School Competition and Efficiency with Publicly Funded Catholic Schools

David Card	Martin Dooley	Abigail Payne
UC Berkeley	McMaster University	McMaster University

September 2007

ABSTRACT

The province of Ontario has two publicly funded school systems: secular schools (known as public schools) that are open to all students, and separate schools that are open to children with Catholic backgrounds. The systems are administered independently and receive equal funding per student. In this paper we use detailed school and student-level data to assess whether competition between the systems leads to improved efficiency. Building on a simple model of school choice, we argue that competitive pressure will be greater in areas where there are more Catholic families who are willing to switch between systems to access higher quality schooling. To measure the determinants of cross-system competition we study the effects of school openings and closings on enrollment growth at nearby elementary schools. We find significant cross-system responses to school openings, with a magnitude that is proportional to the fraction of Catholics in the area, and is higher in faster-growing areas where families are less attached to specific schools. We then test whether schools that face greater cross-system competition have higher productivity, as measured by test score gains between 3rd and 6th grade. Our findings suggest a small positive effect of potential competition on the growth rate of student achievement. We estimate that extending competition to all students would raise average test scores in 6th grade by 2-5% of a standard deviation.

* We are particularly grateful to Olesya Vovk and our research assistants in the Public Economics Data Analysis Laboratory. We also thank David Green, Steven Jones, Patrick McEwen, Derek Neal, Craig Riddell, Arthur Sweetman, and many other conference participants for comments on earlier drafts. This research has been funded from grants from the Canadian Foundation for Innovation, the Ontario Innovation Trust, the Social Sciences and Humanities Research Council, the Council of Ministers of Education, and McMaster University.

Policy makers around the world are struggling to raise the efficiency of public schools. Some economists (notably, Friedman, 1955) have argued that a cost-effective way to boost performance is to limit the monopoly power of local school districts. For this prescription to work, families need to be able to choose between alternative schools, and be willing to change schools in response to perceived quality differences. School administrators also have to be rewarded for producing the quality features that parents demand. So far, school choice initiatives enacted in the U.S. have gone only part way toward satisfying these conditions.[1]

Alternatives to the local monopoly model have a much longer history outside the U.S.[2] In this paper we study school competition in Ontario, Canada, which for over a century has operated two publicly funded school systems: secular schools (known as *public schools*) that are open to all students, and *separate schools* that are open to children with Catholic backgrounds. The two systems are run independently and receive equal funding per student.

This dual system lies somewhere between a traditional local monopoly and a local duopoly. A key constraint is that only children with Catholic backgrounds (about 40% of students, on average) can exercise choice. To the extent that Catholic families are willing to move between public and separate schools, however, the dual system encourages competition and may improve efficiency. Documenting the size of such effects is important not only for understanding the dual system, but also for analyzing proposed choice systems in other settings. Arguably the efficiency effects associated with the Ontario system represent a lower bound of the gains that could be realized in a more general voucher system.

---

[1] Two main initiatives to loosen the control of local school districts are charter schools and school vouchers. See Hoxby (2004), Booker et al. (2005) Bifulco and Ladd (2004) and Carnoy et al (2005) on the issue of charter schools, and Howell and Petersen (2002), Krueger and Zhu (2003) and Ladd (2002) on the issue of vouchers. Both issues remain controversial.

[2] Clark (2005) studies the efficiency of English high schools that opt out of local school district control, while Gibbons, Machin, and Silva (2006) analyze competition between public schools in England. Ahlin (2003) studies the effects of competition in Sweden. Hsieh and Urquiola (2006) study the voucher system in Chile.

We analyze the dual system using a simple model of school choice and quality competition between public and separate schools. We assume that Catholic families choose either a public or separate school, depending on the relative quality of the available schools, their relative convenience, and unobserved tastes for a secular versus Catholic environment. Given local enrollment demand functions, we assume that school managers engage in a simple effort-setting game. If managers are rewarded (at least implicitly) for capturing a larger market share, equilibrium effort will be higher in markets where enrollment demand is more responsive to quality. In particular, managers in *both systems* will work harder when there are more Catholics in the area who are willing to switch systems to access higher quality schooling.

To establish that competition actually matters, and identify the characteristics of schools that make them more or less vulnerable to cross-system competition, we begin by modeling the effect of nearby school openings and closings on enrollment growth at existing schools. We find that the opening of a nearby school by the rival system leads to statistically significant enrollment losses of about 2-3 students per grade. The cross-system flows are approximately proportional to the fraction of Catholic families in the area, and are larger in rapidly growing areas, where families are arguably less attached to specific schools.

We then evaluate the effect of enhanced competition on student achievement, using standardized tests that are administered province-wide to 3rd and 6th graders. We develop an econometric model for the test score gains of a given cohort of students at a given school that depends on student and neighborhood characteristics, and on an index of cross-system competition derived from our enrollment growth model.[3] The key identifying assumption is that variation in the fraction of Catholic families in the surrounding neighborhood has no direct effect

[3] The idea underlying this index is similar to Bucklin, Russell, and Srinivasan's (1998) observation that cross-price elasticities of market shares for competing brands are proportional to the probabilities of switching between brands.

on test score gains of the students at a given school, although it determines the sensitivity of enrollment demand to relative school quality. A concern is that children from families with *any* type of religious affiliation (or from ethnic backgrounds that are more or less likely to be of Catholic faith) may have different achievement growth rates than those from secular or unaffiliated families. Our most general specifications allow test score gains to vary with the local fraction of families with no religious affiliation, and the shares of major ethnic groups.

We find small but significant (or marginally significant) effects of potential competition on the growth rate of mathematics and reading achievement between 3rd and 6th grades. The implied effects are larger at public than separate schools, and also larger in rapidly-growing suburban areas. The estimates imply that extending competition to all students in the province would lead to gains in 6th grade reading and mathematics scores on the order of 0.02-0.05 of a standard deviation.

