be obtained.

⁸On the setting of standards at the local level see Himmler and Schwager (2007).

There are also numerous ways to capture the intensity of competition (ii). Probably most common is the use of a Herfindahl index of student enrollment, which measures the fragmentation of the student population within a given education market. The Herfindahl index that applies to a certain market j is calculated as:

$$H_j = \sum_{i=1}^n s_{ij}^2, \quad (2)$$

where s_{ij} is the share of *VWO*-school i 's students in the total number of *VWO* students in market j .

An even more straightforward measure is the number of *VWO*-schools within an education market, as choice ultimately is a question of the number of alternatives that are on offer.

Even in the presence of school districts, the problem with the above measures is that it is a priori unclear what the geographical boundaries of an education market are. When Tiebout-sorting within a metropolitan area is present, it is insufficient to consider only those institutions within the same school district as a schools's competition. Hence, it makes more sense to count all schools within the metro area as competitors. The Dutch system of school choice without the need to relocate aggravates the problem, as parents can theoretically reside in Amsterdam and send their offspring to a school in a place as far away as Maastricht. As attending a farther away school entails travel cost, it is reasonable to assume that there are limits in terms of distance when it comes to the choice of school.⁹ Following Levin (2004), in this analysis it is assumed that the Dutch *gemeenten* constitute the boundaries to an education market and the Herfindahl index as well as the number of *VWO*-schools are calculated at the *gemeente* level. It seems reasonable to assume that people have some sort of attachment to the municipality where they reside and thus are likely to choose among schools located in the same municipality. Since it is, however, not necessary to attend a school within one's municipality of residence, the number of *VWO*-schools within a 15km radius around the school in question is also used as a robustness check.

One measure that does not carry with it the need to define education markets is the distance in kilometers to the nearest *VWO*-school. Here, the argument is that competition increases in proximity as it becomes more feasible for students to transfer from one school to another. Any positive (or negative, for that matter) effects of competition should then be more pronounced when proximity is high.

In all of the above measures but the Herfindahl index, only catholic schools will be treated as competitors for the non-catholic schools. As Levin (2004) and Dronkers (2004) have stated, catholic schools outperform other forms of schooling, even after controlling for selection effects, making these schools all the more attractive. The reasoning then is that when parents choose a school, the real outside option to public/protestant schooling is a catholic school rather than another public or protestant school. It is also important

⁹Denessen, Driessena and Slegers (2005) find that among 17 reasons Dutch parents cited contributing to the choice of their school, proximity ranked 5th. School quality was found to be the most important reason for a particular choice.

to notice that about 30% of all schools are catholic schools. This is a substantially higher share than in most other countries, making opting into the catholic school sector a possibility that is widely available.

Additionally, the effects of competition on the level of grade inflation are considered. It is often argued that an undesirable effect of competition may be that schools facing competitive pressure will try to attract students by inflating grades, that is, they will apply a lower grading standard. The measure of grade inflation is $\Delta G_{ij} = G_{ij}^s - G_{ij}^c$, where G_{ij}^c denotes the average *centraal examen* grade and G_{ij}^s the average *schoolexamen* grade in school i in district j . The setting of average grades G_{ij}^c is governed by the central standard defined by a committee of experts. The setting of school grades G_{ij}^s on the other hand is governed by locally defined standards. Under coinciding central and school specific standards, one would expect $G_{ij}^s = G_{ij}^c$, because grading scales are identical in central and school exams. An upward deviation of G_{ij}^s from G_{ij}^c then constitutes a local standard that falls short of the central standard. If one is willing to accept that the centrally devised standard is the “true” standard, this may be interpreted as grade inflation.

The final outcome variable considered is per-student spending, which is expected to drop under competitive pressure as schools are forced to operate more efficiently.¹⁰

3.3 Data Sources

The data employed in this analysis stems from six different sources. Data on catholic population was provided by the Institute for Applied Research on Religion (KASKI) of the Radboud University Nijmegen. School-level data concerning students’ present and (in an indirect measure) past performance along with personal traits such as social and cultural status is taken from the *Kwaliteitskaart Voortgezet Onderwijs* (Quality Cards for Secondary Education), issues 2002 – 2004. The *Kwaliteitskaarten* are published on a yearly basis by the Netherlands Inspectorate of Education and contain figures on examination results as well as efficiency measures for Dutch secondary schools. They are being made available to parents and children via the internet in order to facilitate choosing an appropriate secondary school. The school location information given in the Quality Cards are geocoded at the actual street address level and a matrix of distances between all schools is calculated.

The *Kwaliteitskaarten* dataset also provides school-level information on the number of students, administrative form of the school (private/denominational/public), the school branches that can be attended at the school, average class sizes, subject-level average grades attained in school and central exams, the recommended type of secondary school based on students’ performance in primary education (i.e. students’ entrance levels of performance), the percentage of ethnic minority students, the percentage of students receiving financial support from the government (‘study cost allowance’).

¹⁰If parents take per student spending as an indicator of school quality, there may also be a counteracting effect such that schools try to attract students by building a reputation of spending more money per student.

The dependent variable G_{ij} for the central exam is obtained directly from the dataset, whereas ΔG_{ij} for grade inflation is constructed from the performance data of the 2003 and 2004 *Kwaliteitskaarten*. As the original *Kwaliteitskaarten* file reports school-level average grades across subjects only for the central exam, the average school specific (G_{ij}^s) and central (G_{ij}^c) grades covering all subjects are calculated by weighting the average school and central grades in each subject with the number of students that have actually taken part in the exams in that particular subject. Apart from some 'placebo regressions', the empirical analysis will be restricted to the effect of catholic competition on the grades in non-catholic schools.

Controls are added for other possible determinants of academic performance. The percentage of cultural minority (*CUMI*) students is defined as the share of students in a given school branch who have a non-Dutch background.¹¹ It is used along with the percentage of students receiving study cost allowance as a proxy for low social status. These proxies are used, as neither the Inspectorate nor the individual schools collect detailed data on the students' or parents' socioeconomic status.

At the end of *basischool* each student is given a non-binding advice by her teachers as to which school branch is deemed appropriate in secondary education. Since grades from primary education are not available and the advice will obviously be largely based on grades in primary school, we add the advice as a control variable for the incoming students' skill level. Above advice denotes the share of students attending a more demanding branch than the one recommended, i.e. these students are in VWO, yet the given advice was for HAVO – which is the lower school branch adjacent to VWO – at the most. Half above advice denotes the percentage of students who did not get a clear VWO recommendation but rather were ranked in between HAVO and VWO. The percentage of students in ability-tracked classes in the first and second year of secondary education and the average class size from the *Kwaliteitskaarten* are also included. Ability-tracked in this context means that students attend classes with students from their chosen branch – which is VWO in the context of this paper – only, whereas non-tracked students attend classes together with students from other (lower) branches. After the second year of secondary education there are no mixed classes.

In addition to school level data, control variables which are available on the municipality and postcode level are used. Specifically, the *Statusscore postcodegebieden* is a postcode level index of quality of life in a given area. It thus proxies for the students' social background. They are supplied by The Social and Cultural Planning Office of the Netherlands (SCP), a Dutch government agency. The status scores are calculated in 4 year intervals, taking into account variables such as mean education, mean income, average rents etc. Postcode areas that have a low social status are denoted with values greater than zero, areas of higher status receive negative values. These scores are matched with the schools' 4-digit postcodes taken from the *Kwaliteitskaarten*. As they are updated every four years only, postcodes are assigned the same values in both years. Data on per capita income, the share of school aged children in the population, population density and the land area

¹¹While 'cumi' is an official term in the Netherlands and there is a law that specifies the requirements to be considered part of a cultural minority, essentially these are students who themselves or whose parents were born in Eastern Europe or Third World countries.

at the *gemeente* level comes from *Nederland regionaal*, published by the Dutch Office of Statistics (*CBS*).

Since school-level financial endowment as well as characteristics of the teaching staff might influence average grades and standard setting as well as per-student spending, data from the series *Onderwijs in Cijfers (OIC)* is used in some of the estimations, too. *Onderwijs in Cijfers* is published annually by the Dutch Ministry of Education and is intended to provide school managers with information on the above mentioned matters. Variables included in the estimations are the share of short and long term debt in the total annual balance, the rate of student body growth or shrinkage, the rate of staff growth or shrinkage and the share of the staff that are part-timers with less than 80% of a full teaching position. However, data availability is a bit of a problem, as many variables are missing for a large number of schools. Another problem is that the data is not reported at the school level but rather for groups of schools.

