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The effects of competition on the quality of primary schools in the Netherlands

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Abstract in English

We investigate the impact of competition between primary schools on the quality of education in the Netherlands. Do schools facing more competition in their neighbourhood perform better than schools facing less competition? As a measure of school quality, we look at the performance of pupils at the nationwide standard test (the so-called Cito test) in the final year of primary education. Since competition is likely to be endogenous to the quality of schools, we use the distance between the school and the town centre as an instrument for the level of competition faced by a school. The intuition is that schools located close to the town centre, which are easily accessible to a large number of parents, face more competition than schools located further away from the town centre. Using a large range of data on pupil, school and market characteristics, we find that school competition has a small positive significant effect on pupil achievement. An increase in competition by one standard deviation (comparable to 5 additional schools in the market) increases pupil achievement at the Cito test by five to ten percent of the mean standard deviation, so about less than one point. This result is robust to a large range of specifications.

Key words: Education, competition, primary schools, pupil achievement.
JEL code: I20, H70, R5.

Abstract in Dutch

Deze studie onderzoekt het effect van concurrentie tussen basisscholen op de kwaliteit van het onderwijs. Zijn de prestaties van scholen die te maken hebben met meer concurrenten in hun nabije omgeving, hoger dan de prestaties van scholen die minder concurrentie ervaren? Als indicator voor de prestaties van scholen kijken we naar de gemiddelde scores van leerlingen bij de Cito-toets. Om voor potentiële endogeniteit van concurrentie te corrigeren, gebruiken we de afstand tussen de school en het stadscentrum als instrument voor het niveau van de concurrentie die scholen ervaren. De intuïtie is dat scholen die dicht bij het stadscentrum liggen - en die dus goed bereikbaar zijn voor een groot aantal leerlingen - meer concurrentie ervaren dan scholen die ver van het stadscentrum liggen. Gebruik makend van een groot aantal data op leerling-, school- en marktniveau, vinden we dat de concurrentie tussen scholen een klein significant positief effect op de prestaties van leerlingen heeft. Een toename van concurrentie met een standaarddeviatie (vergelijkbaar met 5 extra scholen in de markt) leidt tot een verhoging van de Cito-scores met 5 tot 10% van de gemiddelde standaarddeviatie, dat wil zeggen circa minder dan 1 punt. Dit resultaat is robuust met een groot aantal specificaties.

Steekwoorden: Onderwijs, concurrentie, primair onderwijs, Cito-toets.

Contents

Summary

The objective of the current paper is to investigate the impact of school competition on the quality of Dutch primary schools, as measured by educational outcomes. Our research question is: do schools facing high level of competition in their neighbourhood perform better than schools facing less competition?

There is a very extensive literature on the effect of school competition on educational outcomes, mainly in the U.S. and more recently in the U.K. (Hoxby, 2000; Belfield and Levin, 2003; Gibbons et al., 2008). Overall, the results from this literature are mixed. While some studies find a positive link between competition and educational outcomes, estimates in many other studies lack statistical significance. Our paper contributes to this literature by providing new evidence on the link between competition and educational achievement for the Netherlands, a country with a long tradition of free school choice.

We define geographical markets for school competition by assuming that a school competes with all other schools located within a radius of 1.5 km around the school. This is in line with the evidence that the average distance that pupils travel to go to school in the Netherlands is rather small, about 1.26 km according to data from van der Houwen et al. (2004). Since 90% of children live less than 1 km away from a school and only 1% live further away than 3 km from a school (Statistics Netherlands, 2008), pupils in primary education are not likely to travel long journeys to go to school. Within each school competition market, we construct two competition indexes: 1) the number of alternative schools and 2) the (inverted) Herfindhal index.

We estimate the effect of school competition on educational outcomes, measured by the scores of pupils at the nationwide standard test in the final year of primary education (the so-called Cito test). We obtained data on the Cito test for all pupils in the Netherlands over the 1999-2003 period from the Cito organization. Next to competition, we correct for a large range of pupil, school, and neighbourhood characteristics that also affect the performance of pupils. Data on school characteristics, such as the composition of the pupils' population, size of schools, denomination, etc., were collected from the Inspectorate for Education. Demographic data on geographical markets, e.g. town size and urbanization level and the age and income distribution of population, were obtained from Statistics Netherlands. After restricting our sample to towns of more than 20,000 inhabitants, we are left with a sample of about 6,000 school competition markets per year over the 1999-2003 period, covering about 60% of all pupils.

On methodological grounds, we use an instrumental variable (IV) estimation procedure to account for potential endogeneity of the competition variable. Indeed, a correlation between competition and the quality of schools does not necessarily imply a causal link. Competition may endogenous to the quality of schools in the market if for instance parents tend to crowd out around high-quality schools. As high-quality schools grow larger, this reduces the apparent level of competition in the market. Due to potential endogenous competition, estimates in a

simple OLS regression analysis will be biased. To correct for this effect, we use the distance between the school and the town centre as an instrument for school competition. The intuition is that schools located at the periphery of a town tend to face less competition than schools located close to the town centre. This is because parents living at the town periphery are on average more likely to bring their children to the nearest school in their neighbourhood since choosing another school than the nearest one would imply higher travel costs. This instrumental strategy follows closely the work by Gibbons et al. (2008), who use the distance between the school and the boundary of the educational market as an instrument for competition. Assessing the performance of our IV strategy reveals that this distance measure is a good instrument for the level of competition in the market.

We find evidence of a small significant positive link between competition and pupil achievement both in an OLS and IV framework. Estimates tend to be larger in the IV framework. Our IV estimates show that an increase in one standard deviation in competition (comparable with 5 additional schools in the market) leads to an increase of 5-10% of a standard deviation in the Cito score, so about less than 1 point. Said in another way, if a school has 5 more competing schools in its neighbourhood than another one (for instance 3 compared to 8 schools), pupils in this school will gain on average about 1 extra point at the Cito score. To put this in perspective, the Cito score varies from 500 to 550 points, with a national average of 535 points and a standard deviation of 10 points. Gains on pupil achievement are thus very modest, a result commonly found in the international literature. This result is robust to a large range of specifications.

Why do the effects of competition on pupil achievement tend to be so small? A possible explanation is that parents lack information about the quality of schools, reducing the incentives for schools to compete. In this case, policies aiming to increase transparency on school performance might have beneficial effects on the quality of education. Another possibility is that parents' choice for a school might be driven by other attributes (e.g. school activities, maintenance of buildings) than by pupil achievement. In that case, schools might be competing on other aspects than the Cito scores to attract pupils. Finally, it could also be that schools have only limited possibilities to increase educational outcomes. At last, since the Netherlands have a long tradition and a high level of school competition, gains from further additional competition may be very limited. Future research should provide a better understanding of these mechanisms.

Although small, the gains from competition are not negligible. Indeed, even small increases in pupil achievement can have important impacts in the long-term (Jamison et al., 2007). Several studies show for instance that even a small increase in pupil achievement may have a large impact on future earnings of pupils and economic growth (Mulligan, 1999; Murnane et al., 2003; Hanushek and Kimko, 2000).

1 Introduction[1]

In recent years, many countries have shown interest in public policies aiming to increase competition in education. These policies are motivated by the standard economic argument that more competition would provide an incentive for schools to improve quality. To the extent that parents choose for the best quality schools and that schools benefit from an increase in enrolment – for instance through higher funding – schools will attempt to improve quality in order to retain and attract pupils.

The objective of the current paper is to investigate the impact of school competition on the quality of Dutch primary schools, as measured by educational outcomes. Our research question is: do schools facing high level of competition in their neighbourhood perform better than schools facing less competition? The Netherlands stands out as one of the few countries with a very large freedom of school choice. Freedom of education is even laid down in the Dutch Constitution (Art. 23). In contrast with the U.S. and most European education markets, parents in the Netherlands can send their children to all public or private schools of their choice without financial penalty or geographical restrictions. In addition, there is a trend in recent years towards more accountability and transparency on the quality of Dutch schools. Since recently the Inspectorate of Education publishes quality assessments for all Dutch primary schools on its website. Nevertheless, despite free school choice and increasing transparency, little is known about the effect of school competition on the quality of education in the Netherlands. In parallel, there are recent concerns that the development of very large school boards in primary education might deter competition and thus reduce gains on pupil achievements (Education Council of the Netherlands, 2008).