I. Previous Research

Our work builds on several strands of previous research on school competition, mainly focused on the U.S.[4] An early study by Couch et al. (1993) related district-wide average test scores at public schools to the fraction of local students in private schools, and interpreted the positive correlation as evidence of a competition effect. Subsequent studies using the same approach (Newmark, 1995; Sander, 1999; Geller et al. 2006) have found smaller and generally insignificant effects.[5] Hoxby (1994) argued that private school enrollment varies with the quality of local public schools, leading to an endogeneity bias in Couch et al.'s models. Using the fraction of Catholics in a metropolitan area as an instrument for private enrollment, Hoxby

[4] See Belfield and Levin (2002) for a comprehensive review of studies of competition in public education in the U.S.
[5] An exception is Dee (1998), who estimates a significantly positive effect on high school graduation rates.

obtained a positive competition effect on test outcomes. Subsequent instrumental variables (IV) studies (e.g., Arum, 1996, Jepsen, 2003) have found weaker competition effects, and an extensive re-analysis by Jepsen (2002) concludes that any effects are probably small.

A second and related group of studies examines Tiebout competition between public school districts in the same geographic area. Borland and Howsen (1992) used the Herfindahl index of enrollment shares at different school districts as a measure of Tiebout competition and found a slightly *negative* effect on public school test scores.[6] Arguing that district fragmentation is endogenous, Hoxby (2000) used the number of rivers and streams running through a metropolitan area as an instrument for the Herfindahl index. Although she reported a positive competition effect from this design, Rothstein (2006a) obtained smaller and generally insignificant effects from a variety of alternative specifications. Rothstein (2006b) found no effect of district fragmentation on the degree of sorting between school districts and concluded that inter-district competition effects are small.

More direct evidence on school competition comes from Hsieh and Urquiola's (2006) analysis of private school vouchers in Chile. Using comparisons across different municipalities, they found no evidence that private school entry leads to gains in student outcomes. Consistent with theoretical analyses by Epple and Romano (1998) and Nechyba (2000), however, they find that the introduction of vouchers leads to increased stratification of SES-groups across schools.

A third related literature compares the test scores of students at private and public schools. Coleman, Hoffer and Kilgore (1982) documented that private school students in the U.S. (who mainly attend Catholic schools) have higher test scores than public school students. Cain and Goldberger (1982) cautioned that selectivity biases could account for this gap, and

[6] In an interesting district-level analysis, Millimet and Rangaprasad (2006) test for strategic interactions between the input choices of nearby school districts in Illinois, and report positive and generally significant effects of nearby competitors' choices on a district's choices over pupil/teacher ratios, spending per pupil, and average school size.

subsequent studies have used either Catholic religion, distance to a Catholic school, or the interaction of Catholic religion and distance to a Catholic school as instruments for private school choice (e.g., Evans and Schwab, 1995; Neal, 1997; Grogger and Neal, 2000; Figlio and Ludwig, 2000). Recently, Altonji, Elder, and Taber (2005b) have shown that all three of these instruments have some direct effect on test scores, invalidating the IV design. As discussed below, our identification strategy relies on comparisons between areas with different fractions of Catholic families to identify cross-system competition effects. To deal with the concern raised by Altonji et al.'s findings, however, we use a value-added specification that relates test score gains to an index of local competition that is proportional to the Catholic share.

II. Institutional Detail and Conceptual Framework

a. Institutional Background

Two parallel publicly-funded school systems have co-existed in Ontario since 1841. Originally both systems were financed by local property taxes, with ratepayers choosing which of the two systems to support. The province began an equalization system in the 1930s, and since 1985 the Ontario government has provided (roughly) equal funding for all elementary and secondary schools operated by the two boards.[7]

Today, Ontario public schools are secular and are legally required to accept all students, whereas separate schools restrict enrollment to the children of Catholic families.[8] The province is divided into overlapping partitions of public and separate school boards. As of 2003, there were 31 English speaking public school boards (with an average enrollment of 44,000) and 29

[7] Prior to 1998, provincial funding was based on an equalization plan similar to those used by state governments in the U.S. In 1998 the province shifted to full provincial funding of schools in both systems.

[8] Separate schools have some discretion in setting the degree of "Catholicism" required for admission, but most limit enrollment to baptized Catholics, or the children of a baptized Catholic. Separate schools can also in principle deny admission to students for behavioral or other reasons.

English speaking separate school boards (with an average enrollment of 18,000). There were also 23 "school authorities" that operated schools in remote rural areas, and a handful of French-language school boards.[9]

b. A Simple Model of Enrollment Demand, School Quality, and Managerial Effort

We present a simple model of enrollment choice by Catholic families. We then embed the enrollment demand functions in a model of effort determination by the managers of adjacent public and separate schools, and show how market characteristics – including the fraction of Catholic families in an area – would be expected to affect the efficiency of local schools.

Consider an area with n_1 non-Catholic families and n_2 Catholic families, each with one school-age child. Assume there are only two schools in the area: a public school with quality Q_p and a separate school with quality Q_s. (We discuss the case of multiple schools below). Catholic family i associates payoffs U_{ip} and U_{is} to the choices of the public and separate school, respectively, where

(1a) $U_{ip} = \alpha_{ip} + \beta Q_p - \gamma t_{ip} + \varepsilon_{ip}$

(1b) $U_{is} = \alpha_{is} + \beta Q_s - \gamma t_{is} + \varepsilon_{is}$.

Here, α_{ip} and α_{is} represent family-specific valuations associated with the choices, t_{ip} and t_{is} are the travel costs to the schools, and $(\varepsilon_{ip,}\varepsilon_{is})$ is a pair of random shocks assumed to be independently and identically distributed across the population.[10] Conditional on $(\alpha_{ip},\alpha_{is},Q_p,Q_s,t_{ip},t_{is})$, the probability that family i selects the public school is

$$F[\ \delta_i + \beta\Delta Q - \gamma\Delta t_i\ ]\ ,$$

[9] About 5% of students attend private schools that receive no public funding. We ignore these schools throughout this paper.
[10] A similar "random utility" formulation is widely used in models of demand for differentiated products. See Nevo (2000) for discussion and references, and Hastings, Kane and Staiger (2006) for an application to school choice.

where F is the distribution function of the random variable $v_i = \varepsilon_{ip} - \varepsilon_{is}$, $\delta_i = \alpha_{ip} - \alpha_{is}$ is a family-specific relative taste for public schools, ΔQ is the quality gap between the public and separate schools, and Δt_i is the difference in travel costs to the two schools.