Tables A-1 and A-2 in the appendix display descriptive statistics for the variables used in the estimation.

4 Estimation Results

As stated above, this work is concerned with the effect of catholic competition on non-catholic schools.¹² In all of what follows, a further distinction is made between fully roman-catholic schools and schools that are only in part operated by the catholic church. These partly catholic schools include all kinds of cooperations of the catholic church with other organizations, such as catholic schools cooperating with private/public/protestant schools. If not stated otherwise the competition variable is the number of catholic schools in the municipality.¹³

Descriptive statistics for the dependent variables G_{ij} , ΔG_{ij} and per student spending are shown in tables 1 for the pooled classes of 2002 and 2003, split up by catholic schools and non-catholic schools. On average, grades awarded in central exams are slightly higher in catholic schools. Even though the difference is statistically significant, it does not seem very large, even for school-level averages.¹⁴

¹²non-catholic schools evidently include non-public schools which are not affiliated with the catholic church, such as protestant or private schools. These schools, neither operated by the catholic church nor public, make up about half of the non-catholic schools.

¹³There is one exception: The towns of Hoek van Holland and Hoogvliet are administered by the municipality of Rotterdam, yet they are located rather far away from the actual city. The town Hoek van Holland is 30km away, while Hoogvliet is approximately 15km from Rotterdam. Both towns do not directly border Rotterdam and other municipalities have to be traversed in order to reach Rotterdam. This can be seen in figure 6 in the appendix. For these reasons, Hoek van Holland and Hoogvliet are treated as education markets separate from Rotterdam.

¹⁴Keep in mind, though, that while individual grades range from 0 to 100, most school-level averages range from 60 to 70.

Grade inflation on the other hand seems to be more prevalent in non-catholic schools, the difference in means is again statistically significant. Average spending per student is also higher in non-catholic schools. As schools can gain additional funds from the government when they have a large share of minority students enrolled, no statements on efficiency can be made from this data without controlling for student body composition.

The means of central exam grades and grade differences are significantly different across the groups for both definitions of catholic schools. In the end, however, it doesn't even matter whether or not these differences are significant but rather it matters whether students and their parents *perceive* catholic schools to be superior. From the data it also seems that the pure roman-catholic schools outperform even the partly catholic schools, yet parents may perceive the partly catholic schools mainly as 'catholic' and thus as an alternative to the non-catholic schools. The competition variable which includes these partly catholic schools may thus be the more appropriate one.

When it comes to the competition variables, table 2 shows that the average non-roman-catholic school faces about one roman-catholic competitor, whereas the average non-catholic school faces about 1.4 competitors. The maximum amount of competitors is five. As can be expected from the fact that Dutch municipalities are rather small in land area, the number of competitors within 15km is much higher than when the education market is defined at the municipality level. The larger competitor set of non-catholic schools also goes with a shorter distance to the nearest catholic school; the Herfindahl index ranges from 0.06 which is indicative of a pretty competitive market to 1 for those municipalities harboring one school only.

Table 1: SUMMARY STATISTICS, DEPENDENT VARIABLES.

Variable	(partly) catholic schools			non (partly) catholic schools			diff \neq 0
	N	Mean	SD	N	Mean	SD	
Central grade	369	64.40	2.59	639	63.91	3.08	**
Grade inflation	369	4.39	2.17	639	5.08	2.81	***
Per student spending	176	5880	1257	308	6032	1175	<i>no</i>

Variable	Roman-catholic schools			non Roman-catholic schools			diff \neq 0
	N	Mean	SD	N	Mean	SD	
Central grade	275	64.63	2.41	733	63.89	3.07	***
Grade inflation	275	4.16	2.04	733	5.08	2.76	***
Per student spending	129	5827	1305	355	6032	1166	*

The upper part considers all schools that are in part catholic as competition, whereas the bottom part considers only fully Roman-Catholic schools as competition.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimation results when the central grade is used as the outcome variable are presented in table 3 for non-catholic schools¹⁵ and in table 4 for non-roman-catholic schools.¹⁶ Spec-

¹⁵Non-catholic schools are not even partly operated by the catholic church. The competition variable thus includes schools that are only in part operated by the catholic church.

¹⁶Non-roman-catholic schools may be partly operated by the catholic church, yet they are not fully roman-catholic. The competition variable thus includes only those schools that are fully operated by the catholic church.

Table 2: SUMMARY STATISTICS, COMPETITION VARIABLES.

non (partly) catholic schools					
Variable	N	Mean	SD	Min	Max
No. cath. schools gemeente	639	1.41	1.67	0	5
No. cath. schools 15km radius	639	4.96	4.11	0	15
km to (partly) cath. school	639	6.16	7.29	0.08	42.55
Herfindahl gemeente	631	0.40	0.31	0.06	1
non Roman-catholic schools					
Variable	N	Mean	SD	Min	Max
No. cath. schools gemeente	733	0.97	1.33	0	5
No. cath. schools 15km radius	733	3.44	3.03	0	12
km to Roman-cath. school	733	12.23	17.41	0.15	86.66
Herfindahl gemeente	725	0.42	0.32	0.06	1

The upper part considers all schools that are not even in part catholic schools, whereas the bottom part considers those schools that are not Roman-Catholic schools.

ification (1) includes the number of competitors and a year dummy only. Whenever municipality characteristics are added in column (2), the coefficient on competition actually becomes positive and in the case of non-catholic schools significant. Including school level control variables in column (3) further increases the effect of competition. It can be seen that the school level variables now pick up the effects from the municipality level controls, all of which now turn insignificant. The control variables mostly point in the theoretically expected direction. A high share of minority students and students whose advice after *basisschool* deemed *VWO* too demanding lead to lower average grades. The same goes for a high percentage of untracked students. Somewhat surprising is the highly significant positive coefficient of class size. This could be due to the fact that Dutch schools receive extra funding for low ability students. These funds are often used to lower class size. In the end this means that smaller classes are a proxy of sorts for a high number of underachieving students. The non-religious school dummy has a negative coefficient, indicating that among the non-catholic schools, those schools not affiliated with any religion perform even worse.¹⁷ Including school finance measures in column (4) does not alter the results from column (3) much. The financial variables do not add much in terms of explanatory value, as only short term debt is even marginally significant. This is not too surprising, as these variables are reported at an aggregated level of groups of schools. On the downside, many observations are lost due to the limited availability of the financial variables. To put the coefficients into perspective, a one standard deviation change in competition increases central exam grades by 0.15 (non-catholic schools) and 0.1 (non-roman-catholic schools) standard deviations, respectively. This is not a huge effect, but according to Belfield and Levin (2002) in the range of what other studies find. Overall, it seems that competition has a small but significant positive impact on central exam grades.

¹⁷Alternatively, dummies for the specific denominations can be included. This leaves the results unchanged, the only two significant dummies are those for the non-catholic religious schools. The non-religious school dummy thus captures the same effect. Similarly, including dummies for the Dutch dioceses (*bisdommen*) does not significantly reduce the estimated effect of competition.

In order to retain as many observations as possible, from here on only specification (3) is used, as the additional controls do not add much in terms of explanatory value yet they significantly reduce the sample size. In addition, we were unable to obtain information from the Dutch authorities with regards to why so many observations are missing. It is thus not clear on what criteria the smaller sample would be selected, i.e. whether schools report their financial data voluntarily. In that case, a selection model would have to be estimated to obtain unbiased results.

4.1 Endogeneity of Competition

Another issue that has to be dealt with is the possible endogeneity of competition to local school quality. That is, in an area where public school quality is low, demand for alternative forms of schooling may be especially high, causing a downward bias in the competition coefficients estimated by OLS. To overcome this problem, 2SLS estimation is employed, where the estimation equations are

$$C_{ij} = \gamma_0 + \mathbf{I}_j\gamma_1 + \mathbf{X}_i\gamma_2 + \mathbf{Z}_j\gamma_3 + u_{ij} \quad (3)$$

and

$$G_{ij} = \beta_0 + \beta_1 C_{ij} + \mathbf{X}_i\beta_2 + \mathbf{Z}_j\beta_3 + \varepsilon_{ij}. \quad (4)$$

The first stage is given by (3) and the second stage by (4), where the definitions are as in (1) and I_j is the set of instruments.