There is a very extensive literature on the effects of school competition on educational outcomes, mainly in the U.S. and more recently in the U.K (Hoxby, 2000; Belfield and Levin, 2003; Gibbons et al., 2008). Overall, the results from this literature are mixed. While some studies find a positive link between competition and educational outcomes, estimates in many other studies lack statistical significance. A crucial issue when measuring the effect of school competition on quality is the endogeneity problem. Parents choose to live close to high-quality schools and these schools will in general attract most pupils. As high-quality schools grow larger, they may appear more and more monopolistic in the market. As a result, the level of competition in the market is endogenously related to the quality of schools. On methodological grounds, the literature is divided between two strands. One strand in the literature evaluates policies aiming to extend school choice and the impact of these reforms on educational outcomes. The effects are then compared with a control group or counterfactual not affected by

[1] We thank Bas van der Klaauw (VU Amsterdam), Maarten Cornet (Ministry of Finance), André de Moor, Geert de Boer (Ministry of Education, Culture and Science), Judith Post (Ministry of Economic Affairs), Ib Waterreus (Education Council of the Netherlands), Paul de Bijl, Pierre Koning, Dinand Webbink and Bas ter Weel, (CPB), as well as participants of seminars given at the ZEW in Manheim, University of Groningen and at the CPB for many valuable comments.

the policy.[2] Because these policy reforms are localised, it is often difficult to generalise these results to other educational markets. Holmes et al. (2003) investigate how the introduction of school choice in North Carolina, via an increase in the number of charter[3] schools both temporally and geographically, affects the performance of traditional public schools measured by standard performance tests. The results of the paper imply an approximate one percent increase in achievement when a traditional school faces competition from a charter school. The increase represents approximately one quarter of the mean standard deviation of observed gains, suggesting a considerable return to school choice. Hsieh and Urquiola (2003) analyze the effect of the school reform in Chile in 1981 on educational outcomes. By providing vouchers to any student wishing to attend private schools, Chile expanded school choice of prospective pupils. Using OLS and IV estimation approaches, the authors find no evidence that choice improved average educational outcomes. However, they do find evidence that the reform led to increased sorting (cream-skimming), as the 'best' public school students left for the private sector.

Our paper is connected to the second strand in the literature, which studies the effects of implicit variation in the level of school competition in a cross-section of markets. The main challenge of these studies is to establish a causal link – net of other effects – between pupil achievement and school competition, i.e., to circumvent the problem of endogeneity between competition and educational performance.[4] Belfield and Levin (2003) review the cross-sectional research evidence on the effects of competition on education outcomes. Looking at 41 empirical studies in the U.S., they find that a majority of the studies show positive statistically significant impacts of competition on educational outcomes. Although negative correlations are rare, a large number of estimates lack statistical significance. Overall, they conclude that, if any, the gains from competition tend to be very modest: a one standard deviation increase in competition measured by the Herfindhal index or the enrolment rate at an alternative school increases test scores by approximately 10% of a standard deviation.[5] Hoxby (2000) analyses the effect of the level of choice (Tiebout choice) available in different school markets, on schools' productivity and sorting of students. Using an instrumental variable approach, where instruments are derived from the natural boundaries (rivers and streams), she concludes that "metropolitan areas with greater choice have more productive public schools and less private schooling". IV estimation results show that student achievement is higher when there is more choice among districts. An

[2] Since choice extension may not be randomly assigned across markets, the main issue in these studies is to correct for potential endogenous location of the new schools.

[3] In the United States, charter schools are publicly funded schools permitted to operate autonomously and free from many of the regulations other public schools must follow. In return for this flexibility, the school is accountable for achieving certain goals, notably regarding pupil achievement.

[4] Typically, estimation techniques using instrumental variables are preferred over ordinary least squares estimations as being more 'methodologically sound' since they explicitly address the issue of endogenous competition. In turn, however, the reliability of IV estimates highly depends on the quality of the instrument.

[5] Within the cross-sectional studies mentioned by Belfield and Levin (2003) a large range of U.S. studies look at whether competition by private schools lead to an increase in educational attainment within public schools. Most of these studies also rely on IV estimation techniques using the share of Catholics in the population as an instrument for local private enrolment (Hoxby, 1994; Dee, 1998; Sander, 1999; Jepsen, 2002)

increase from 0 to 1 in the index of Tiebout choice generates reading scores that are 3.8 to 5.8 points higher and math scores that are 2.7 to 3.1 points higher. It means that test scores rise by one-quarter to one-half of a standard deviation. Rothstein (2007) criticized the results of Hoxby on the grounds that her approach to measuring rivers and streams was very imprecise, i.e., that the instrument used is weak. When Rothstein applies alternative constructions of the same variables, he obtains smaller estimates that are never significant.

Looking at data for England, Gibbons et al. (2008) empirically analyse the causality between school choice and school competition on the performance of schools, focusing on the gain in pupil's educational attainment on reading, English, and mathematics test scores from age 6/7 to age 10/11. The authors apply OLS and IV estimation approaches, where they generate instruments for choice and competition in terms of distance from the educational market boundary.[6] OLS estimates show that pupils in schools facing more competition seem to do marginally better, but the impact of pupil's choice availability is more varied. IV estimates show no evidence of more choice or more competition among schools improving pupil's attainment. They also find that it is only in 'majority controlled' schools, i.e. schools owned by a foundation or charitable institution which has majority representation in the school governing body, that competition is causally linked to school performance. For these schools the effect is relatively large: one extra school increases the value added by 20% of a standard deviation. According to Gibbons et al. (2008) this could be explained by the fact that these schools have more freedom and flexibility in their management practices and teaching methods.

Our paper contributes to this literature by providing new evidence on the link between competition and educational achievement for the Netherlands, a country with a long tradition of free school choice.[7] We define geographical markets for school competition and estimate the effect of competition on pupil performance measured by standard test-scores at the end of primary school (the so-called Cito test). We obtained data on the Cito test for all pupils in the Netherlands over the 1999-2003 period from the Cito organization, the company in charge of educational assessments in the Netherlands. In addition, we also collected data on a large range of pupil, school, and neighbourhood characteristics. In order to correct for the endogeneity of our competition variable, we use the distance between the school and the town centre as an instrument for school competition. The intuition is that schools located close to the town centre face more competition than schools located at the boundary of the town because schools located close to the town centre are accessible to a larger number of pupils. Assessing the performance of our IV strategy reveals that this distance measure is a good instrument for the level of competition in the market. This instrumental strategy is closely related to the work by Gibbons et al. (2008), who use the distance between the school and the boundary of the educational market as an instrument for competition in the school market in England.

[6] In the U.K. educational markets are defined within the boundaries of a Local Education Authority (LEA). A LEA is a local council which is responsible for education within a certain geographical domain.

[7] To our knowledge, the only other paper that looks at the effects of competition on school quality is Dijkgraaf et al. (2008). Their paper differs from ours since they focus on secondary education and only conduct OLS estimations.

Our empirical results suggest that pupils enrolled in schools facing more competition in their neighbourhood perform better than pupils in schools facing less competition. We find evidence of a small positive link between competition and pupil achievement both in OLS and IV frameworks, although the estimates are larger in the IV approach, a result commonly found in the literature. A one standard deviation increase in competition leads to an increase of 5-10% of the mean standard deviation of the Cito score (so less than 1 point). This result is robust to a large range of different specifications.

The paper is organised as follows. Section 2 describes the education system in the Netherlands. Section 3 presents the main methodological issues and our empirical strategy. Section 4 describes the data and sample construction. Section 5 presents our main results on the effects of competition on the Cito scores and some robustness checks. Section 6 concludes.

2 School choice and competition in Dutch primary schools

There are about 7,000 primary schools in the Netherlands. Education is compulsory at age 5 and older, but most parents send their children to school at age 4. Primary education consists of mainstream primary education (BAO), special primary education (SBAO) and (advanced) special education (SO) for children with learning and behavioural difficulties and children with learning disabilities. In the remainder of this study, we only focus on mainstream primary education, as special education represents a specific market.

Dutch education distinguishes two systems: the public schools and the publicly-funded private schools. Private schools are inspired by a religion or a philosophy. In private education a distinction is made between Protestant, Roman Catholic schools, and other private institutions. This last category includes schools with a specific educational concept (anthroposophist, Montessori, "Free Schools," etc.), as well as some special religious schools (Jewish, Islamite). The evolution of the shares of each type of schools into Dutch primary education is given in Table 2.1. All religious groups and other groups representing certain philosophies of life - called 'denomination' - are free to start their own school and are, up to minimum standards, free to decide about didactics of the school. If there are a sufficient number of parents in a community who want to send their children to a public school, they can force the local government to start one.