Assume that the area can be divided into a set of neighborhoods k=1,2…K, and that all families in neighborhood k have the same travel cost differential Δt_k. The share of Catholic families who choose a public school is

$$(2) \qquad s_k(\Delta Q, \Delta t_k) = \int F[\, \delta_i + \beta\Delta Q - \gamma\Delta t_k \,]\, h(\delta_i|k)\, d\delta_i$$

where $h(\delta_i|k)$ represents the density of relative tastes among Catholic families in neighborhood k.[11] Letting n_{2k} represent the number of Catholic families in neighborhood k, the overall fraction of Catholics who choose the public school is

$$s(\Delta Q) \equiv \sum_k n_{2k}/n_2 \times s_k(\Delta Q, \Delta t_k) .$$

Public school enrollment is therefore

$$(3a) \qquad E_p = n_1 + n_2\, s(\Delta Q),$$

while separate school enrollment is:

$$(3b) \qquad E_s = n_2 \, [\, 1 - s(\Delta Q) \,] \; .$$

The responsiveness of public and separate school enrollment to the quality gap between schools is:

$$(4) \qquad \partial E_p/\partial \Delta Q = - \partial E_s/\partial \Delta Q = n_2\, s'(\Delta Q)$$

$$= n_2 \sum_k n_{2k}/n_2 \; \partial s_k(\Delta Q, \Delta t_k)/\partial \Delta Q \; ,$$

where

$$\partial s_k(\Delta Q, \Delta t_k)/\partial \Delta Q = \beta \int f[\, \delta_i + \beta\Delta Q - \gamma\Delta t_k \,]\, h(\delta_i|k)\, d\delta_i$$

[11] As an example, suppose δ_i is normally distributed with mean δ_k and variance σ^2 in neighborhood k. Then $s_k = \int \sigma^{-1} F[\sigma{\cdot}z+\delta_k+\beta\Delta Q-\gamma\Delta t_k]\varphi(z)dz$ where $\varphi(z)$ is the standard normal density.

and f[ ] is the density associated with F[ ]. This derivative is non-negative, with a magnitude that depends on the extent of taste heterogeneity among Catholic families. At one extreme, the population consists of only two types: families who always choose public schools ($\delta_i = \infty$) and those who never do ($\delta_i = -\infty$). In this case $\partial s_k / \partial \Delta Q = 0$, since neither type responds to quality. At the opposite extreme, $\delta_i = \delta$ (i.e., h is degenerate). In this case, all the Catholic families in neighborhood k choose the public school if and only if $\delta + \beta \Delta Q - \gamma \Delta t_k > 0$, implying that $s(\Delta Q)$ is a step function with jumps at each neighborhood threshold. For simplicity we assume that h lies between these two extremes, and is strictly positive on $(-\infty, \infty)$.

Assume that school quality is an increasing concave function of the level of effort (e) exerted by school managers (or management teams):

$$Q_\ell = q(e_\ell), \text{ for } \ell = \{s,p\},$$

and that the preferences of each manager are represented by a linear function of effort and the *share* of local students attending his or her school:

$$U_\ell(E_\ell, e_\ell) = \theta E_\ell / n - e_\ell ,$$

where $\theta > 0$ reflects the relative weight on market share. Assuming that managers engage in a simple effort-setting game, the first order conditions for optimal effort choices are:

(5a) $\theta \, (n_2/n) \, s'(\Delta Q) \, q'(e_p) - 1 = 0$

(5b) $\theta \, (n_2/n) \, s'(\Delta Q) \, q'(e_s) - 1 = 0$.

Since these equations are symmetric, both managers supply the same level of effort e^*, with

(6) $q'(e^*) = 1 / [\theta \, (n_2/n) \, s'(0)]$.

By assumption $q'(e)$ is decreasing in e, so equilibrium effort is increasing in $(n_2/n)s'(0)$, the derivative of market share with respect to the quality gap, evaluated at $\Delta Q = 0$. Note that since only Catholic families can exercise choice, this is proportional to the local fraction of Catholics.

c. Assessing the Sensitivity of Enrollment Demand to Relative Quality

In the absence of direct information on school quality it is difficult to measure the reaction of market shares to relative quality. Nevertheless, under our assumed demand model, important insights can be gained by studying the responses of enrollment at a given school to a change in the number of nearby schools operated by the competing system. For example, suppose that a new separate school is opened with the same quality as the existing separate school. The predicted change in enrollment at the public school is:

$$\partial E_p/\partial Open_s = n_2 \sum_k (n_{2k}/n_2) \ \partial s_k(\Delta Q, \Delta t_k)/\partial \Delta t_k \times \partial \Delta t_k/\partial Open_s$$

where $\partial \Delta t_k/\partial Open_s$ represents the relative change in travel costs in neighborhood k to attend a public versus separate school. For neighborhoods that are closer to the new separate school than the old one, this expression will be negative, leading some families to switch systems. From equation (2), however, the responsiveness of demand to a change in relative travel costs is proportional to the responsiveness to a change in relative quality:

(7) $$\partial s_k(\Delta Q, \Delta t_k)/\partial \Delta t_k = -\gamma/\beta \ \partial s_k(\Delta Q, \Delta t_k)/\partial \Delta Q \ .$$

Thus, the enrollment response to a nearby opening is proportional to a weighted sum of the derivatives of the market shares in each neighborhood with respect to quality:

(8) $$\partial E_p/\partial Open_s = -\gamma/\beta \ n_2 \sum_k (n_{2k}/n_2) \ \partial s_k(\Delta Q, \Delta t_k)/\partial \Delta Q \times \partial \Delta t_k/\partial Open_s \ ,$$

where the "weight, " $\partial \Delta t_k/\partial Open_s$, depends on the change in relative travel costs experienced by families in each neighborhood. Assuming that the travel cost changes are a function of local geography, and don't covary systematically with the distribution of tastes, we can use differences in the observed changes in enrollment following nearby openings by the competing system to infer the relative sensitivity of enrollment demand to quality.

The following table summarizes the main assumptions of our model, and the relationship between the strength of local quality competition incentives and the reaction of enrollment to the opening of a new school by the rival system.