The instruments proposed are the number of catholics living in the education market and its square. As catholics tend to found and attend catholic schools, their number is obviously closely related to the number of catholic schools in the education market. Exogeneity can be assumed because there is no reason to believe that catholics fare better on standardized tests. Moreover, geographical areas where catholics dominate are largely historically predetermined.

The first stage results (table 5) indicate that both instruments are highly significant and that there is no problem with weak instruments. The second stage coefficients (table 6) are scaled down a bit compared with the OLS results and as is always the case with 2SLS the standard errors increase significantly, rendering the effect of competition insignificant for non-roman-catholic schools. Hausman tests of statistical differences in the OLS and 2SLS estimates, however, fail to reject exogeneity of the competition variable in both cases. When it comes to instrument exogeneity, standard overidentification tests fail to reject the exogeneity of the instruments at any reasonable level.

It should be noted however, that the overidentification tests do not carry much weight here, as both instruments are derived from the same reasoning. Thus, in an alternative specification shown in tables A-3 and A-4 in the appendix, the total length of the road network within a municipality is used as an additional instrument. This instrument is closely related to population size, which is used as an instrument for competition by Geller, Sjoquist and Walker (2006) as well as Hsieh and Urquiola (2006), yet it also takes

Table 3: OLS, DEPENDENT VARIABLE IS CENTRAL EXAM GRADE. (PARTLY) CATHOLIC COMPETITION.

	(1)	(2)	(3)	(4)
(Partly) catholic schools	-0.1370	(0.107)	0.1930**	(0.096)
Above advice %			0.2846***	(0.083)
Half above advice %			-0.0455***	(0.011)
Minority (cumi) students %			-0.0131*	(0.008)
Study cost recipients %			-0.0846***	(0.019)
Tracked in grade 1 %			-0.0383*	(0.019)
Tracked in grade 2 %			0.0112**	(0.004)
Class size grade 1			-0.0006	(0.004)
Class size grade 2			0.1455***	(0.049)
Non-religious school dummy			-0.0098	(0.051)
Number of students VWO (1000s)			-0.6643**	(0.263)
Number of students brin (1000s)			-0.0188	(1.158)
Short term debt %			-0.0010	(0.124)
Long term debt %				
Staff growth %				
Number of students growth %				
Part time staff %				
Quality of life				
Average income (1000 Euro)			-0.4972***	(0.143)
Population share school aged			-0.2390**	(0.111)
Pop. density (1000/km ²)			0.1499*	(0.077)
Land area (km ²)			-0.2031**	(0.092)
Year 2003	0.2065	(0.150)	-0.0043***	(0.001)
Intercept	64.0009	(0.190)	0.2020	(0.135)
			64.9437	(2.132)
<i>N</i>	639	633	542	462
adj. <i>R</i> ²	0.004	0.048	0.326	0.338

All schools that are at least in part catholic count towards the competition variable. The estimations thus represent the effect of (partly) catholic schools on those schools that are in no way affiliated with the catholic church. Standard errors in parentheses allow for clustering on the municipality (gemeente) level.
 * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: OLS, DEPENDENT VARIABLE IS CENTRAL EXAM GRADE. (ROMAN) CATHOLIC COMPETITION.

	(1)	(2)	(3)	(4)
Roman catholic schools	-0.1971	(0.140)	0.1548	(0.095)
Above advice %			0.2326***	(0.086)
Half above advice %			-0.0475***	(0.011)
Minority (cumi) students %			-0.0154**	(0.008)
Study cost recipients %			-0.0934***	(0.016)
Tracked in grade 1 %			-0.0285	(0.018)
Tracked in grade 2 %			0.0083*	(0.004)
Class size grade 1			0.0002	(0.004)
Class size grade 2			0.1389***	(0.046)
Non-religious school dummy			-0.0227	(0.052)
Number of students VWO (1000s)			-0.4246*	(0.246)
Number of students brin (1000s)			-0.0037	(1.201)
Short term debt %			-0.0088	(0.122)
Long term debt %				(0.0167)
Staff growth %				(0.0158)
Number of students growth %				(0.0077)
Part time staff %				(0.0059)
Quality of life				(0.0063)
Average income (1000 Euro)			-0.1432	(0.139)
Population share school aged			-0.2497*	(0.137)
Pop. density (1000/km ²)			0.0678	(0.061)
Land area (km ²)			0.0087	(0.090)
Year 2003			-0.0002	(0.001)
Intercept	0.2634*	(0.139)	0.3901***	(0.135)
	63.9441	(0.168)	65.5102	(2.643)
<i>N</i>	733	721	616	529
adj. <i>R</i> ²	0.006	0.063	0.306	0.310

All schools that are roman-catholic count towards the competition variable. The estimations thus represent the effect of roman-catholic schools on those schools that are in not *purely* roman-catholic, yet they may affiliated with the catholic church. Standard errors in parentheses allow for clustering on the municipality (gemeente) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

into account the accessibility of schools.¹⁸ Any urban/rural differences in achievement are tried to capture by controlling for population density and land area at the market level. Population density should also not react to school quality, as it is not necessary to physically move to the vicinity of the school of choice. The results from these alternative 2SLS estimations are virtually identical and the overidentification statistic is even smaller.

In the end, the 2SLS results indicate that we can have some confidence in the validity of the baseline OLS results.

Table 5: FIRST STAGE STATISTICS.

	(1) (Partly) catholic	(2) Roman-catholic
Catholics in municip. (1000s)	0.1071*** (0.0112)	0.0643*** (0.0166)
Cath in municip. squared	-0.0007*** (0.0001)	-0.0003* (0.0002)
F-test excluded instr.	F(2,140)=58.36 p=0.000	F(2,153)=15.63 p=0.000
partial R^2 excluded instr.	0.61	0.41
R^2	0.83	0.66
N	542	616

Estimates are for 1st stage of 2SLS. Number of schools is the dependent variable of 1st stage. Estimates shown for the excluded instruments only. Control variables are as in column (3) of the baseline OLS tables 3 and 4. Standard errors in parentheses allow for clustering by municipality.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.2 Robustness checks

Table 7 displays results for some alternative specifications. In all of these, the dependent variable is the central exam grade. The top part (a) of the table shows that the effect of catholic competition on public schools is somewhat larger than for all non-catholic schools. This is intuitively consistent with the finding that non-religious schools are the worst schools among the non-catholic schools.

Because there may be urban/rural differences in the effects of competition and because catholic competition might not have as much of an effect in predominantly catholic dioceses, part (b) of the table shows how sensitive the results are to dropping these schools from the sample.¹⁹ While dropping the *grote 4* (big 4) cities Amsterdam, Utrecht, Rotterdam and Den Haag slightly reduces the competition effects, the impact of catholic alternatives seems to be especially large in those dioceses that are not predominantly catholic. The effect of catholic competition seems to be largest in non-catholic areas outside the *grote 4*.

An important question is whether the effect of competition is truly an effect that can

¹⁸Gibbons and Olmo (2006) find that academic achievement is higher in urban areas of the UK. This could cast doubt on the assumption of exogeneity. However, they expressly attribute this effect to higher levels of competition.

¹⁹The dioceses of Roermond, Breda and Den Bosch are classified as predominantly catholic dioceses because the share of catholics in the population is above 40% in all three.

Table 6: 2SLS, DEPENDENT VARIABLE IS CENTRAL EXAM GRADE.