Table 2.1 General education, type of institution

	1990/1991		1994/1995		2004/2005		2007/2008	
	# of schools	%	# of schools	%	# of schools	%	# of schools	%
Total denomination	8,450	100	7,860	100	6,986	100	6,913	100
Public	2,961	35	2,686	34	2,317	33	2,277	33
Protestant	2,545	30	2,365	30	2,092	30	2,079	30
Roman Catholic	2,483	29	2,311	29	2,072	30	2,078	30
Other private education	461	5	498	6	505	7	479	7

Source: Statistics Netherlands

In the Netherlands, all public and private schools are equally financed by the government based on the number and distribution of pupils. Schools with a majority of pupils considered to be the ones who need more attention, get higher funding. Pupils are weighted on the basis of a number of criteria. Up to 2006 which is the period relevant for our empirical analysis, the weighting scheme was as follows: (1) children from a Dutch cultural background whose parents have low level of education: a weighting of 0.25; (2) children of barge-operators: 0.40; (3) children of caravan dwellers and gypsies: 0.70; (4) children from a non-Dutch cultural background whose parents have a low level of education and low-skilled occupations: 0.90; (5) all other children:

no weighting.[8] This weighing scheme implies that for each pupil weighted 0.25, 0.40, 0.70, 0.90, a school gets respectively 25%, 40%, 70%, and 90% extra funding. In addition, schools receive extra personnel and other resources on the basis of these weightings.[9] In order to qualify for extra funding under the weighting system, a school must meet a number of additional criteria, such as the minimum percentage of pupils with a certain weighting. No additional funds are allocated if the school fails to meet these minimum requirements.

Primary education is free since schools which are funded are not allowed to require extra payment from the parents, although they can ask voluntary contributions to cover the costs of extra activities (such as school trips and cultural events). Public schools are not allowed to refuse children who want to come to the school unless they are already full. Officially, private schools are allowed to refuse children on the basis of their identity (denomination). This means that they may require that parents, pupils, and teachers accept the principles on which the school is founded. This requirement is in most cases a purely procedural process. Indeed, many public schools offer nowadays religious classes and a growing number of 'religious' schools are open to 'non-religious' children. Additionally, the difference between teaching methods tends to become less visible. The private and 'new' schools with alternative teaching methods have had a large influence upon public schools. Nowadays, alternative teaching curriculum can be found in many public schools. This was also due to the Education Act from 1985, which stated that schools had to adapt their teaching methods to the individual child.

Parents have in principle the complete freedom of choice of a school, since all public and private schools are free of charge and there are no geographical restrictions on school choice.[10] Parents generally collect information on schools through school folders, websites and visits. Several reports have looked at the motives of parents in their choice of school in primary education (Karsten et al., 2002; Herweijer and Vogels, 2004). Survey results indicate that parents state the 'quality of education' as the most important determinant of a school choice. However, parents interpret the quality of education as a very broad concept. To get an idea of the quality of a school, parents look at a wide range of indicators: the Cito test, the reputation of the school, the number of pupils that continues into higher secondary education, the quality

[8] Changes to the system were introduced on 1 August 2006 and will be completed over a four-year period. In the new system, the weightings are as follows: (1) a weighting of 0.3 if both parents' highest level of education is junior secondary vocational education (LBO/VBO), (2) a weighting of 1.2 if one parent's highest level of education is primary education and the other parent's is LBO/VBO and (3) a weighting of 0 for other pupils. The new weighting system will run parallel with the old one up to 2009. (Source: Stadsblad, 2006, No 283, 'Besluit van 19 mei 2006, houdende wijziging van het Besluit bekostiging WPO in verband met een wijziging van de gewichtenregeling')

9 Next to this main funding scheme, there is a range of other special funding schemes targeted for special purposes, such as the small class scheme (Groepsgrootte en kwaliteit) or the scheme for disadvantaged pupils (Onderwijsachterstanden).

[10] In practice, in certain specific cases the freedom of choice might be limited by different factors. In certain areas in Amsterdam, for instance, several primary schools adopt a postcode policy: only children living in the same postcode as the school can register at the school. Also, schools might refuse children due to capacity constraints (when schools are full). Schools and municipalities might also recommend parents to choose for another school (for instance if the municipality has implemented a policy against school segregation, aiming to avoid the concentration of non-Dutch background in certain schools).

assessments of the Inspectorate of Education, etc. Remarkably, parents from a Dutch background also tend to put a high weight on the level of segregation in the school (Karsten et al., 2002, p.104), with higher quality coinciding with less pupils from a non-Dutch background.[11] In the surveys, this comes out under the labelling 'matching between school and home' ('our type of people'), 'atmosphere at school' and 'identification with the school'.

After quality, another important determinant of school choice is the distance to school. Most parents choose a school in their immediate neighbourhood. A survey on the travel behaviour from home to school of children in primary education finds that the average distance that children travel is of 1.26 km (Van der Houwen et al., 2004).[12] Finally, parents' choice is often irrespective of denomination. In 1990, 7% of the parents had no preference for the denomination of the school. In 2000, this share increased to 20%. In 1999, 40% of the parents sent their children to a school whose denomination did not match with the parents' religious background (Herweijer and Vogels, 2004).[13]

Schools compete with other schools for pupils in a relevant market in order to maximise their revenues and minimize their costs. Webbink and Burger (2006) discuss how the current Dutch financing system provides incentives for schools to improve their performance. Firstly, given the current financing scheme based on the number of pupils, schools have incentives to attract more pupils in order to receive more funding.[14] Secondly, with more pupils the chance that public financing is stopped because the school is too small (the so-called 'closing-down' norm) decreases. Finally, the salary scale of school directors also depends on the size of the school.[15] According to this financing scheme, pupils are thus valuable assets for schools and its management.

According to standard efficiency arguments from economic theory, competition between schools in order to attract and retain pupils will force schools to improve the quality of education (e.g., educational outcomes) so as to keep up with their competitors. This theoretical argument rests, however, on several assumptions: 1) parents are informed about quality of schools; 2) parents are free to choose the school they prefer; 3) school resources increase with the number of pupils 4) schools have some autonomy and flexibility in their teaching methods; and 5) schools are allowed to expand in order to accommodate for extra demand. As discussed previously, to a large extent these assumptions hold true in the Dutch context, since parents can freely choose for a school, schools' budget increase with the size of the school, and schools

[11] This is coined as the 'white schools' versus 'black schools' issue.

[12] Unfortunately, the report does not mention other statistics such as standard deviation or maximum distance traveled by pupils.

[13] Nevertheless, in certain regions in the Netherlands where religion plays an important role, denomination is still likely to be important.

[14] Webbink and Burger (2006) also find that the financing system creates some tensions between incentives to increase quality and incentives to integrate pupils from a low socio-economic background. Even though schools receive more funding for disadvantaged students from a non-Dutch background, these pupils are more costly for the school as they require more teaching resources and effort.

[15] Even though teachers are not paid according to the size of the school, having more pupils can also be beneficial for teachers as they have more resources for teaching (hence it decreases teachers' effort).

have a large degree of autonomy. In general, schools can also acquire new buildings to expand their size.[16] As a result, we expect to find a positive effect of competition on the quality of schools.

[16] There might be some exceptions to this in particular in the city centre of the main metropolitan areas. Anecdotal evidence reveals that some schools in the region of Amsterdam and Hilversum face capacity constraints.

3 Empirical approach

3.1 Defining school competition

In this paper, we define the concept of school competition in a spatial context. We assume that a school competes with all other schools located within a radius of 1.5 km around the school.[17] This is illustrated in Figure 3.1. Within each school competition market, we constructed the "competitors" variables as the number of alternative schools within a fixed radius of 1.5 km around a school[18] and the inverted Herfindhal index[19] as follows:

$$HHI_m = 1 - \sum_i^n s_{i,m}{}^2 , \qquad (2)$$

where s_i is the market share of a school i in a market m. A high level of competition in the market is thus reflected by a high value of the Herfindhal index.

We do not have data on the residential location of pupils attending a given school, so that we cannot trace how far pupils are actually travelling to go to school. Nevertheless, our school market definition is in line with the evidence that the average distance that pupils travel to go to school in the Netherlands is rather small, about 1.26 km according to data from van der Houwen et al. (2004).[20] According to recent data from Statistics Netherlands (2008), accessibility of schools is very good in the Netherlands. The nearest primary school is located on average at 0.580 km - so less than 10 minutes walk - from a pupil's residence. About 90% of children live less than 1 km away from a school and 60% less than 500m. About 1% of the children live further away than 3 km from a school. As a result, parents are not likely to make long journeys to bring their children to schools, simply because they have plenty of choice in their neighbourhood. According to our definition of school markets, there are on average 6 schools within a fixed radius of 1.5 km around each school.[21] In our robustness analysis, we will also consider larger markets around a school (within a radius of 2.5 km around a school). In general, our definition of school competition within a fixed radius around a school is likely to be affected by other factors such as town size and urbanization. Highly urbanized markets will

[17] Given the way we construct our markets, in the case of connected towns, the number of competing schools also includes school which are located in adjacent towns.

[18] Therefore, monopoly markets have zero alternative competing schools within a school market.

[19] To ease interpretation of the results, we invert the Herfindhal index such that a lower (higher) value indicates lower (higher) competition. A value of 0 indicates thus a monopoly market.