	Catholic Family	**Non-Catholic Family**
Factors Affecting Choice:	Family Specific Valuation of Secular vs. Catholic Environment Relative Distance to Public & Separate Schools (Δt) Relative Quality of Separate & Public Schools (ΔQ)	Must attend Public School
	Separate School	**Public School**
Market Share	C (1 − s(ΔQ, Δt)) C = fraction Catholics s(ΔQ, Δt) = share who attend public schools	1 − C (1 − s(ΔQ, Δt))
Equilibrium Effort	Varies with C ∂s(ΔQ, Δt)/∂ΔQ	(symmetric equilibrium)
Enrollment Response to Competitor Opening	− C ∂s(ΔQ, Δt)/∂Δt × ∂Δt/∂Open Demand model implies proportionality: ∂s(ΔQ, Δt)/∂Δt = k ∂s(ΔQ, Δt)/∂ΔQ	C ∂s(ΔQ, Δt)/∂Δt × ∂Δt/∂Open

d. Extensions and Implementation

Contrary to the model so far, most cities and towns have more than one school of each type. Since school boards use attendance zones (or "catchment areas," as they are known in Ontario) to assign neighborhoods to specific schools, even with multiple schools Catholic families can only choose between two alternatives (their assigned public and separate schools), whereas non-Catholics have no choice. Unless the attendance zones of the two systems happen to overlap, however, the manager of a given school competes against multiple managers in the opposing system, leading to a more complex equilibrium in the effort setting game.

To simplify notation, define a neighborhood by the identity of its assigned schools: thus students in neighborhood (j,k) can attend either public school j or separate school k. Let n_{2jk} represent the number of Catholic students in neighborhood (j,k) and let

$$s_{jk}(\Delta Q_{jk}, \Delta t_{jk}) = \int F[\ \delta_i + \beta\Delta Q_{jk} - \gamma\Delta t_{jk}\ ]\ h(\delta_i|j,k)\ d\delta_i$$

represent the share of these students who attend public school j, given the quality differential ΔQ_{jk} and relative travel costs Δt_{jk}. Public school j's attendance zone includes n_{1j} non-Catholic students and $n_{2j} = \Sigma_k\ n_{2jk}$ Catholic students (with similar expressions for separate school k).[12] Total enrollment at public school j is therefore

$$E_j = n_{1j} + n_{2j}\ \Sigma_k\ n_{2jk}/n_{2j}\ \ s_{jk}(\Delta Q_{jk}, \Delta t_{jk})\ ,$$

while total enrollment at separate school k is

$$E_k = n_{2k}\ \Sigma_j\ n_{2jk}/n_{2k}\ \ (1-s_{jk}(\Delta Q_{jk}, \Delta t_{jk}))\ .$$

Assuming that school quality depends on managerial effort as before, and that school managers have the same objective function specified earlier, the first order condition for the effort choice of the manager of the j^{th} public school is

$$\text{(9a)} \quad \theta\ (n_{2j}/n_j)\ \{\ \Sigma_k\ (n_{2jk}/n_{2j})\ \partial s_{jk}(\Delta Q_{jk}, \Delta t_{jk})/\partial\Delta Q\ \}\ \ q'(e_j) - 1 = 0\ ,$$

while the corresponding condition for the manager of the k^{th} separate school is

$$\text{(9b)} \quad \theta\ (n_{2k}/n_k)\ \{\ \Sigma_j\ (n_{2jk}/n_{2k})\ \partial s_{jk}(\Delta Q_{jk}, \Delta t_{jk})/\partial\Delta Q\ \}\ q'(e_k) - 1 = 0\ .$$

As a benchmark, consider the case in which: (i) the distribution of tastes is the same in all neighborhoods (i.e., $h(\delta_i|j,k)= h(\delta_i)$); (ii) relative travel costs are the same in all neighborhoods (i.e., $\Delta t_{jk}= \Delta t$); (iii) the relative fraction of Catholic students is constant and equal to n_2/n across all neighborhoods. Under these conditions,

$$s_{jk}(\Delta Q_{jk}, \Delta t_{jk}) = s(\Delta Q_{jk}, \Delta t)\ \equiv \int F[\delta_i + \beta\Delta Q_{jk} - \gamma\Delta t]\ h(\delta_i)d\delta_i\ ,$$

and the effort game has a symmetric equilibrium with $e_j= e_k=e^*$, where e^* satisfies the condition

[12] Note that n_{2jk} can be 0 if there is no neighborhood where public school j and separate school k compete.

(10) $\theta\ (n_2/n)\ \partial s(0, \Delta t)/\partial \Delta Q\ \ q'(e^*)\ -\ 1\ =\ 0.$

This is the same as the equilibrium condition in the two-school case given by equation (6).

More generally, in a multi-school setting the incentives for effort of the manager of a given school depend on the fraction of students in the catchment area who can potentially move to the other system, and on a weighted average of the derivatives of the enrollment share in each neighborhood with respect to relative school quality (i.e., $\Sigma_k\ (n_{2jk}/n_{2j})\ \partial s_{jk}(\Delta Q_{jk}, \Delta t_{jk})/\partial \Delta Q$). As in the simpler two-school setting, this derivative is closely related to the sensitivity of enrollment to a change in the number of nearby schools operated by the competing system. In particular, holding constant the spatial arrangement of homes and schools, schools with market shares that are more sensitive to quality will lose more students when the opposing system opens a new school nearby.[13]

We use this insight to develop an index of the cross-system competitive pressure facing a given school. Specifically, we estimate a flexible model of the enrollment changes at a given school as nearby schools open or close, and take the predicted enrollment losses associated with a nearby opening by the opposing system as our index of competitive pressure.[14] Note that these losses are proportional to the fraction of Catholic families around the school. Thus, as a simple check we use the local fraction of Catholics as a base measure of potential competition.

[13] This can be easily established with a slight modification of equations (7) and (8).