	(1) (Partly) catholic		(2) Roman-catholic	
(Partly) catholic schools	0.2434*	(0.127)		
Roman catholic schools			0.1700	(0.155)
Above advice %	-0.0456***	(0.011)	-0.0473***	(0.010)
Half above advice %	-0.0136*	(0.008)	-0.0157**	(0.008)
Minority (cumi) students %	-0.0831***	(0.020)	-0.0915***	(0.017)
Study cost recipients %	-0.0384**	(0.019)	-0.0289	(0.018)
Tracked in grade 1 %	0.0111**	(0.004)	0.0083*	(0.004)
Tracked in grade 2 %	-0.0007	(0.004)	0.0002	(0.004)
Class size grade 1	0.1466***	(0.048)	0.1413***	(0.045)
Class size grade 2	-0.0101	(0.050)	-0.0233	(0.052)
Non-religious school dummy	-0.6707**	(0.264)	-0.4278*	(0.244)
Number of students VWO (1000s)	0.0414	(1.182)	0.0869	(1.247)
Number of students brin (1000s)	-0.0055	(0.121)	-0.0147	(0.119)
Quality of life	-0.0757	(0.146)	-0.1381	(0.140)
Average income (1000 Euro)	-0.1818	(0.138)	-0.2497*	(0.135)
Population share school aged	0.0748	(0.075)	0.0557	(0.063)
Pop. density (1000/km ²)	-0.0507	(0.097)	0.0221	(0.087)
Land area (km ²)	-0.0008	(0.001)	0.0000	(0.001)
Year 2003	0.4060***	(0.137)	0.3859***	(0.137)
Intercept	64.3534	(2.741)	65.6897	(2.627)
<i>N</i>	542		616	
adj. <i>R</i> ²	0.325		0.306	
test of overid. restr. $\chi^2(1)$	0.010	(<i>p</i> = 0.920)	0.145	(<i>p</i> = 0.703)

Second stage estimates, instruments are the number of catholics in the municipality and its square. All schools that are at least in part catholic schools count towards the competition variable in column (1), whereas only roman-catholic schools are considered in column (2). Control variables are as in column (3) of the baseline OLS tables 3 and 4. Standard errors in parentheses allow for clustering on the municipality (gemeente) level.

* *p* < 0.10, ** *p* < 0.05, *** *p* < 0.01.

only be found when catholic schools are treated as the competitors. The bottom part (c) of table 7 shows that the number of other schools than the catholic ones does not have an impact on exam grades and that catholic competition does not improve the outcome for other catholic schools. These estimates are in line with the assumption of this paper that competition in the Netherlands is mainly inter-denominational and affects the non-catholic schools

Other proxies for competition are employed in table 8. The number of schools within a 15km radius is significant at the ten percent level. If it is in fact true that households mostly choose schools that are located within their own *gemeente*, then the 15km radius is an inappropriate specification as it will almost inevitably contain schools in other municipalities. The same argument is true for distance to the nearest catholic school (not significant), as this will sometimes be the distance to a school outside the municipality. In addition, a drawback of the data used is that all distances are calculated 'as the crow flies', thus neglecting geographical obstacles such as rivers or bad connecting roads between places. The Herfindahl measure of competition does not solely depend on catholic school competition. Higher concentration is associated with lower average grades, yet the coefficient is significant only in one of the 2SLS estimations. Even though the Herfindahl index comprises the shares of all schools in a market, it is still heavily influenced by the number of catholic schools in the market. Thus, the significant coefficient does not stand

Table 7: ROBUSTNESS CHECKS, DEPENDENT VARIABLE EXAM GRADE.

	(1) (Partly) catholic	(2) Roman-catholic
<i>(a) catholic competition, effect on public schools</i>		
Number of catholic schools in muni.	0.3723*** (0.129)	
Number of rom.-cath. schools in muni.		0.3353** (0.137)
<i>(b) catholic competition (# cat schools), sub-samples</i>		
Catholic, w/out big 4 cities	0.2494** (0.108)	
Rom.-cath., w/out big 4 cities		0.2020* (0.111)
Catholic, w/out cath. dioceses	0.3409*** (0.087)	
Rom.-cath., w/out cath. dioceses		0.3027*** (0.094)
Catholic, w/out big 4 and cath. dioc.	0.3711*** (0.141)	
Rom.-cath., w/out big 4 and cath. dioc.		0.3595** (0.159)
<i>(c) other forms of competition, placebo regressions</i>		
All competitors on all schools	0.0293	(0.036)
All competitors on non-cat. schools	0.0461	(0.047)
All competitors on non-rom.-cat. schools	0.0380	(0.043)
Cat. competitors on cat. schools	-0.0034	(0.118)
R.-cat. competitors on rom.-cat. schools	0.0119	(0.146)
Non-cat. competitors on all schools	-0.0049	(0.046)
Non-rom.-cat. comp. on all schools	0.0080	(0.041)
Non-cat. competitors on non-cath schools	0.0174	(0.059)
Non-rom.-cat. comp. on non-rom.-cath. sch.	0.0192	(0.050)
Non-cat. competitors on cath. schools	-0.0835	(0.077)
Non-rom.-cat. comp. on rom.-cath. schools	-0.0245	(0.095)

Part (a) shows the effect of 'number of catholic/roman-catholic schools in municipality' on central exam grades in public schools. Part (b) shows the coefficients of the variable 'number of catholic/ roman-catholic schools in municipality'. The bottom part (c) shows coefficients for other forms of competition that are not believed to have an effect on academic achievement. Where applicable, all schools that are at least in part catholic schools count towards the competition variable in column (1), whereas only roman-catholic schools are considered in column (2). Only coefficients of the competition variable are displayed. Control variables are as in column (3) of the baseline OLS tables 3 and 4. Standard errors in parentheses allow for clustering on the municipality (gemeente) level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

against the hypothesis that catholic schools are the real competition. Quite the contrary, the effect should be reduced in comparison to a competition measure that considers only catholic schools. Taken together, the rather weak results for the alternative competition measures provide some support for treating the municipalities as separate education markets.

4.3 Alternative outcome variables

Two alternative outcomes of competition are considered in this section. When it comes to per-student spending, there is clearly no effect to be found.²⁰ More interesting results are

²⁰The only significant effect is found for the distance measure. The farther the nearest catholic school is away, the more money non-catholic schools spend per student. Since the distance measure did not have an effect on exam grades, an interpretation of this result is hard to come up with. In addition, the per

Table 8: OTHER MEASURES OF COMPETITION.

	(1)	(2)		
	(Partly) catholic		Roman-catholic	
<i>OLS estimates</i>				
Cath. schools w/in 15km	0.075**	(0.037)		
km to nearest catholic school	0.004	(0.021)		
Roman-cath. schools w/in 15km			0.075	(0.047)
km to nearest rom.-cath. school			-0.007	(0.008)
Herfindahl enrolment	-0.685	(0.572)	-0.385	(0.535)
<i>2SLS estimates</i>				
Cath. schools w/in 15km	0.137*	(0.075)		
km to nearest catholic school	-0.057	(0.038)		
Roman-cath. schools w/in 15km			0.079	(0.082)
km to nearest rom.-cath. school			-0.011	(0.015)
Herfindahl enrolment	-1.719*	(1.020)	-0.774	(1.068)

OLS estimates in upper half, second stage 2SLS estimates in bottom part of table. Instruments are the number of catholics in the municipality and its square. All schools that are at least in part catholic schools count towards the competition variable in column (1), whereas only roman-catholic schools are considered in column (2). Control variables are as in column (3) of the baseline OLS tables 3 and 4. Standard errors in parentheses allow for clustering on the municipality (gemeente) level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

obtained for the effect of competition on grade inflation. As stated above, theory suggests that under competitive pressure, schools will tend to award higher *schoolexamen*-grades in order to attract students. Somewhat puzzling is the fact that OLS results show that higher levels of competition actually induce lower levels of grade inflation.²¹ The magnitude of the effect is similar to the effect on central grades: a one standard deviation shift in competition lowers grade inflation by 0.1 standard deviations. In light of the finding that competition increases the central exam grades, this means that obviously schools do not react to competition by inflating local school grades by the same amount.

This section so far has provided some tentative evidence that competition may not be so detrimental after all, not even when it comes to grade inflation.

5 Distributional Analysis – QR and IVQR

Whenever competition in the education sector is discussed, a major concern is that the consequences of choice may be very different at different points of the achievement distribution. Specifically, it is often argued, that the best schools will be able to lure the most able students away from the badly performing schools. When this is the case, positive effects of competition on the mean school may still be observed, that is, the average effect of competition may be beneficial. At the same time, it may be the case that the effects of

student spending data is available for only roughly half of the schools.

²¹2SLS results are not reported, since Hausman tests again fail to reject exogeneity of the competition variable.

Table 9: ALTERNATIVE OUTCOME MEASURES.