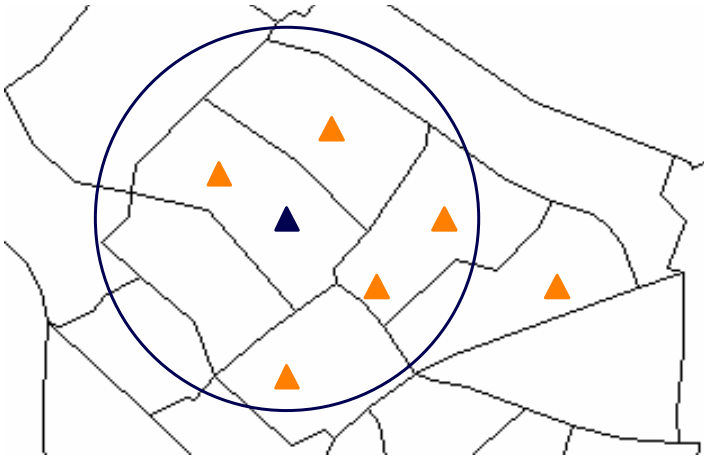
[20] This average is based on a representative sample of 7,500 Dutch parents. We do not have information on the maximum distance home-school in the Netherlands in the sample. In rural areas, the average and maximum distance travelled is likely to be larger than in urbanized areas.

[21] Obviously, in rural areas parents might travel long journeys, but we will exclude these markets at a later stage in our analysis (see Section 4).

have a higher density of schools than less urbanized markets. We will control for these factors in our analysis.

Other approaches in the literature define school markets as metropolitan areas (Hoxby, 2000; Hsieh and Urquiola, 2003) or according to travel patterns when data on pupil residential location are available (Gibbons et al., 2008). There is a large literature on defining spatial competition in geographical markets (using metropolitan areas, fixed radius distance or journey times) related to measuring competition among hospitals (see Propper et al., 2004, and Wong et al., 2005, for a review).

Figure 3.1 School market as a circle (with radius of 1.5 km) around each school



In this example, the school in black competes with 5 other schools (in grey). The map describes 4-digit postcode areas.

Due to data constraints, we can only measure distances between the centres of 4-digit postcode areas. This implies that we have to deal with potential measurement errors in our empirical analysis. More precise distance data (for instance between two schools or between two centres of 6-digits postcode areas) are not available. As a consequence, our circles of 1.5 km are in fact circles around the centre of the 4-digit postcode area in which the school is located. If the centre of another 4-digit postcode falls (does not fall) within this circle, all schools located in this postcode area will also (will not) be included in our market.[22] This implies that for certain markets competition will be underestimated and for other markets overestimated. We will come back on this issue when we discuss our empirical strategy.

[22] On average, our school markets are composed of 3.5 postcode areas.

3.2 Measuring school quality

When choosing a school, parents compare the quality of the different schools in their neighbourhood. As a measure of school quality, we look at the performance of pupils attending the school on a standardized test score, namely the so-called Cito test. About 80% of Dutch pupils participate in a nationwide standardized Cito test in their final year of primary school. The objective of the Cito is to test the skills acquired by students over the years in the primary school on four areas:

1. Language (spelling, writing, reading and vocabulary);
2. Arithmetic (understanding of numbers, mental arithmetic, percentages, fractions, dealing with measures, weights, money and time);
3. Information processing (use of texts and other information sources, reading and understanding of tables, graphs and maps);
4. World orientation (optional):[23] applying knowledge in the fields of geography, history, biology, science and form of government.

The complete test consists of over 200 multiple choice questions. Pupils have incentives to perform well since pupils' test scores are one of the acceptance criteria into different levels of secondary education. Averages scores of schools' pupils are commonly used by the Inspectorate of Education to evaluate the quality of primary schools. Average Cito scores are in principle public information and are often available on folders and websites published by the schools. Parents then may use this information to select a school for their children next to other criteria. Since 2003, the Inspectorate also publishes an assessment of whether a school performs above or below the average of schools with a comparable student population on its website,

Yet, we may question whether the Cito test truly reflects the quality of a school. As stated earlier, parents may value the quality of schools on other aspects which are less easily quantifiable such as reputation, atmosphere, building maintenance, extra activities, etc. Another problem when using standard test scores to measure school quality is that they may be sensitive to strategic behaviour by schools. This can occur whenever schools choose for instance to publish test scores after excluding low-performing students (see Chorny and Webbink, 2008, for a study of this issue on Amsterdam schools). Our data are, however, exempt from this problem since we obtained the Cito scores directly from the Cito organization and not from the schools. Still, our data might be affected by the so-called *teaching-to-the-test* behaviour. This would mean that the Cito test might be overrated as schools train pupils on skills specific to the test at the expense of other topics. This should not be a problem if tests are well designed to cover the school curriculum.

[23] In our empirical analysis, we abstract from looking at scores on world-orientation.

Despite these shortcomings, the Cito scores data present the advantage to be readily accessible. In addition, the Cito scores are correlated with other aspects that matter to parents, such as the level of segregation[24] or the percentage of pupils that continue into secondary education. Finally, many international studies show that parents are not indifferent to standardized tests scores. Evidence using house prices show that parents do take average pupil achievement at schools in consideration when choosing their residential location (Black, 1999; Kane, Staiger and Reigg, 2005). Using U.K. data, Gibbons and Silva (2008) show that parental perception of educational excellence is also related to standard test scores. Even though we cannot directly generalize these results to the Netherlands, this gives some support to our choice of measuring school quality through standardized test scores. Finally, in order to measure the impact of school competition on the added-value of a school[25], we will adjust the Cito scores to correct for the distribution of pupils within the school (i.e., the share of pupils with a non-Dutch background). Indeed, average Cito tests of a school are not indicative of the added-value of the school, but instead mainly reflect the distribution of the pupil population within the school. Schools with a high percentage of pupils from a low socio-economic background are likely to score low on the Cito test.

At last, we also considered looking at another measure of school quality next to Cito scores, namely the assessments of school quality by the Inspectorate of Education (the so-called 'quality cards'). Since the 1999/2000 school year, the Inspectorate of Education assesses all primary schools on a regular basis on four aspects: 1: school performance, 2. didactic performance, 3. learning material, and 4. support and guidance for pupils. The main advantage of the quality cards is that they might reflect other aspects of quality, such as guidance of pupils, materials, etc., which are not captured by the Cito test but that are very relevant for parents. Since the information on quality cards is obtained directly from the schools, they could however be sensitive to strategic behaviour by school. Unfortunately, the quality of these data proved to be insufficient to perform our analysis. The number of observations is relatively limited and the data show too little variation.[26]

We estimate the effect of competition on the quality of schools, in a simple regression analysis framework (OLS/IV), correcting for school and neighbourhood characteristics. The following specification sketches our empirical approach:

$$performance_{ism} = \alpha\, comp_m + x'_{ism}\,\beta + \varepsilon_{ism} \qquad (1)$$

[24] In our data, we find a positive correlation of 0.6 between the percentage of pupils with a Dutch background and pupils' Cito scores.

[25] There are several ways to measure the added-value of a school, for instance by correcting for prior educational achievement (when the pupil enters the school) or by correcting for pupil's socio-economic background.

[26] In the dataset we obtained from the Inspectorate of Education, the assessments were reported as a binary variable (sufficient/insufficient).

where $performance_{ism}$ is the Cito test score for pupil *i*, attending school *s*, located in market *m*; $comp_{sm}$ is a competition index for school *s* in market *m*; x'_{ism} is a vector of pupil, school, and neighbourhood characteristics (such as demographic and income characteristics of the neighbourhood).

3.3 IV strategy

One of the main issues when measuring the effects of competition on school quality is that the level of competition observed in a market may be endogenous to the quality performance of schools. Thus, a correlation between competition and school performance does not necessarily imply a causal link. This problem occurs since families tend to consider the quality of schools when deciding in which neighbourhood to live. As a result of such residential sorting, the level of competition that we observe in the market might be endogenously determined by the quality of schools in the market. Residential sorting might for instance lead to families crowding around high-quality schools, so that high-quality schools tend to be larger than low-quality schools. As high-quality schools grow larger this reduces the apparent level of competition in the market. In that case there is a reverse causality between competition and the quality of schools. In addition, due to the selection of parents into certain neighbourhoods, there might be unobserved factors affecting the pupils' performance which may also be correlated with competition, causing competition to be endogenous to the quality of schools. This could occur if socio-economic characteristics or preferences of families, which are correlated with school quality, are also related to the level of school competition in the market. For instance, if parents of pupils performing well at school are dissatisfied with the quality of schools, they can try to create alternative schools for themselves, thereby increasing the level of competition in the market. It could also be that parents with specific socio-economic characteristics have a preference for a specific supply of schools, affecting the market share and market penetration of these schools.