[14] If a nearby opening causes enrollment losses, and the catchment areas of the existing schools are increased to compensate, the net change we observe will underestimate the number of students who switched systems. This will affect the scale of our competition index but will not necessarily lead to biases in the measured effect of the index on school efficiency.

e. Modeling the Effect of Competition on Student Achievement

The second step in our empirical analysis is to relate the degree of competition between systems to the academic achievement of students. Our achievement measures are based on standardized tests written by students in the 3rd and 6th grades. Building on existing studies (e.g., Rivkin, Hanushek, and Kain, 2005) we assume that the test score of student i in grade g who attends school s in area a depends on observed student characteristics X_{isa}, on school characteristics Z_{sa} (including an indicator for whether the school is public or separate), on the observed characteristics of the local area W_a, and on an measure of cross-system competitive pressure, IC_{sa}, that depends on characteristics of the school and the area:

$$(11) \quad T_{gisa} = X_{gisa}b_{gx} + Z_{sa}b_{gz} + W_a b_{gw} + IC_{sa}b_{gI} + e_{gisa} ,$$

where e_{gisa} represents unobserved determinants of achievement. Note that the coefficients on the explanatory variables in (11) are all grade-specific. If $b_{6I}>b_{3I}>0$, for example, then an increase in competitive pressure affects both the level of achievement in grade 3 and the rate of achievement growth between 3rd and 6th grades.

Our theoretical model suggests that a key determinant of competitive pressure is the fraction of Catholic families in the area (C_a). In fact, based on the model and our estimates of the enrollment responses to nearby school openings, we use two different proxies for competition: one is just C_a, the other is the product of C_a with a measure of local population growth. We also construct indexes of the form:

$$IC_{sa} = C_a \times Z_{1sa} \hat{\rho}$$

where Z_{1sa} is either a constant or a measure of local population growth, and $\hat{\rho}$ is a set of estimated coefficients from our enrollment growth models. All of these measures pose a potential problem for OLS estimation of (11) if there are unobserved ability components that happen to be correlated with C_a. Studies from the U.S. suggest that Catholic students have higher test scores than non-Catholics (e.g., Grogger and Neal, 2000). Since we do not observe the religious affiliation of test-takers, any function of C_a will tend to pick up the individual Catholic effect. In addition, evidence assembled by Altonji, Elder, and Taber (2005b) suggests that the local fraction of Catholic children has some direct effect on achievement, potentially leading to biased inferences about the impact of our competition measures.

We address these concerns by estimating models with school×cohort fixed effects that enter the time-invariant covariates as interactions with a dummy for grade 6 ($Gr6_g$):

(12) $T_{gisa} = X_{gisa}b_{gx} + Z_{sa}Gr6_g\, b_z + W_aGr6_g\, b_w + IC_{sa}Gr6_g\, b_I + \xi_{coh,isa} + e'_{gisa}$,

where $\xi_{coh,isa}$ represents a fixed effect for the cohort of students at school s who were in third grade with student i. With school×cohort fixed effects included we can only identify the effects of the time-invariant variables on the growth of student achievement between 3rd and 6th grades. The coefficient of the competitive index in (12), for example, is $b_I=b_{6I}-b_{3I}$, with similar expressions for b_z and b_w .

If the same students are present at each school in 3rd and 6th grades, estimates obtained from equation (12) are equivalent to estimates from a model estimated on the changes in individual test scores between grade 3 and grade 6.[15] With in- and out-migration, however, a model with school×cohort effects will not in general yield the same coefficient estimates as a first-differenced model fit on the sample who remain at a given school (the conventional value-added approach). OLS estimation of equation (12) will yield consistent estimates of the value-added coefficients if the average abilities of the leavers and joiners at a given school are equal.[16]

[15] This is true provided that the first differenced specification allows grade-specific coefficients for the time-varying individual X's.
[16] A differenced model for the stayers, by comparison, requires that school leavers are as good as randomly selected.

Although this assumption is likely to hold exactly, we believe it is reasonable and maintain it throughout our analysis.

A second key assumption is that the measure of competitive pressure is orthogonal to unobserved determinants of achievement *growth*. We control for factors that may be jointly correlated with achievement growth and our compound indexes by adding local population growth directly in the test growth model, and by including controls for the local fractions of different ethnic groups. In some specifications we also control for the fraction of families with no religious affiliation, or non-Christian affiliation.

III. Enrollment Responses to Nearby Openings and Closings

In this section we estimate the cross-system enrollment responses to openings and closings of nearby elementary schools. We begin by briefly describing our sample of opened and closed schools, and the characteristics of the nearby affected schools. We then discuss a basic model that measures the effects of nearby openings and closings on enrollment growth at existing schools. Finally, we estimate models that allow the effects of nearby openings to vary with area characteristics.

a. Identification of Openings and Closings

We obtained a file containing information on all publicly funded schools in operation in Ontario between 1990 and 2004. We eliminate schools operated by French language school boards and those with no students in grades 2-4.[17] We define a school as newly opened if enrollment in grades 2-4 is positive in a given year (the "opening year") and if *total* enrollment is

[17] We include "French Immersion" schools as they are offered by the English language school boards. During the 1990s the number of elementary schools in operation in the province remained fairly stable, at around 2300 public schools and 1100 separate schools.

zero in all previous years. Similarly, a school is defined as closing if enrollment in grades 2-4 is positive in a given year and if *total* enrollment is zero in the next year (the "closing year") and all subsequent years.[18] More detailed information on how we processed the list of schools and checked opening and closing dates is provided in Appendix 1.

Panel A of Table 1 reports some information on the openings and closings in our sample. There were 252 openings and 212 closings in the public system and 169 openings and 102 closings in the separate school system. As shown in the second column of the table, about 60% of the openings and 70% of the closings occurred in the last 6 years of the sample, reflecting a major reorganization in 1998 that reduced the number of school boards in the province.[19]

The majority of openings are observed in the ring of rapidly growing suburbs around metropolitan Toronto. Closings are concentrated in the older central neighborhoods of Toronto, and in more remote rural areas. We use the "forward sortation area" (FSA) defined by the first 3 characters of a school's postal code to define the neighborhoods around each school. Openings and closings by the two systems are positively correlated across FSA's, reflecting population trends that affect both systems. Among FSAs with at least one opening, for example, nearly one-half experienced openings by both systems, while among those with at least one closing, one quarter experienced closings by both systems. Using Census information tabulated at the FSA level we compared areas with openings and closings. As might be expected, a major difference

[18] Schools are sometimes paired together for administrative purposes. When this occurs both schools are listed as in operation, though enrollment is only reported at one of the schools. We identified "pairing events" and verified their status with information from the Ministry of Education. They are not counted as openings or closings.