	(1) (Partly) catholic	(2) Roman-catholic
<i>catholic competition, effect on grade inflation</i>		
Number of catholic schools in muni.	-0.1695* (0.0899)	
Number of rom.-cath. schools in muni.		-0.1601* (0.0952)
<i>N</i>	542	616
<i>catholic competition, effect on per student spending</i>		
Number of catholic schools in muni.	-1.8138 (46.3016)	
Number of rom.-cath. schools in muni.		16.1708 (61.8937)
<i>N</i>	252	288

estimates of the effect of 'number of catholic/roman-catholic schools in municipality' on grade inflation and per student spending. Control variables are as in column (3) of the baseline OLS tables 3 and 4. Standard errors in parentheses allow for clustering by municipality.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

competition are actually negative for the underachieving schools because they lose their most able students to the 'elite' schools at the upper tail of the achievement distribution for whom the effects of competition would then be positive. Thus, the results presented in the previous section are misleading, whenever the effect varies across the distribution. A tool that is very useful in this context is quantile regression (QR), as proposed by Koenker and Bassett (1978). In general notation, it allows the calculation of the τ -th quantile of a dependent variable Y given the independent variables X by solving:

$$\boldsymbol{\beta}(\tau) = \arg \min_{\boldsymbol{\beta}} E[\rho_{\tau}(Y - \mathbf{X}\boldsymbol{\beta})], \quad (5)$$

where ρ_{τ} is the 'check function' or 'loss function' given by:

$$\rho_{\tau}(\varepsilon) = [\tau - 1(\varepsilon < 0)]\varepsilon, \quad (6)$$

and $\varepsilon = (Y - \mathbf{X}\boldsymbol{\beta})$. The check function thus generates asymmetrically weighted absolute residuals. The $\boldsymbol{\beta}$ that minimizes equation (5) contains the parameters of interest for quantile τ .

A quantile regression in the context of this paper can be written in the form of a random coefficients model. The effect of competition on academic achievement in the presence of heterogeneous effects across the distribution of the outcome variable can then be represented by the following estimation equation:

$$G_{ij} = \alpha(U)C_{ij} + \mathbf{X}_i\boldsymbol{\beta}(U) + \mathbf{Z}_j\boldsymbol{\delta}(U) + \varepsilon_{ij}(U), \quad (7)$$

where – as defined earlier in the paper – G_{ij} are academic outcomes, C_{ij} is the measure of competition and \mathbf{X}_i as well as \mathbf{Z}_j are vectors of control variables.²² In the spirit of Doksum (1974), the rank term U can be interpreted as unobserved, innate ability or proneness (in this context, e.g. proneness to learn). Unobserved ability is normalized to be uniformly distributed and thus represent the rank of the individuals when it comes to ability: $U|C, \mathbf{X}_i, \mathbf{Z}_j \sim \text{Uniform}(0, 1)$. Individuals with the same observable characteristics will exhibit heterogenous outcomes whenever their rank in U differs. The use of QR can thus be interpreted as accounting for unobserved heterogeneity.

While QR has become increasingly popular in the recent past (perhaps due to its now wide availability in commonly used statistics packages), conventional QR suffers from the same problems as OLS whenever endogeneity is present. That is, equation (7) gives unbiased results only if competition is not determined together with U . As has been laid out earlier, it is not unlikely that C_{ij} may be statistically dependent on U . This means that even though in the previous sections of this paper, 2SLS estimates did not point to any endogeneity issues at the mean, things may be different at other quantiles. As endogeneity problems can be countered through the use of instrumental variables in regular OLS situations, intuitively the question of whether IV methods can be applied to QR comes to mind. Indeed, a method of coping with endogeneity in the context of QR has been suggested and further developed by Chernozhukov and Hansen (2005, 2006, 2007 and 2008) and has been dubbed instrumental variable quantile regression or inverse quantile regression (IVQR).²³

Again using the random coefficients model from equation (7), the assumptions underlying the IVQR model are:

- (a1) $\alpha(U)C_{ij} + \mathbf{X}_i\boldsymbol{\beta}(U) + \mathbf{Z}_j\boldsymbol{\delta}(U)$ is strictly increasing in U .
- (a2) $U|\mathbf{X}_i, \mathbf{Z}_j, \mathbf{I}_{ij} \sim \text{Uniform}(0, 1)$. U is independent of $\mathbf{X}_i, \mathbf{Z}_j$ and the instruments \mathbf{I}_{ij} which are excluded from the structural equation (7) (where \mathbf{I} consists of at least as many instruments as there are endogenous variables, $\dim(\mathbf{I}) \geq \dim(C)$). In what follows, it is possible to plug in the instruments themselves into the regressions. Alternatively, one can run a 'first stage', where similar to 2SLS, the endogenous variable is linearly projected onto the exogenous variables plus the excluded instruments. The predicted values of the endogenous variable then make up \mathbf{I}_{ij} . The latter approach is chosen for the estimations in this paper.
- (a3) Rank invariance or rank similarity: Under each realization of the endogenous variable C_{ij} , an observation's rank would stay the same or change only in terms of

²²The corresponding fixed coefficients model with additive disturbances can be written as: $G_{ij} = \alpha C_{ij} + \mathbf{X}_i\boldsymbol{\beta} + \mathbf{Z}_j\boldsymbol{\delta} + \varepsilon_{ij}(U)$.

²³IVQR has not yet been implemented in any statistics packages, yet the MATLAB code is kindly provided by Chris Hansen on his website.

random slippages.

From the structural equation (7) and the monotonicity assumption (a1) it can be seen that $G_{ij} \leq \alpha(\tau)C_{ij} + \mathbf{X}_i\boldsymbol{\beta}(\tau) + \mathbf{Z}_j\boldsymbol{\delta}(\tau)$ is equivalent to $U \leq \tau$ where τ denotes the quantile of interest. Considering (a1) and (a2), it then follows that

$$P[G_{ij} \leq Q_G(\tau|C_{ij}, \mathbf{X}_i, \mathbf{Z}_j)|\mathbf{X}_i, \mathbf{Z}_j, \mathbf{I}_{ij}] = \tau,^{24} \quad (8)$$

which is equivalent to

$$P[G_{ij} \leq \alpha(\tau)C_{ij} + \mathbf{X}_i\boldsymbol{\beta}(\tau) + \mathbf{Z}_j\boldsymbol{\delta}(\tau)|\mathbf{X}_i, \mathbf{Z}_j, \mathbf{I}_{ij}] = \tau. \quad (9)$$

This moment condition is what Chernozhukov and Hansen (2005, 2006) call the main implication of the model. Equation (9) essentially states that the τ -th quantile of the random variable $G_{ij} - \alpha(\tau)C_{ij} - \mathbf{X}_i\boldsymbol{\beta}(\tau) - \mathbf{Z}_j\boldsymbol{\delta}(\tau)$ given $\mathbf{X}_i, \mathbf{Z}_j, \mathbf{I}_{ij}$ is equal to zero.

The coefficients $\boldsymbol{\beta}^*$, $\boldsymbol{\delta}^*$ and most importantly γ should then equal zero in the following quantile regression:

$$G_{ij} - \alpha(\tau)C_{ij} - \mathbf{X}_i\boldsymbol{\beta}(\tau) - \mathbf{Z}_j\boldsymbol{\delta}(\tau) = \mathbf{X}_i\boldsymbol{\beta}^*(\tau) + \mathbf{Z}_j\boldsymbol{\delta}^*(\tau) + \mathbf{I}_{ij}\gamma(\tau), \quad (10)$$

Since $\alpha(\tau)$ in equation (10) is unknown, an $\hat{\alpha}(\tau)$ must be chosen so that it minimizes the distance of γ from zero. For a finite sample size n this can be evaluated using a Wald statistic $W_n(\alpha)$ and the coefficient $\hat{\alpha}(\tau)$ can be chosen accordingly:

$$\hat{\alpha}(\tau) = \arg \inf_{\alpha \in \mathcal{A}} W_n(\alpha), \quad (11)$$

where

$$(\hat{\boldsymbol{\beta}}(\alpha, \tau), \hat{\boldsymbol{\delta}}(\alpha, \tau), \hat{\gamma}(\alpha, \tau)) = \arg \inf_{(\boldsymbol{\beta}, \boldsymbol{\delta}, \gamma)} Q_{G,n}(\tau, \alpha, \boldsymbol{\beta}, \boldsymbol{\delta}, \gamma) \quad (12)$$

and \mathcal{A} is a grid of potential values for α , $W_n(\alpha) = n(\hat{\gamma}(\alpha, \tau))' \widehat{M}(\alpha)(\hat{\gamma}(\alpha, \tau))$ and $M(\alpha)$ is