In brief, the endogeneity problem is the fact that the market structure we observe is actually related to the quality of schools, which makes it difficult to estimate a causal link. The implications of endogenous competition are that estimates in a simple OLS regression analysis will be biased. Instead, we will adopt an IV strategy in which we use an instrument for our competition variable. This instrument should be correlated with the level of competition in the market but not with the quality of schools. We use the distance between the school and the town centre: the closer (further away) schools are from the town centre, the more (less) competition they face. The intuition is that families living at the boundary of the town are more likely to go to the nearest schools than families living close to the centre of the town. This is because families living at the periphery of the town face longer journeys and thus higher travel costs to go to a school other than the nearest. As a consequence, schools located close to the market boundary face less competition than schools located at the centre of the market. This approach

follows closely the study of Gibbons et al. (2008) who use the distance to the boundary of the educational market[27] as an instrument for competition in the school market in England.

This IV strategy rests on several assumptions. Firstly, school choice should decrease with respect to the distance to the town centre.[28] In other words, there should not be more schools at the periphery of the town than in the centre. Related to this, schools and population should not be more densely populated around the town periphery than in the centre. Finally, after correcting for observable characteristics, the distance school-town centre should not be correlated with the quality of schools (or other unobserved variables affecting the quality of schools). These are empirical issues that will be addressed when we test the power of our instrument in Section 5.

Additional data limit is due to the lack of precision of our distance measures. As noted earlier, we only measure distances between the centres of two 4-digit postcode area. In our dataset, all schools located in the same postcode area will therefore be at equal distance from the town centre wherever their actual location is.[29] Our instrument will thus be measured with error. In practice, this does not need to affect our estimates as long as we have a good instrument (Card, 1999, p. 1821).

[27] In the case of England, this is the Local Educational Authority (LEA).

[28] Yet, according to anecdotal evidence, in the city of The Hague a large number of schools tend to be located far away from the town centre. School choice should thus increase with the distance to the town centre. A quick look at our data shows that this holds true. We find a positive correlation between the number of schools in a 1.5km market and distance to the town centre. Nevertheless, for towns of comparable sizes such as Amsterdam, Rotterdam and Utrecht, we find a negative correlation between distance to centre and school choice as suggested by our empirical strategy.

[29] In small towns composed of only one 4-digit postcode our instrumented school-town centre distance will then be set to 0km for all schools.

4 Data and sample construction

We obtained Cito scores at the pupil level from the Cito organisation for the period 1999-2003. The dataset includes the standard total Cito test score[30] as well as the component scores. We excluded the bottom and top 1% of the pupils to avoid potential outliers. The only additional information that we have at the pupil level is the gender.

Next to pupil data, we obtained several datasets from the Inspectorate of Education with information on the Dutch primary schools. We have a dataset with the addresses of all primary schools in mainstream education in the Netherlands, a dataset with the composition and size of the pupil population of each school and finally a dataset reporting the number of teachers[31], and the average Cito test results at the school level. We have also obtained a dataset from the CFI organisation,[32] which includes the composition of school boards over the same period. Regarding school denomination, we make a distinction between four groups: public schools, Catholic schools, Protestant schools and other private schools (mainly interconfessional schools and free schools). We dropped a group of specific private schools namely orthodox Protestant schools (reformed and evangelistic), Islamite, Hindu and Jewish schools as these schools constitute very specific markets and we cannot reasonably assume that these schools are competing with the other group of public and private schools.

In our dataset, about 15% of schools have more than one building location. A school can for instance have three different buildings spread across a town. Unfortunately, our data on school performance and school characteristics are not available at the location level, but only at the administrative level (the school name). We assume therefore that school performance is uniform across school locations. Further, we divide the total number of pupils of a school equally across its locations, since we do not have detailed data on the number of pupil per school building. To test whether this would significantly affect our results, we also conducted our empirical analysis on the sample of markets with schools with only one location. We find similar results as when we include markets with schools with several locations. Finally, when we build our competition variables, we assume that when a school has several locations within the same market (see Section 3.1 on our definition of markets) these school buildings are not competing with one another. This is a realistic assumption since within a same market school buildings are often located very close to one another (often in the same street in an adjacent building).

In total, we construct about 6,000 school competition markets (defined as a geographical market within a radius of 1.5 km around every school) distributed over 3,000 4-digit postcode

[30] The total Cito score and its components are standardized with mean 0 and standard deviation 1.

[31] Data on teachers are missing for the years 1999 and 2003, so we excluded them from our analysis. We conducted the analysis on the 2000-2002 sample and on the 1999-2003 sample excluding data on teachers. This did not affect our estimates on the effects of competition. In addition, the number of teachers is highly correlated with the total number of pupils in a school and with the percentage of pupils with a non-Dutch background.

[32] CFI (Central Funding of Institutions) is an agency of the Ministry of Education, Culture and Science in charge of the funding of Dutch education institutions.

areas in about 1,600 towns. We obtained demographic data at the 4-digit postcode area and town level from Statistics Netherlands (CBS). The dataset includes information about the number of inhabitants and the age and income distributions. To correct for market characteristics, we include demographic variables of the 4-digit postcode area in which the school is located. We also control for the size and urbanization at the town level. This is mainly to correct for a scale effect in our instrumental variable (the larger the town, the larger the distance to the town centre). We obtained geocoded data on administrative towns and 4-digit postcode areas from the Geotran company. This allowed us to compute all our distance variables (between two centres of 4-digit postcodes and between the centre of a 4-digit postcode and the town centre) using a Geographical Information System (GIS) software.
Finally, we restrict our sample to towns of more than 20,000 inhabitants. In small rural towns with low school density our competition indices are very highly correlated with urbanization and town sizes variables, leading to multicollinearity problems.[33] In larger markets, however, competition is only partly related to town size and urbanization and we find more mixed patterns of competition, town size, and urbanization levels. An additional problem with small rural towns is that there is not much variation in our instrument variable. Since we measure our distance data between centres of 4-digit postcode areas, for most of these small towns composed of only one postcode area the distance school-town centre is set to zero. We are left with a sample covering about 50% of all primary schools in the Netherlands and 60% of all pupils. Figure A1 in Appendix plots the distribution of the number of alternative schools within our geographical markets.

Since we restrict our sample to large towns, we are not able to estimate the impact of school competition on educational outcomes in small rural towns. Nevertheless, in towns with more than 20,000 inhabitants, we find a large diversity of market structures, ranging from monopoly to highly competitive markets as plotted in Figure A1 in Appendix. In theory, however, there are no reasons to believe that competition works differently between large and small towns. A monopoly school in a small rural town will lack incentives to improve performance just as a monopoly school in a large urban town. The question is whether the intensity of competition across oligopoly markets in small and large towns is likely to differ. It could for instance be that school denomination plays a greater role in small towns than in large ones.[34] In that case, schools would be offering differentiated products and competition incentives would be weaker in small towns. Another potential difference between oligopoly markets across small and large towns, is that in large towns we will have a lot of adjacent school markets. This would for instance imply that in a large town, even if a school has only one competitor in its market, this competitor may itself have a large range of competitors within a radius of 1.5 km. Hence, the intensity of competition might be higher in a duopoly market in a large town than in a small

[33] Descriptive statistics of small towns of less than 20,000 inhabitants and correlation indices can be found in Appendix.
[34] As an illustration, Catholic (public) schools tend to be overrepresented (underrepresented) in small towns. In towns of less than 20000 inhabitants, 46% (25%) of the schools are Catholic (public), against 33% (33%) in larger towns.

town, where the number of adjacent markets is by definition limited. Given the difficulty of extrapolating our results to small towns, we will therefore abstract from this issue.

Table 4.1 gives the descriptive statistics of our sample dataset. On average, there are about 6.5 alternative schools within a school market (the mean standard deviation is 5 schools). The inverted Herfindhal index is of 0.78 on average, reflecting a high level of competition.

Table 4.1 Descriptive statistics, 1999-2003, Towns of 20,000+ inhabitants

	Mean	Std. Dev.	Min.	Max.	Obs.
Pupil characteristics					
Cito (standardized with mean 0 and std. dev. 1)	0	1	– 2.5	1.6	358,767
Gender	0.50	0.50	0	1	358,767
School characteristics					
Number of pupils	324	143	20	1,238	358,767
% pupils subsidy 1.90	0.20	0.26	0	1	358,767
Size of school board [a]	5.67	2.94	1	10	358,767
Public schools (dummy)	0.33	0.47	0	1	358,767
Catholic schools (dummy)	0.33	0.47	0	1	358,767
Protestant schools (dummy)	0.25	0.43	0	1	358,767
Other schools (dummy)	0.09	0.28	0	1	358,767
Market characteristics					
Postcode level variables					
% population with high income	0.36	0.06	0.09	0.59	358,767
% population with low income	0.45	0.06	0.29	0.72	358,767
% population under 14 years	0.18	0.04	0.02	0.31	358,767
Town level variables					
Town size (in 1000s inhabitants)	157	191	21	656	358,767
Town urbanization[b]	3.2	0.7	2.0	4.0	358,767
Competition variables (1.5km)					
Number of alternative schools	6.5	4.8	0	27.0	358,767
Herfindhal index (inverted)	0.78	0.16	0	0.96	358,767
Distance to town centre	2.6	2.1	0	23	358,241
Number of alternative public schools	2.4	2.7	0	13	118,208
Number of alternative Catholic schools	1.8	1.6	0	8	101,274
Number of alternative Protestant schools	2.0	1.9	0	12	88,764
Number of alternative schools belonging to a different school board	3.1	2.1	0	14	117,491
Competition variables (2.5km)					
Number of alternative schools	14.7	10.1	0	62	362,090
Herfindhal index (inverted)	0.89	0.10	0	0.98	362,090

[a] Deciles of number of schools in school board, 1=very small, 10=very large

[b] Quartiles of number of addresses per km^2, 1= ;very low urbanization, 4= very high urbanization

5 Results

5.1 Basic specification

Tables 5.1 and 5.2 summarize the effects of competition on pupils' achievement, i.e., the coefficients of interest in this study. The first panel of Table 5.1 gives the results of IV estimation on the total Cito score of each pupil, while the first panel of Table 5.2 gives the IV estimates on each component of the Cito score: language, arithmetic and information processing. The results are presented for both competition variables: the number of competing schools and the (inverted) Herfindhal index. Columns (1) and (2) in Table 5.1 give the base specification used in the remainder of this study.