[19] At the same time the province moved from a funding system that combined local property taxes and extensive equalization payments to one with full funding from the province.

is in the fraction of newer houses (i.e. houses built after 1991). This ranges from 4% in FSA's with only closings to 18.6% in those with only openings.[20]

b. Defining Nearby Schools

Our next step is to define the set of schools that were potentially affected by an opening or closing event. For simplicity, we limit attention to non-rural affected schools, as identified by their postal codes.[21] As explained in more detail in Appendix 2, we start by including all existing schools in a circle around the newly opened or closed school, with radius equal to the average travel distance from home to school for students at nearby elementary schools.[22] This procedure selects a smaller radius (typically 1-2 kilometers) in densely populated areas, and a wider radius in suburban and rural areas. We then used satellite images and printed maps to eliminate schools that were separated from the newly opened or closed school by a major travel barrier (e.g., a controlled-access highway or ravine). We have checked the sensitivity of our results to the inclusion of these "rejected" schools and find similar (although typically weaker) evidence of cross-system competition when they are included.[23]

The third column in Panel A of Table 1 reports the share of opening and closing events for which we were able to identify at least one non-rural affected school. This ranges from 65% for public school closures to over 90% for separate school closures. In columns 4 and 5, we

[20] There is also some variation in income and family structure. FSA's with only openings have the highest average income and lowest fraction of single parents, whereas those with only closings have the lowest family incomes and the most single parents. Differences in religious affiliation, education, and family size are smaller, although the fraction of immigrants tends to be lower in areas with both openings and closings than in other areas, as does the fraction of Catholics.

[21] Because openings or closings of rural schools could affect non-rural schools, we identify <u>all</u> openings and closings, but only study the effects on urban/suburban schools.

[22] We obtained information for one year on the postal codes of all students attending each elementary school in the province. We use centroids of the postal codes for the schools and the homes to compute travel distances.

[23] We also created a data set that included only the schools near an opening or closing that are excluded from the main analysis sample. The estimated effects of openings and closings on these "excluded" schools are small and statistically insignificant.

report the means and standard deviations of total enrollment (for grades 1-6) at the opened and closed schools, classified by whether we can identify at least one affected non-rural school. Typically, a newly opened school has about 320 students in the period after opening, with little difference between those that are close to other schools and those that are not. Closing schools tend to be much smaller, especially those with no nearby urban or suburban school.

Panel B of Table 1 shows the number of affected schools associated with various opening/closing events, and the average distance between the opening/closing school and the affected school(s). An interesting feature of the data is that affected schools in the competing system tend to be slightly closer to the opening/closing school than affected schools in the same system. This suggests that the opening and closings events have the potential to induce at least some students to move between the rival systems.

Panel C of Table 1 shows the distribution of the number of affected schools for each type of opening or closing event. On average, a school opening affects 2.6 nearby schools, whereas a closing affects 3.6 nearby schools. The smaller number for openings reflects their concentration in suburban areas with a relatively low density of existing schools. Closing schools, by comparison, tend to be drawn from older neighborhoods where schools are closer together. In view of the relatively small size of closing schools (Panel A) and the relatively high number of nearby schools, the impact of a closing on any single nearby school is likely to be modest.

c. Effects of Nearby Openings and Closings on Enrollment

Our third step is to estimate the effect of nearby openings and closings on affected schools. Of the roughly 2,600 non-rural elementary schools that were in operation for at least two years, 945 were affected by at least one opening or closing event and have enrollment data from both before and after the event.[24] A cross-classification of these schools by the number of "affecting events" (i.e. nearby openings and closings) is presented in Appendix Table 3. Two-thirds were affected by only one event, and another quarter was affected by exactly two events. Only about 10% were affected by three or more opening/closing events.

Using the data on these affected schools, we estimate enrollment models of the form:

$$(13) \quad \Delta E_{sat} = X_{sat}b + \sum_{j=1}^{4} Event_{jst} \times \{ D_s d_{j-pub} + (1-D_s) d_{j-sep} \} + \alpha_s + \omega_t + e_{sat},$$

where ΔE_{sat} is a measure of enrollment growth at school s in area a in year t; X_{sat} is a vector of time-varying school and area characteristics; $Event_{jst}$ is a counter for the cumulative number of opening/closing events at nearby public/separate schools that have affected this school so far, D_s is a dummy for a public school, α_s is a school fixed effect, ω_t is a period fixed effect, and e_{sat} represents an error term. Note that we identify four types of events -- public openings, separate openings, public closings, and separate closings -- and allow separate coefficients (d_{j-pub} and d_{j-sep}) for the effect of each event type on nearby public and separate schools.

Our primary measure of enrollment growth is the percentage increase in enrollment at a school from grades 1-5 in the previous year to grades 2-6 in the current year.[25] This measure averages the growth rates of the five continuing cohorts at the school and captures any systematic losses or gains in enrollment among students who are already attending the school. As an alternative we use the change in grade 1 enrollment from the previous year to the current year. This measure is noisier because of year-to-year fluctuations in the size of the grade 1 entry cohort. On the other hand, to the extent that parents make a "once for all" school choice when

[24] We exclude middle schools that never had any enrollment below 6^{th} grade during the sample period. Combined schools that have both grades 1-6 and 7-8 are included in our final sample in any year that they have grades 1 to 6.
[25] Our school level database includes enrollment by grade for each school, as well as the enrollment of ungraded students in special education and other programs. We allocated these students uniformly across all grades offered by the school. For schools that do not offer all grades from 1 to 6, we modify the enrollment measure to reflect only those grades for which the school consistently has enrollment.

their children first enter elementary school, the growth in first grade enrollment may be more sensitive to changes in the availability of alternative schools than the growth in continuing enrollment.

Table 2 presents the means and standard deviations of these two enrollment measures for the schools in our sample. The first row also shows average first-grade enrollments. A typical public school in our sample has about 50 first grade students (and similar enrollments at higher grades), while a typical separate school is a little smaller (44 students). Between consecutive years grade 1 enrollment rises at an average rate of 1.9% in the public schools and 2.4% in separate schools. Growth rates vary substantially across schools, with a standard deviation of 26% for the public schools and 31% for the separate schools. Average enrollment growth from grades 1-5 to grades 2-6 is smaller (under 1% at both public and separate schools), and less variable.