²⁴The conditional quantiles $Q_G(\tau|C_{ij}, \mathbf{X}_i, \mathbf{Z}_j) = \alpha(\tau)C_{ij} + \mathbf{X}_i\boldsymbol{\beta}(\tau) + \mathbf{Z}_j\boldsymbol{\delta}(\tau)$ of the structural QR equation suffer from endogeneity bias. Thus, Chernozhukov and Hansen (2008) define the structural quantile function (SQF) as $S_G(\tau|c_{ij}, \mathbf{x}_i, \mathbf{z}_j) = \alpha(\tau)c_{ij} + \mathbf{x}_i\boldsymbol{\beta}(\tau) + \mathbf{z}_j\boldsymbol{\delta}(\tau)$, where the lowercase variables denote realizations of the random variables defined above. The SQF gives the latent outcome G_{ij} when the endogenous variable C_{ij} is fixed at a certain level and the disturbance is sampled independent of C_{ij} . Because of the endogeneity of competition, the SQF is a different function than the regular conditional quantile function $Q_G(\tau|C_{ij}, \mathbf{X}_i, \mathbf{Z}_j)$ that can be derived analogous to equation (5). In the presence of endogeneity however, $S_G(\tau|c_{ij}, \mathbf{x}_i, \mathbf{z}_j)$ cannot be directly estimated via a QR because the outcomes are latent, however the use of suitable instruments can overcome this limitation. In order to keep the notation simple, we will not discriminate between Q_G and S_G .

the inverse of the asymptotic variance $\sqrt{n}(\widehat{\gamma}(\tau) - \gamma(\tau))$. $W_n(\alpha)$ then becomes the Wald statistic for testing $\gamma(\alpha, \tau) = 0$. Estimates for the parameters can then be written as $(\widehat{\alpha}(\tau), \widehat{\beta}(\tau), \widehat{\delta}(\tau)) = (\widehat{\alpha}(\tau), \widehat{\beta}(\widehat{\alpha}(\tau), \tau), \widehat{\delta}(\widehat{\alpha}(\tau), \tau))$.

To find a practical way of estimating the IVQR model, consider that equation (10) can be stated as:

$$G_{ij} - \alpha(\tau)C_{ij} = \mathbf{X}_i(\boldsymbol{\beta}(\tau) + \boldsymbol{\beta}^*(\tau)) + \mathbf{Z}_j(\boldsymbol{\delta}(\tau) + \boldsymbol{\delta}^*(\tau)) + \mathbf{I}_{ij}\gamma(\tau), \quad (13)$$

with $(\boldsymbol{\beta}(\tau) + \boldsymbol{\beta}^*(\tau)) = \boldsymbol{\beta}(\tau)$ and $(\boldsymbol{\delta}(\tau) + \boldsymbol{\delta}^*(\tau)) = \boldsymbol{\delta}(\tau)$. In practice, the first step of IVQR consists of running the τ -quantile regression of $G_{ij} - \alpha C_{ij}$ on $\mathbf{X}_i, \mathbf{Z}_j$ and \mathbf{I}_{ij} for a given grid of values of α , thus obtaining the coefficients $\boldsymbol{\beta}(\alpha, \tau), \boldsymbol{\delta}(\alpha, \tau)$ and $\gamma(\alpha, \tau)$. In a second step, the $\widehat{\alpha}(\tau)$ is chosen which minimizes $W_n(\alpha)$. The coefficients of $\widehat{\beta}(\tau), \widehat{\delta}(\tau)$ are then implied by $\widehat{\beta}(\widehat{\alpha}(\tau), \tau), \widehat{\delta}(\widehat{\alpha}(\tau), \tau)$.

In what follows, estimates for the effect of competition on educational achievement and grade inflation are presented for the 5th to the 95th quantile (in steps of 5) using both QR and IVQR.

5.1 QR and IVQR estimates

The main results of both QR and IVQR are summarized in table 10 while figures 1 and 2 visualize the results.

The conventional QR results suggest that the effects of competition are positive for all schools except for those at the top of the grade distribution. These estimates are statistically significant for all but the 5th quantile and the top two deciles. Thus, contrary to what one might expect, it does not seem that the schools at the bottom of the grade distribution suffer from cream skimming by the schools at the top of the grade distribution and the IVQR results do nothing to change this impression. The IVQR estimates are mostly in the range of what QR suggests and – as is to be expected – standard errors are somewhat inflated.

From the QR results, competition seems to have the smallest restraining effect on grade inflation in the bottom part of the distribution of grade inflation. That is, schools which already practice little grade inflation²⁵ do not react to competition by raising their local grading standards. It is the middle part of the distribution, starting at the 35th quantile that seems to react to competition by actually increasing their local grading standards. Obviously, one would have hoped for schools at the top of the grade inflation distribution to raise their standards the most as a reaction to competition. Still, the result clearly points out that schools that already practice heavy grade inflation do not try and attract

²⁵While there are a few schools that award lower school grades than central exam grades, the 5th percentile already practices grade inflation.

students by further inflating their grades in response to competitive pressure. Once again, the IVQR results confirm the QR results.

6 Conclusion

This paper analyzed the effect of competition among secondary schools on achievement and grading standards in a setting that satisfies most of the criteria that are stipulated by school choice proponents. The Dutch empirical evidence is in line with theoretical predictions. Most of the empirical results support the notion of competition in the educational sector yielding beneficial results, i.e. leading to higher central exam scores while at the same time exerting a restraining effect on grade inflation. Competition in the Netherlands appears to be driven by catholic schools, while the availability of non-catholic alternatives doesn't seem to induce markedly higher educational attainment or lower levels of grade inflation.²⁶ No evidence of endogeneity of competition could be found and quantile regression results clear concerns that competition may be detrimental to schools at the bottom of the grade distribution.

The placebo regressions suggest that sorting by ability and consequently peer effects is not what's driving these results. Suppose that school choice leads to perfect segregation by ability, i.e. all high-ability students leave for a catholic competitor. Those students remaining in the public sector would then attain considerably lower grades than the former mixed-ability student population. Then, using only non-catholic grades as the outcome variable could lead to the assumption that competition leads to lower achievement when this market is compared to one where no segregation occurs for lack of alternatives. Even when a rich set of controls is used, one couldn't completely disentangle the effect of sorting from the impact of competition. From the OLS results one could then hypothesize that in the Netherlands, the less able students leave for catholic schools. From the placebo regression results it seems, however, that catholic schools are not affected by competition at all. Competition does not seem to affect catholic grades, thus the competition effect net of sorting is supposedly still positive.

The bottom line of this paper is that competition as measured by the availability of catholic schools in close proximity seems to have positive effects on educational achievement as well the setting of standards. The latter result runs counter the tempting assumption that competition leads to a deterioration of standards – a claim that we can now clearly discard, at least in the Dutch context. There is, however, a need to look deeper into the mechanisms that drive the setting of standards at the local level. Also, so far only competition in the pre-university branch of education has been considered. Hence, it will be interesting to see whether these effects carry over to the lower school branches.

²⁶Placebo regressions for the dependent variable grade inflation are not reported. Just as in the case of exam grades, they show no significant effects.

Table 10: QR AND IVQR COEFFICIENTS, COMPETITION VARIABLE CATHOLIC SCHOOLS IN MUNICIPALITY.