We find evidence of a small positive link between school competition and educational outcomes. Pupils in schools facing more competition in their neighbourhood perform on average better than pupils in schools facing less competition. In columns (1) and (2) in Table 5.1, an increase in competition by one standard deviation lead to an increase in the Cito score by 4.7% and 7.5% of a standard deviation when we measure competition using the number of alternative schools and the Herfindhal index, respectively. When we include town fixed effects, the effects are slightly lower as shown in columns (3) and (4) in Table 5.1. Looking at the different components of the Cito score (columns (5) to (10) in Table 5.2), the largest effect of competition is found on the language part.

The general result over all specifications in the first panels of Tables 5.1 and 5.2 is that the gains from competition tend to be in the range of 5 to less than 10% of a standard deviation in pupil achievement. Put differently, an increase in one standard deviation in competition leads to an increase of 5-10% of a standard deviation in the Cito score[35], so about less than 1 point. At first sight, this effect seems modest since increasing the level of competition in the market by one standard deviation is comparable to about five additional schools in the market (see Table 4.1). A large increase in competition is needed to raise the level of pupil achievement by one extra point.

The second panels of Tables 5.1 and 5.2 give the results of OLS estimations. In these specifications, the effects of endogenous competition are not corrected for. In an OLS framework the effects of competition on the Cito scores are much lower. There is a small significant effect on the total Cito scores only when we include town fixed effects. A small positive (negative) link is found for the effect of competition on the language (arithmetic) part, while most other specifications lack statistical significance.

[35] The standard deviation of the Cito-score on all pupils in the Netherlands is of 10 points according to www.cito.nl.

Table 5.1 Baseline estimates, IV and OLS results, Dependent variable = total Cito per pupil

	Cito total (1)	Cito total (2)	Cito total (3)	Cito total (4)
IV estimation results				
Number of alternative schools	0.047***		0.034**	
	(0.014)		(0.014)	
HHI		0.075***		0.053**
		(0.022)		(0.022)
Controls	Yes	Yes	Yes	Yes
Town Fixed Effects	No	No	Yes	Yes
Obs	358137	358137	358137	358137
OLS estimation results				
Number of alternative schools	0.004		0.017**	
	(0.004)		(0.004)	
HHI		−0.000		0.009*
		(0.005)		(0.005)
Controls	Yes	Yes	Yes	Yes
Town Fixed Effects	No	No	Yes	Yes
Obs	358663	358663	358663	358663

We control for all variables as in Table 5.3.

The competition variables are standardized with mean 0 and standard deviation 1.

Standard errors are given in brackets, ***p<0.01, ** p<0.05, *p<0.10.

Robust standard errors, clustered at the school level per year

Table 5.2 **Baseline estimates, IV and OLS results, Dependent variable= Cito score per pupil per component**

	Cito language (5)	Cito arithmetic (6)	Cito information (7)	Cito language (8)	Cito arithmetic (9)	Cito information (10)
IV estimation results						
Number of alternative schools	0.054***	0.027*	0.049***			
	(0.014)	(0.014)	(0.013)			
HHI				0.086***	0.043*	0.078***
				(0.022)	(0.023)	(0.020)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Town Fixed Effects	No	No	No	No	No	No
Obs	358,137	358,137	358,137	358,137	358,137	358,137
OLS estimation results						
Number of alternative schools	0.009**	−0.001	0.003			
	(0.004)	(0.004)	(0.004)			
HHI				0.009*	−0.012**	0.003
				(0.005)	(0.005)	(0.005)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Town Fixed Effects	No	No	No	No	No	No
Obs	358,663	358,663	358,663	358,663	358,663	358,663

We control for all variables as in Table 5.3.

The competition variables are standardized with mean 0 and standard deviation 1.

Standard errors are given in brackets, ***p<0.01, ** p<0.05, *p<0.10.

Robust standard errors, clustered at the school level per year

Next to competition effects, Table 5.3 gives the effects of other factors, such as pupil, school, and neighbourhood characteristics, explaining pupil achievements. All coefficients have the expected signs. On average large schools perform better than small schools. Schools with a large share of pupils with a non-Dutch background perform on average worse than schools with more pupils with a Dutch background. Schools falling under larger school boards seem to perform worse than schools falling under smaller school boards. Finally, Catholic schools perform better than public and Protestant schools. Pupils in schools located in wealthy neighbourhood have higher Cito scores than pupils going to schools in less wealthy areas. All these coefficients, however, should be interpreted with caution since they may not necessarily reflect causal links.

Table 5.3 Baseline specification, IV results, dependent variable=CITO per pupil

Competition		
Number of alternative schools	0.047***	
	(0.014)	
(inverted) Herfindhal index		0.075***
		(0.022)
Pupils		
Gender (0=female, 1= male)	0.039***	0.039***
	(0.003)	(0.003)
School characteristics		
Total number of pupils	0.000***	0.000***
	(0.000)	(0.000)
Percentage of pupil weight 1.90	− 0.957***	− 0.934***
	(0.022)	(0.019)
Size of school board	− 0.009***	− 0.009***
	(0.001)	(0.001)
Catholic schools	0.055***	0.058***
	(0.008)	(0.008)
Protestant schools	− 0.010	− 0.009
	(0.008)	(0.008)
Other schools	0.130***	0.130***
	(0.012)	(0.013)
Market characteristics		
Town size	0.000	0.000***
	(0.000)	(0.000)
Town urbanization city	− 0.058***	− 0.062***
	(0.006)	(0.007)
% of high incomes	1.082***	1.052***
	(0.054)	(0.053)
% of low incomes	− 0.353***	− 0.331***
	(0.074)	(0.075)
% population aged under 14	− 0.788***	− 0.753***
	(0.088)	(0.088)
Observations	358,137	358,137

Competition variables are standardized with mean 0 and standard deviation 1.
Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10
Robust standard errors, clustered at the school level per year.

5.2 Assessment of IV strategy

As stated in Section 3.3, we instrument our competition variables with the logarithm of the distance between the centre of the postcode of the school and the town centre. The intuition is that the larger the distance (being further away from the town centre), the lower the level of competition in the market, since parents living further away from the town centre are more likely to enrol their children into the school 'around the corner'. In order to assess the choice of our IV strategy, we look at the results of the first stages estimates of the IV regressions. In the first stage of the regression, we estimate the effect of the logarithm of the distance school-town centre on the level of competition in our school markets. We expect a significant negative effect if competition indeed decreases with the distance from the town centre.

Table 5.4 gives the results of our first stage estimates. We find that the distance instrument is always very powerful in explaining the level of competition in the market. Areas with less school competition are located on average further away from the town centre than areas with more school competition. A 10% increase in the distance between the school and the town centre reduces the number of alternative competing schools by 4.03% of a standard deviation, so the set of competing schools is reduced by 0.2 (=4.8*0.0403, the standard deviation is 4.8). This corresponds to 3% of the mean (=0.2/6.5 since there are 6.5 competing schools on average in a school market).[36] The F-test for excluded instruments is always high (Steiger and Stock, 1997) and always lies above 10, the reference threshold for strong instruments. Since our first stage results report a lower explanatory power (R^2) when using the Herfindahl index as a measure of competition (0.21), compared to the number of competing schools (0.42), we might expect that our IV approach works better when instrumenting the number of schools variable. The strong link between competition and our distance measure also suggests that potential measurement error in our distance measures is not likely to affect our results. Next to distance to the town centre, other market and school characteristics also affect the level of competition in a market as shown in Table 5.4. School competition tends for instance to be higher in larger urbanized markets with a high share of young people.[37]

[36] Gibbons et al. (2008) find similar effect of distance on the number of competing schools.