We include two time-varying school level controls in our enrollment growth models: an indicator for whether the school is paired with another school for administrative purposes, the share of new teachers in the school, and the total administrative experience of the principal. [26] As neighborhood controls we use linear interpolation of FSA-level means from the 1991, 1996, and 2001 Censuses to construct time-varying measures of total FSA population, the shares of the population aged 5-9 and 10-14, the share of recently constructed houses in the FSA, and various demographic characteristics of the local population, including the fractions of residents who are Catholic.[27] In addition to these Census-based controls, we use our school database to estimate the fractions of local children enrolled in public Francophone schools and private schools.

[26] We have explored specifications that also include whether the school has recently opened (within the last 6 years). The results are similar to those reported in this paper.
[27] Measures on religion were only collected in the 1991 and 2001 Censuses. In assigning FSA characteristics to schools, we use the FSAs boundaries as of 1996, and link FSA's across Census years using information provided by

Estimation results for a basic version of equation (13) are reported in Table 3. The first 2 rows of the table show the estimated coefficients associated with nearby openings, while rows 3-4 show the coefficients associated with nearby closings. Looking first at changes in grade one enrollment (column 1), the estimated coefficients suggest that nearby openings lead to enrollment losses of 6-8% at nearby schools in the same system, presumably reflecting the re-alignment of attendance zones. More important from our perspective are the cross-system enrollment changes, which are also negative, but about one-half as large. In particular, we estimate that grade 1 enrollment at separate schools is reduced by 4.5% (or about 2 students) when a public school is opened nearby, while the average loss at public schools when a separate school opens nearby is 3.4% (or roughly 2 students).

The results using the within-cohort enrollment change measure (column 2) are generally similar, but more precisely estimated. The opening of a public school is estimated to cause enrollment losses of about 4% at nearby public schools, and 2% at nearby separate schools. Given average enrollment of about 50 students per grade, these estimates imply a net movement of 2-3 students per grade from nearby affected schools to the newly opened public school, with only slightly smaller cross-system impacts than own effects. The opening of a new separate school leads to a relatively large "own effect" of -7% on nearby separate schools, and a -3% "cross effect" at nearby public schools.[28]

In contrast to the significant cross-system responses to openings, neither enrollment measure gives much evidence of a cross-system reaction to closings. For example, the results in column 2 show that a public school closing is associated with a 3% enrollment gain at nearby

---

Statistics Canada. 1991 data are unavailable for a few FSAs: in these cases we use data for 1996 to assign information to the period from 1990 to 1996. Summary statistics on the census measures are provided in Appendix Table 4.

[28] One explanation for the larger own-system effect of separate school openings is that the separate school boards allow more over-crowding at their existing schools before opening a new school.

public schools but a small enrollment *loss* at nearby separate schools. Likewise, separate school closings are estimated to cause small enrollment losses at nearby public schools.

What explains the different reactions to openings and closings? As noted earlier, closing schools are smaller and closer to more existing schools. Both considerations suggest that a closing would exert a relatively smaller impact on a nearby school. A related factor is that the cross-system responses to openings and closings depend on how they affect relative travel times. In high-density neighborhoods the net impacts of an opening or closing on relative travel times will tend to be smaller than in low-density suburbs. Since closings are concentrated in urban neighborhoods, whereas openings are concentrated in fast-growing suburbs (with typically larger attendance zones) the expected cross-system impacts of closings are smaller.

A third possibility is that the Catholic families in newer suburban neighborhoods have less affinity for a particular school or system, perhaps because they have had had less time to establish links in the community.[29] To evaluate this hypothesis we fit a series of models that allow the nearby opening effects to vary with a simple proxy for the "newness" of an area – the rate of growth of the population in the surrounding FSA in the previous year. The results are presented in column 2 of Table 4.[30] (For reference, column 1 of this table reproduces the opening effects from the model in column 2 of Table 3). The interaction coefficients in column 2 show that nearby openings have consistently larger (i.e., more negative) own and cross-system effects in areas with faster population growth. The larger own-system effects are presumably <u>not</u> the result of parental choice, since families are assigned to a given school within each of the two

---

[29] Yet another possibility is that parents prefer new schools. In this case the cross-system response to an opening includes the demand effect associated with a new school. Interestingly, we see no evidence of this effect. In fact, without controlling for other neighborhood characteristics, newer schools have <u>bigger</u> enrollment losses following the opening of a nearby school by the competing system. Most of this effect disappears when we control for population growth in the neighborhood.

[30] Note that the estimated models in Table 4 include reactions to nearby closings, but for simplicity these are not reported in the table.

systems depending on where they live. Instead, we interpret the own-effect interactions as showing that boards make bigger attendance zone adjustments when they open a new school in a rapidly growing suburb than in an older neighborhood.[31] The cross-system opening interactions are also strongly negative, suggesting that Catholic parents in these neighborhoods are more willing to switch systems when the rival system opens a nearby school. The responses in areas with stable or declining population, by comparison, are very small and similar in magnitude to the cross-system enrollment flows following school closings.

d. Determinants of Cross-system Competition

A key implication of the model developed in section II is that the derivative of enrollment with respect to changes in the schools offered by the competing system is proportional to the fraction of Catholics in the local area.[32] To test this we include interactions of the cross-system opening indicators with the fraction Catholic in the local area, which ranges in our sample from 16 to 85%. Results for four versions of this specification are reported in columns 3-6 of Table 4.

The specification in column 3 includes both the main effects of cross-system openings, and their interactions with the local fraction of Catholics. Judging by the sampling errors of the estimates from this model we do not have enough power to separately identify the main opening effects and the interaction terms. To improve precision, we fit the restricted model reported in column 4 that excludes the main effects. This specification imposes the prediction of our theoretical model that the opening responses vary proportionally with the fraction of Catholics in the area, and fits as well as the less restrictive model. Interestingly, the magnitudes of the

[31] The mean annual population growth rate across FSA's is 0.02 (i.e., 2%), whereas the 95th percentile is 0.10 (10%). Thus, the own system effects for public schools show a 10% bigger enrollment loss at a public school in a very high growth area than in an average area following the opening of another nearby public school.