QUANTILE	CENTRAL EXAM GRADES				GRADE INFLATION			
	(QR)	(IVQR)	(QR)	(IVQR)	(QR)	(IVQR)	(QR)	(IVQR)
05	0.337	(0.210)	0.16	(0.278)	0.168	(0.222)	0.18	(0.290)
10	0.325*	(0.182)	0.32*	(0.184)	-0.028	(0.150)	0.24	(0.237)
15	0.360**	(0.152)	0.34	(0.285)	0.021	(0.129)	0.06	(0.191)
20	0.275**	(0.139)	0.40*	(0.212)	-0.105	(0.120)	-0.08	(0.137)
25	0.236*	(0.136)	0.33*	(0.181)	-0.070	(0.105)	-0.04	(0.116)
30	0.329**	(0.138)	0.42**	(0.163)	-0.082	(0.103)	-0.08	(0.118)
35	0.329**	(0.138)	0.40**	(0.173)	-0.219**	(0.096)	-0.22**	(0.097)
40	0.349**	(0.138)	0.36**	(0.178)	-0.263***	(0.092)	-0.23**	(0.097)
45	0.323***	(0.117)	0.25	(0.154)	-0.210**	(0.089)	-0.21**	(0.087)
50	0.345***	(0.105)	0.29**	(0.130)	-0.225**	(0.089)	-0.24**	(0.093)
55	0.354***	(0.101)	0.34***	(0.100)	-0.247***	(0.093)	-0.24**	(0.095)
60	0.308***	(0.100)	0.31***	(0.099)	-0.257***	(0.097)	-0.26**	(0.122)
65	0.287***	(0.104)	0.25**	(0.104)	-0.235**	(0.108)	-0.22	(0.145)
70	0.232**	(0.103)	0.25**	(0.106)	-0.276*	(0.150)	-0.28	(0.189)
75	0.245**	(0.110)	0.29**	(0.147)	-0.219	(0.166)	-0.27	(0.223)
80	0.130	(0.116)	0.12	(0.157)	-0.196	(0.161)	-0.20	(0.201)
85	0.137	(0.135)	0.12	(0.237)	-0.308*	(0.170)	-0.31	(0.213)
90	-0.057	(0.132)	-0.06	(0.230)	-0.223	(0.171)	-0.29	(0.459)
95	-0.050	(0.246)	-0.12	(0.413)	-0.064	(0.177)	-0.17	(0.344)

All schools that are at least in part catholic count towards the competition variable. The estimations thus represent the effect of (partly) catholic schools on those schools that are in no way affiliated with the catholic church. Only coefficients of the competition variable are displayed. Control variables are as in column (3) of the baseline OLS tables 3 and 4.
 * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

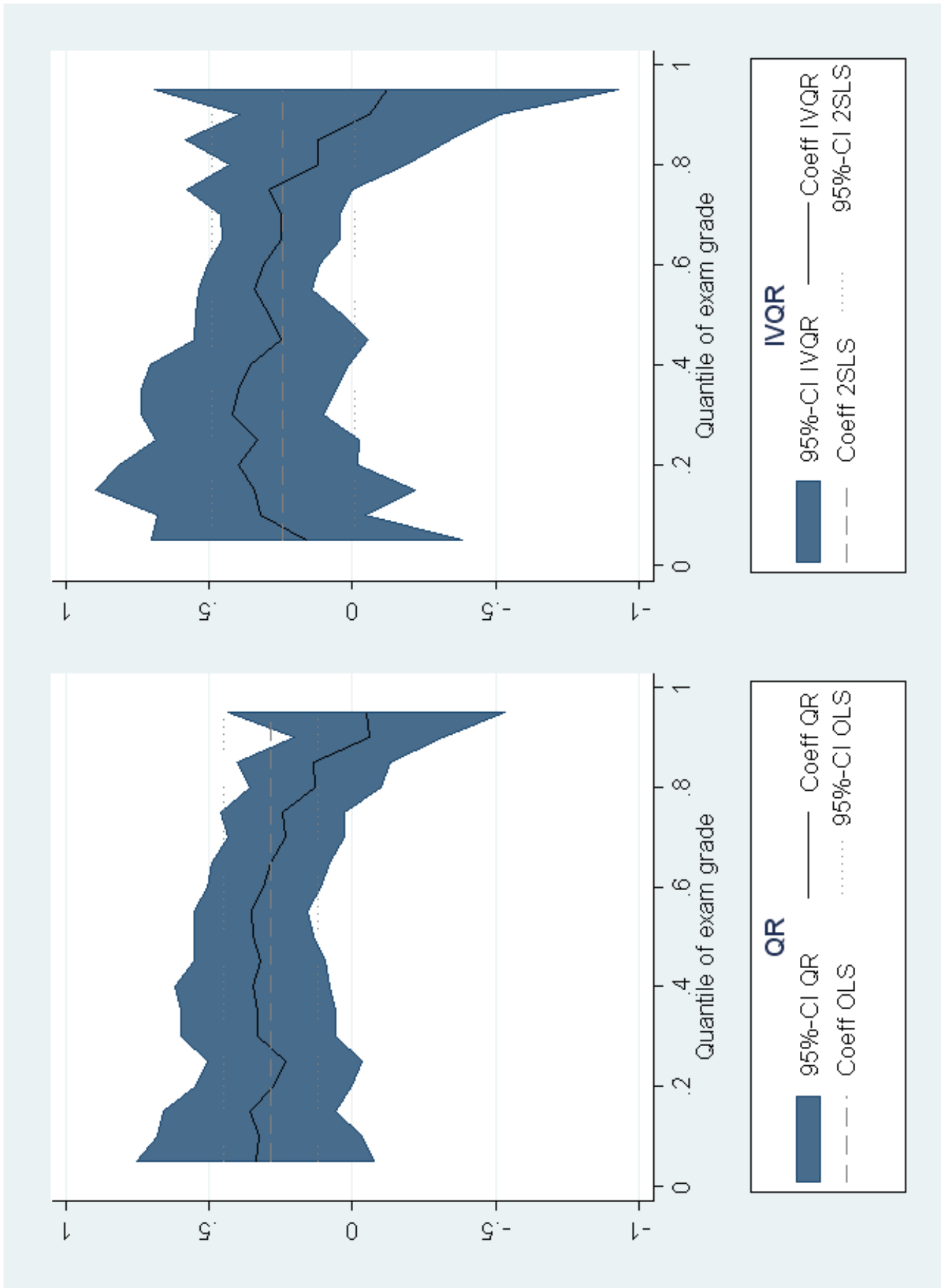


Figure 1: QR AND IVQR ESTIMATES, CENTRAL EXAM GRADES.