[37] Socio-economic characteristics (e.g. percentage of pupils with a non-Dutch background, share of population under 14 years-old, etc.) also capture aspects of town size – neighbourhoods with a large number of pupils with a non-Dutch background are for instance overrepresented in very large metropolitan areas. As a result, these variables tend to be more correlated with the number of schools in a market than with the Herfindhal index. In addition, variables reflecting town size and urbanization are by definition more correlated with the number of schools variable than with the Herfindhal index (based on market shares). This explains why coefficients on market characteristics tend to be larger on the number of alternative schools than on the HHI. When we exclude the four largest cities in the Netherlands, we find similar coefficients across both definitions of competition.

Table 5.4 First stage estimates, Dependent variables= number of alternative schools / inverted Herfindhal Index

	Number of alternative schools	Number of alternative schools	HHI	HHI
	(1)	(2)	(1)	(2)
Competition				
Log(distance school-town centre)	– 0.423***	– 0.403***	– 0.271***	– 0.253***
	(0.015)	(0.015)	(0.010)	(0.010)
Pupils				
Gender (0=female, 1= male)		0.001		– 0.001
		(0.003)		(0.002)
School characteristics				
Total number of pupils		– 0.001***		– 0.000***
		(0.000)		(0.000)
Percentage of pupil weight 1.90		0.695***		0.128***
		(0.058)		(0.029)
Size of school board		0.020***		0.005**
		(0.003)		(0.002)
Catholic schools		– 0.093***		– 0.108***
		(0.022)		(0.014)
Protestant schools		0.095***		0.042***
		(0.024)		(0.014)
Other schools		– 0.045		– 0.040**
		(0.032)		(0.020)
Market characteristics				
Town size	0.003***	0.003***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Town urbanization	0.241***	0.238***	0.188***	0.196***
	(0.011)	(0.011)	(0.009)	(0.010)
% of high incomes		– 1.103***		– 0.303***
		(0.172)		(0.085)
% of low incomes		0.161		– 0.198
		(0.243)		(0.135)
% population aged under 14		1.240***		0.318**
		(0.302)		(0.153)
Observations	371,790	358,137	371,790	358,137
R-squared	0.38	0.42	0.19	0.21
F-test on excluded instruments	743	725	680	618
Partial R2 on excluded instruments	0.06	0.06	0.06	0.05

The competition variables are standardized with mean 0 and standard deviation 1.
Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10
Robust standard errors, clustered at the school level per year.

The fact that on a large sample of Dutch towns we find a strong negative coefficient suggests that on average school competition does tend to decrease with the distance to the town centre. An important assumption in our IV strategy is that distance to the town centre is not correlated with other unobserved characteristics of pupils, schools and neighbourhoods that we are not controlling for, which may still affect pupil achievement. In other words, the question is whether our distance variable still captures other features of pupils, schools and neighbourhood close to town centre, which may have a direct influence on educational outcomes. For instance, pupils in the town centre may be more motivated and value test results more than pupils at the boundary of the town. If most able pupils live in the town centre, then pupils' ability will be negatively correlated with the distance between the school and the town centre. Similarly, parents living close to the town centre may be more involved into their children's education than parents living at the boundary of the town. In addition, schools close to the town centre may also have better management practices than schools at the periphery.

We attempt to minimize the concerns about potential correlation between school quality and the distance measure by controlling for a large set of covariates in our baseline estimation. For instance, parents' involvement in the education of pupils might be captured by our covariates on the percentage of the population with a high income since, according to Table 5.3, pupils going to schools in wealthy areas have higher Cito scores than others.

Using additional data from the PRIMA survey, a project aiming to assess the development of primary education, we can provide some illustrative evidence that our instrument is not strongly correlated with other pupils' characteristics. In particular, we show that pupils' ability and family background characteristics are not correlated with our distance variable. We obtained data on pupils' characteristics such as pupil's IQ score and education of parents in about 600 primary schools over the 1994-1999 period.[38] The main drawback of this dataset is that it may suffer from self-selection since participation of schools into the project was voluntary. Yet, it provides useful information for our illustration purposes. We average the pupil's characteristics at the 4-digit postcode level and match these data with our demographic dataset including distance to the town centre.[39] After selecting only pupils in grade 8 and dropping missing values, we are left with about 400 postcode areas. Table A3 in Appendix provides the descriptive statistics of this sample. Table 5.5 gives the results of regressing pupils' characteristics such as pupil's IQ and parents' education on our distance measure. In column (1) we control for town size variables only[40], while in column (2) we add all our covariates as in Table 5.3. The coefficients on our distance measures are never significant, suggesting that IQ and parents' education are not correlated with the distance to the town centre.

[38] Although these data cover an earlier period than the period studied in our Cito analysis, geographical sorting of pupils is not likely to have changed much over the subsequent period. The PRIMA survey was also conducted in later years, but these data were not readily available for our purposes.

[39] The PRIMA survey uses another identification number for schools than in our Cito dataset. Therefore, we can only match both datasets at the 4-digit postcode level. We also compute the average per postcode area of all school characteristics.

[40] We control only for town size and urbanization. This is to correct for an obvious scale effect in our distance measures (larger distances in larger towns).

Next to data on pupils' characteristics, we also collected additional data on the yearly outflow of teachers per school. We did not use these data in our baseline specification due to missing values. Distance to the town centre could be correlated with the outflow of teachers if for instance schools at the periphery had different working conditions (or working 'atmosphere') and management practices than schools in the town centre. Here again, we did not find evidence that the yearly outflow of teachers is correlated with our instrument. Overall, these findings are encouraging, but we cannot completely rule out the fact that our distance measure may be correlated with other unobservables we cannot measure. In a similar way, Gibbons et al. (2008) also check for potential correlation between their distance instrument and a large set of pupils, schools and neighbourhood characteristics and also find no evidence for significant association between these variables and their instrument.

Table 5.5 Estimates of effects of log(distance school-town centre) on pupil's characteristics

	IQ pupil (1)	IQ pupil (1)	Education father (2)	Education father (2)	Education mother (3)	Education mother (3)
Log(distance school - town centre)	0.123	– 0.058	0.091	0.067	0.067	0.029
	(0.140)	(0.139)	(0.056)	(0.050)	(0.056)	(0.049)
Controls	Town variables	All	Town variables	All	Town variables	All
Observations	367	346	355	335	354	334
R-squared	0.11	0.22	0.14	0.35	0.11	0.34

Regression coefficients obtained from separate regressions of above pupils' characteristics on the log of distance between school and town centre. Observations at the 4-digit postcode level area. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10. Robust standard errors, clustered at the school level per year. Controls in column (1) include town size and urbanization variable, Controls in column (2) include the same controls as in Table 5.3 where the controls are averaged at the postcode level (except town size and urbanization variable).

5.3 Robustness checks

To check the robustness of our results, we conduct an additional range of specifications using robust estimation of standard errors (clustered at the school level per year). Year dummies are never significant so we do not include them. Including dummies for the 4 largest cities in the Netherlands (Amsterdam, Rotterdam, The Hague and Utrecht), we find that pupils in Amsterdam and Rotterdam had higher Cito scores than pupils in other smaller cities in the country, all other things being equal. Excluding all markets in these 4 large cities tend to slightly reduce the effect of competition on quality. Finally, we also include non-linear terms for our competition variables. These are never significant both in OLS and IV specifications.

Table 5.5 gives the IV results for different town size samples. The effects of competition on the Cito score tend to be more important in larger towns. As explained earlier, this could be

potentially explained by the fact that the intensity of competition might be higher in large towns given a certain number of competitors (more adjacent markets), or simply because parents give more importance to school denominations in smaller markets.

Table 5.6 IV results, different samples, dependent Variable = CITO per pupil

	(1)		(2)		(3)		(4)	
	20,000+	20,000+l	40,000+	40,000+	70,000+	70,000+	20,000+ excl. 4 largest towns	20,000+ excl. 4 largest towns
Number of alternative schools	0.047***		0.055***		0.076**		0.033**	
	(0.014)		(0.017)		(0.022		(0.017)	
HHI		0.075***		0.118***		0.186***		0.040**
		(0.022)		(0.037)		(0.055)		(0.020)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	358,137	358,137	244,698	244,698	183,584	183,584	290,165	290,165
First stage coefficient log(distance)	– 0.403***	– 0.248***	– 0.441***	– 0.201***	– 0.405***	– 0.160***	– 0.380***	– 0.315***
	(0.015)	(0.010)	(0.022)	(0.012)	(0.027)	(0.013)	(0.014)	(0.016)
F-test for excluded instruments	725	618	404	313	227	167	783	633
Partial R-squared	0.06	0.05	0.05	0.04	0.04	0.03	0.09	0.07

The competition variables are standardized with mean 0 and standard deviation 1.
Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10
Robust standard errors, clustered at the school level per year.