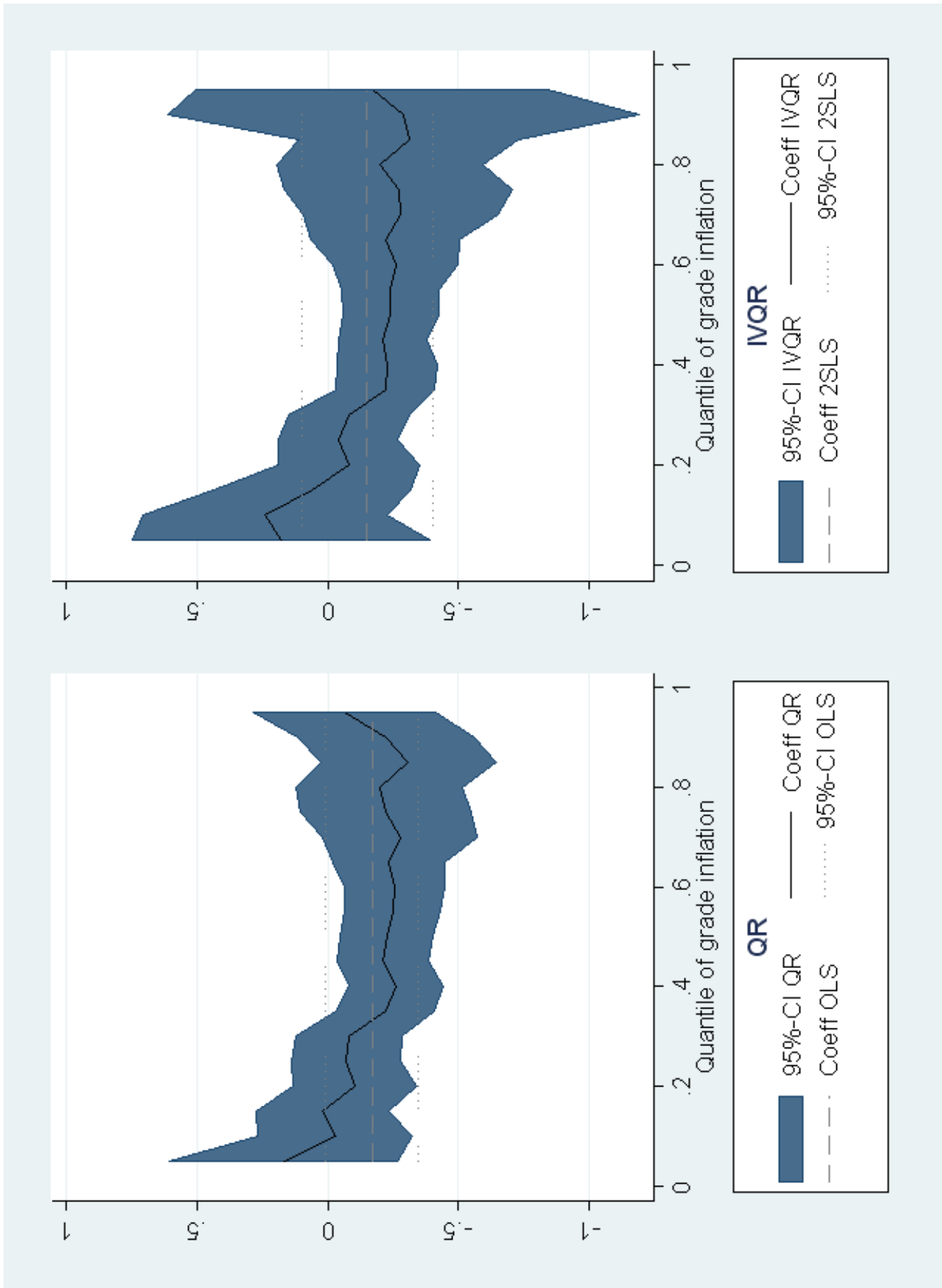


Figure 2: QR AND IVQR ESTIMATES, GRADE INFLATION.

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Appendix



ROTTERDAM, DEELGEMEENTEN. SHADED AREAS ARE THE ROTTERDAM BOROUGHS.
Source: Centrum voor Onderzoek en Statistiek, Rotterdam

Table A-1: SUMMARY STATISTICS, NON-CATHOLIC SCHOOLS.

	<i>N</i>	Mean	Std. Dev.	Min	Max
Above advice %	575	22.22	17.95	0	100.00
Half above advice %	575	37.98	24.11	0	100.00
Minority (cumi) students %	616	5.44	9.82	0	78.94
Study cost recipients %	615	28.07	11.33	8.67	100.00
Tracked in grade 1 %	591	34.32	34.59	0	100.00
Tracked in grade 2 %	584	61.14	36.21	0	100.00
Class size grade 1	597	25.28	2.64	16.00	32.00
Class size grade 2	587	25.22	2.65	11.00	31.00
Non-religious school dummy	639	0.65	0.47	0	1.00
Number of students VWO (1000s)	620	241.05	117.10	6.00	785.00
Number of students brin (1000s)	614	1849.83	1104.02	97.00	5697.00
Short term debt %	538	32.23	11.18	0	86.80
Long term debt %	538	3.36	7.20	0	54.30
Staff growth %	608	2.84	5.70	-25.50	30.50
Number of students growth %	608	1.88	5.02	-16.20	27.60
Part time staff %	608	37.59	9.73	15.90	69.00
Quality of life	639	0.03	1.07	-2.74	3.52
Average income (1000 Euro)	633	12.99	1.12	10.80	19.20
Population share school aged	638	17.67	1.82	13.90	24.00
Pop. density (1000/km ²)	638	2.04	1.59	0.05	5.67
Land area (km ²)	638	117.96	118.00	6.62	765.39
Number of catholics (1000s)	638	22.59	25.76	0.22	108.48

Table A-2: SUMMARY STATISTICS, NON ROMAN-CATHOLIC SCHOOLS.

	<i>N</i>	Mean	Std. Dev.	Min	Max
Above advice %	659	22.49	17.70	0	100.00
Half above advice %	659	38.16	24.03	0	100.00
Minority (cumi) students %	710	5.47	9.95	0	78.94
Study cost recipients %	708	28.18	11.77	8.67	100.00
Tracked in grade 1 %	683	33.74	34.13	0	100.00
Tracked in grade 2 %	675	61.31	35.90	0	100.00
Class size grade 1	689	25.24	2.66	16.00	32.00
Class size grade 2	678	25.20	2.62	11.00	301.00
Non-religious school dummy	733	0.57	0.49	0	1.00
Number of students VWO (1000s)	709	241.21	114.97	6.00	785.00
Number of students brin (1000s)	708	1857.34	1070.33	97.00	5697.00
Short term debt %	625	32.35	11.04	0	86.80
Long term debt %	625	3.49	7.50	0	54.30
Staff growth %	696	2.87	5.78	-25.50	30.50
Number of students growth %	700	1.86	5.14	-16.20	35.50
Part time staff %	696	37.31	9.55	15.90	69.00
Quality of life	733	0.06	1.08	-2.74	3.52
Average income (1000 Euro)	721	12.98	1.12	10.80	19.20
Population share school aged	729	17.72	1.87	13.90	24.10
Pop. density (1000/km ²)	729	1.99	1.58	0.05	5.67
Land area (km ²)	729	118.78	119.92	6.62	765.39
Number of catholics (1000s)	729	22.85	25.20	0.22	108.48

Table A-3: FIRST STAGE STATISTICS, ADDITIONAL INSTRUMENT.

	(1) (Partly) catholic		(2) Roman-catholic	
Catholics in municip. (1000s)	0.0921***	(0.0101)	0.0513***	(0.0170)
Cath in municip. squared	-0.0006***	(0.0001)	-0.0003	(0.0002)
Road network (km)	0.0007***	(0.0002)	0.0008*	(0.0004)
F-test excluded instr.	F(3,140)=47.84 p=0.000		F(3,153)=14.96 p=0.000	
partial R^2 excluded instr.	0.63		0.43	
R^2	0.83		0.66	
N	542		616	

Estimates are for 1st stage of 2SLS. Number of schools is the dependent variable of 1st stage. Estimates shown for the excluded instruments only. Control variables are as in column (3) of the baseline OLS tables 3 and 4. Standard errors in parentheses allow for clustering by municipality.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A-4: 2SLS CENTRAL EXAM, ADD'L INSTRUMENT

	(1) (Partly) catholic		(2) Roman-catholic	
(Partly) catholic schools	0.2459*	(0.133)		
Roman catholic schools			0.1961	(0.166)
Above advice %	-0.0456***	(0.011)	-0.0474***	(0.010)
Half above advice %	-0.0136*	(0.008)	-0.0156**	(0.008)
Minority (cumi) students %	-0.0832***	(0.020)	-0.0923***	(0.017)
Study cost recipients %	-0.0384**	(0.019)	-0.0288	(0.018)
Tracked in grade 1 %	0.0111**	(0.004)	0.0083*	(0.004)
Tracked in grade 2 %	-0.0007	(0.004)	0.0002	(0.004)
Class size grade 1	0.1465***	(0.047)	0.1403***	(0.045)
Class size grade 2	-0.0101	(0.050)	-0.0230	(0.052)
Non-religious school dummy	-0.6703**	(0.266)	-0.4265*	(0.244)
Number of students VWO (1000s)	0.0379	(1.198)	0.0492	(1.266)
Number of students brin (1000s)	-0.0052	(0.120)	-0.0123	(0.118)
Quality of life	-0.0759	(0.146)	-0.1402	(0.140)
Average income (1000 Euro)	-0.1819	(0.139)	-0.2497*	(0.135)
Population share school aged	0.0754	(0.076)	0.0607	(0.064)
Pop. density (1000/km ²)	-0.0516	(0.095)	0.0165	(0.085)
Land area (km ²)	-0.0008	(0.001)	-0.0001	(0.001)
Year 2003	0.4062***	(0.137)	0.3877***	(0.136)
Intercept	64.3431	(2.761)	65.6149	(2.658)
N	542		616	
adj. R^2	0.325		0.306	
test of overid. restr. $\chi^2(2)$	0.016	($p = 0.992$)	0.548	($p = 0.760$)

Second stage estimates, instruments are the number of catholics in the municipality and its square and the length of the road network in the municipality. All schools that are at least in part catholic schools count towards the competition variable in column (1), whereas only roman-catholic schools are considered in column (2). Control variables are as in column (3) of the baseline OLS tables 3 and 4. Standard errors in parentheses allow for clustering on the municipality (gemeente) level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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