We also test for different assumptions on the way schools compete with one another as suggested by Dutch policymakers. In column (1) in Table 5.7 we assume that public schools compete only with other public schools. Similarly, in columns (2) and (3) we assume that Catholic and Protestant schools only compete with other Catholic and Protestant schools, respectively. We only find a significant positive effect of competition on pupil outcomes in the case of Catholic schools. In the literature, higher incentives for Catholic schools are often attributed to better governance and religious fervour. In column (4) of Table 5.7 we assume that schools are only competing with schools falling under a different school board. By definition, this implies that public schools are not competing with one another since all public schools in a town fall under the responsibility of the municipality. Since this may be seen as a far-stretched assumption, in column (5) we assume that each public school behaves as an independent school board. Using the school board definition of school competition, estimates of the effects of competition are larger than in our baseline specification, suggesting that schools might indeed

have more incentives to compete with schools from a different school board (column (4)). The effects of competition are larger when we additionally assume that public schools compete with one another (column (5)). Finally, in column (6) we assume that schools compete with all other schools located within a 2.5 km radius around each school. In that case, school markets are much larger with on average 14 competitors per market, so that we may be overestimating the level of competition in the market.

Table 5.7 IV estimations, robustness checks, different definitions of school competition

	(1) Public	(2) Catholic	(3) Protestant	(4) School board	(5) School board	(6) 2.5 km
Number of alternative schools	0.043	0.057***	− 0.052*	0.054***	0.069***	0.069***
	(0.037)	(0.017)	(0.028)	(0.02)	(0.02)	(0.02)
HHI	0.049	0.079***	− 0.057	0.11***	0.14***	0.10***
	(0.042)	(0.024)	(0.040)	(0.04)	(0.04)	(0.03)
Observations	117681	117697	88764	361564	361564	358241

Competition variables are standardized with mean 0 and standard deviation 1.Robust standard errors, clustered at the school level per year. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10. We control for the same variables as in our baseline specification in Table 5.3. First-stage results always show a strong negative link between distance to town and competition. Columns (4) and (5) assume that schools are competing with all other schools in the market falling under a different school board. In column (4), we count all public schools as one school board (since all public schools are administrated by the local municipality). In column (5), we count all public schools as one independent school board. In column (6) we measure the number of alternative schools within a fixed radius of 2.5 km around each school.

6 Conclusions

In this paper, we look at the causal links between competition and pupil achievement in Dutch primary schools. Our research question is: Do schools that face more competition in their neighbourhood perform better than schools facing less competition? In order to answer this question, we construct the relevant markets for primary school competition as a zone of 1.5 km radius around every school and compute different competition indices within these markets. We estimate the effect of school competition on the Cito score at the pupil level using an instrumental variable approach. We use the intuition that schools located at the periphery of a town are likely to face less competition than schools located close to the town centre. This is because parents living at the town periphery face higher travel costs to bring their children to a school in the centre and are therefore more likely to go to the nearest school in their neighbourhood. Hence, we use the distance between the school and the town centre as an instrument for competition. Assessing the performance of our IV strategy reveals that this distance measure is a good instrument for the level of competition in the market.

In an OLS framework, we find a small positive relationship between school competition and the Cito score. When we control for endogeneity issues using our IV strategy, we find a larger effect of competition on pupil achievements. Yet, the effects remain very small. A one standard deviation increase in competition increases the average Cito score by 5-10% of a standard deviation, so about less than 1 point. This result is robust to a large range of specifications. Gains from school competition on pupil achievement are thus very modest, a result commonly found in the international literature.

Why do the effects of competition on pupil achievement tend to be so small? A possible explanation is that parents lack information about the quality of schools, thereby reducing the incentives for schools to compete. In this case, policies aiming to increase transparency on school performance might have beneficial effects on the quality of education. While newspapers publish school ranking for secondary schools in the Netherlands, such tables are not available yet in primary education. Since 2003, quality assessments of primary schools ('quality cards') have been published on the website of the Inspectorate of Education. Yet, it is not clear how many parents actually use this information when choosing a school. In general, the benefits of policies aiming to increase competition in school markets should also be weighed against other potential costs associated with an increase in competition, such as for instance an increase in school segregation. The potential effects of competition on segregation in Dutch schools are, however, out of the scope of this study.

Another possibility for the small effect of competition on educational outcomes is that parents might value other factors, such as school activities, maintenance of buildings, above the Cito scores when choosing for a school. In that case, schools might be competing on other aspects than only pupil achievement. Finally, since the Netherlands have a long tradition and a

high level of school competition, gains from further additional competition may also be limited. Future research should provide a better understanding of these mechanisms.

Yet, the very modest gains from competition on pupil achievement are not negligible. It is well established in the literature that even small increases in pupil achievement can have important impacts in the long-term (Jamison et al., 2007). Several studies show for instance that even a small increase in pupil achievement may have a large impact on future earnings of pupils (Mulligan, 1999; Murnane et al., 2003; Lazear, 2003). These studies suggest that one standard deviation increase in math performance at the end of high school translates into 12% higher annual earnings, implying that a one standard deviation increase in performance would boost their earnings by $3600 for each year of their working life. Finally, Hanushek and Kimko (2000) also establish the causal effect between higher test scores and economic growth and conclude that one standard deviation difference on test performance is related to 1 percent difference in annual growth rates of GDP per capita.

The present study opens many opportunities for further research. Firstly, the IV approach used in this paper could be reproduced for schools in secondary education. Secondly, on methodological grounds, the recent introduction of a postcode policy in the city of Amsterdam could provide a useful natural experiment to measure the impact of a restriction in competition on the Cito scores. Nevertheless, the effects of this policy on test performance will only be effective in a few years. Finally, more research is needed to grasp how parents actually choose a school in the Dutch market. Data on the travelling behaviour of pupils would greatly improve this type of analysis.

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Appendix

Table A1 Descriptives statistics, towns of 20,000- inhabitants

Label	Mean	Std. Dev.	Min	Max	Obs
School characteristics					
Number of pupils	245	116	2	786	253,528
% pupils subsidy 1.90	0.04	0.07	0	0.85	253,528
Public schools (dummy)	0.25	0.43	0	1	253,528
Catholic schools (dummy)	0.46	0.50	0	1	253,528
Protestant schools (dummy)	0.26	0.44	0	1	253,528
Other schools (dummy)	0.03	0.17	0	1	253,528
Postcode level variables					
% population with high income	0.33	0.06	0.12	0.64	253,528
% population with low income	0.46	0.04	0.29	0.60	253,528
% population 0-14 years	0.20	0.03	0.09	0.36	253,528
Town level variables					
Town size (in 1000s inhabitants)	8.4	5	0	20	253,528
Town urbanization	1.5	0.6	1.0	4.0	253,528
Competition variables (1.5km)					
Number of alternative schools	2.6	2.1	0	11.0	253,528
Herfindhal index (inverted)	0.5	0.3	0	0.9	253,528
Distance to town centre	0.3	0.8	0	6	253,528
Number of alternative public schools	0.53	0.80	0	4	63,218
Number of alternative Catholic schools	0.90	1.1	0	4	114,697
Number of alternative Protestant schools	1.19	1.64	0	8	65,515

Table A2 Correlation matrix, competition indices and town characteristics

	Number of alternative schools	HHI
Sample of towns 20,000- inhabitants		
Town size	0.72	– 0.68
Town urbanization	0.60	– 0.59
Sample of towns 20,000+ inhabitants		
Town size	0.50	– 0.28
Town urbanization	0.35	– 0.27

Table A3 **Descriptive statistics, Prima data and demographic data at the 4-digit postcode level (except town size and town urbanization)**

Variable	Mean	Std,Dev	Min	Max	Obs
School size (number of pupils)	286.19	92.95	68.04	597.60	369
Percentage of pupils weight 1.90	0.31	0.26	0.00	0.97	369
Size of school board	5.90	2.42	1	10	369
Town size	165.78	193.92	20.92	655.94	369
Town urbanization	3.27	0.70	2	4	369
% high incomes	0.35	0.07	0.12	0.67	399
% low incomes	0.48	0.06	0.32	0.72	429
% young 0-14	0.18	0.04	0.02	0.29	430
Number of alternative schools (1.5km)	6.76	5.28	0	25.61	369
Herfindhal index (1.5km)	0.78	0.15	0	0.96	369
Distance to town centre	3.54	2.00	1.00	11.58	367
IQ test pupil	25.06	1.53	19.79	29.50	430
Level of education father	2.27	0.59	1	4	418
Level of education mother	2.15	0.57	1	4	418

IQ of pupils is computed on a scale up to 30 points. The education level of parents is defined as follows: 1=low education, 2=low vocational education, 3=middle vocational education,4=high (vocational) education.

Figure A1 **Distribution of the number of alternative schools within a fixed radius of 1.5 km, Towns of 20,000+inhabitants**