[32] Strictly speaking this is only true if the distribution of preferences for secular versus Catholic education among Catholic families does not vary with the local fraction of Catholics.

coefficients suggest that in very-high Catholic areas, the own and cross-system reactions to nearby openings are similar.

The model in column 5 of Table 4 allows the cross effects to vary with both the local Catholic share and the population growth rate. Echoing the results in column 2, the triple interaction terms (in rows 8 and 12) are relatively large in magnitude and statistically significant, whereas the two-way interactions of the Catholic share with the opening indicator (in rows 7 and 11) are small. Our final specification, in column (6), therefore drops the Catholic interactions and includes only the triple interactions of Opening×Catholic Share×Population Growth. This model implies that in an FSA with a growth rate of 0.05 (the average among FSA's with new openings) and a 40% Catholic share, the opening of a new public school leads to enrollment losses of about 2 percent at nearby separate schools, while the opening of a new separate school leads to enrollment losses of about 3% at nearby public schools. In areas with a greater share of Catholics or faster population growth, the reactions are bigger, whereas in areas with few Catholics, or negligible growth, the reactions are essentially 0.

An important pattern than emerges across all the specifications in Table 4 is that the cross-system enrollment responses to nearby openings are larger at public schools than separate schools. The models in columns 4 and 6, for example, suggest that holding constant the local share of Catholics and local population growth, the effects are about 2 times larger at public schools. This may seem surprising because at a typical public school only a fraction of the children are Catholic (and therefore eligible to switch systems) whereas at a separate school all the children could potentially switch. In an area with a 40% Catholic share, for example, the model in column 4 implies that the opening of a new separate school causes a 3.6% enrollment loss at a nearby public school, or something like 1/5 of all the Catholic students at the school, whereas the opening of a new public school causes only a 2% enrollment loss at a nearby separate school. One explanation is that Catholic families with children in public schools are indifferent to secular versus religious school environments, but are relatively sensitive to school proximity, whereas most of the families with children at separate schools are highly committed to a Catholic education. To the extent this is true we would expect local competition to exert a bigger influence on public schools than separate schools – an implication that we confirm below in our test score models.

IV. Impacts of Competition on Student Achievement

The final step in our empirical analysis is to measure the effects of the local competitive environment on student achievement. As noted in Section IId, we measure achievement using standardized tests administered each spring to students in grades 3 and 6.[33] Test data are available from 1998 to 2005, allowing us to track a series of 5 cohorts, starting with students who were in 3rd grade in 1997-98, and ending with those in 3rd grade in 2001-02. We have data for roughly 65,000 public school students and 32,000 separate school students in each cohort.

The test sample has limited information on individual test takers, including gender, whether a student is classified as "exceptional" (i.e., special needs) or "gifted", whether he or she attended kindergarten, and whether he/she is enrolled in an English-as-a-Second-Language (ESL) or French Immersion program. (We do not know whether a student is Catholic). Means for these characteristics by grade and public versus separate school status are shown in the upper rows of Table 5. There are some small but statistically significant differences between students

[33] Data on EQAO tests were provided under a Freedom of Information Request submitted to the Ministry of Education. EQAO will not release test records for schools with fewer than 15 students enrolled in the grade of the test. Thus, our analysis does not include those schools with low enrollments. While many of these smaller schools are located in rural areas, some are special alternative schools located in urban areas.

in the two systems. For example, separate school students are a little more likely to have attended kindergarten, are less likely to be classified as exceptional or gifted, and are less likely to be enrolled in ESL or French Immersion.

We limit our analysis sample to children in school-cohort groups that have both 3rd and 6th grade test scores, with at least 10 test takers in each grade. We also compare the number of test takers in a cohort in 3rd and 6th grades, and eliminate school-cohort groups for which the ratio is greater than 1.4 or less than 0.71(=1/1.4). We have compared results using different exclusion rules and find that the coefficients estimates are similar, though typically a little smaller in absolute value, when we retain cohorts with a wider range of variation in the number of test takers. The fraction of test takers excluded depends on the test and grade and also varies between systems. Our final sample includes 65-70% of all public school test takers and a higher fraction (85-96%) of all separate school test takers. These students are drawn from approximately 9000 school-cohort groups who attended 2000 different schools.

Summary statistics for the test outcomes of the analysis sample are presented in the bottom rows of Table 5.[34] We show the mean test scores by grade and public/separate school status for the three main test components: reading, mathematics, and writing. The test results are reported on a relatively coarse scale of 1-4 with 4 representing the top score.[35] The mean test score is typically around 2.6 while the standard deviation ranges from 0.6 to 0.8. Math test scores are a little higher for public school students, especially in grade 3, while writing scores are a little higher in separate schools, and reading scores are very similar.

[34] Appendix Table 5 shows the mean test score outcomes for the overall samples of test takers, and presents some information on the fractions of students whose scores are missing. Many of the missing observations are attributable to exceptional students, who are not required to take the test.
[35] This limited scale poses a potential attenuation problem, although the fraction of students coded with the minimum score is less than 10% while the fraction coded with the top score is less than 15%.

Table 6 presents estimation results for four alternative specifications of equation (12), fit separately to individual scores in reading, mathematics, and writing. Each specification includes the six student-level controls available in our data set with grade-specific coefficients (gender, ESL status, French immersion, gifted status, exceptional status, and whether the student attended kindergarten), as well as dummies indicating whether a student's gender or kindergarten attendance is unknown. We also include cohort-specific means of the student variables, along with the fraction of the cohort with missing test scores and the fraction of missing students who are coded as exceptional, all interacted with grade 6 status. In addition, the models include a dummy for 6^{th} grade test-takers, and interactions of the 6^{th} grade dummy with a separate school indicator and five FSA-level characteristics: the population growth rate, the fraction of immigrants in the FSA, and the fractions in the FSA who report East Asian, South Asian, or European ethnicity.[36] All the models also include school×cohort fixed effects.

We use two alternative proxies for the strength of local competition. The first is the just the fraction of Catholics in the FSA, while the second (based on the results in Table 4) is the fraction of Catholics multiplied by the local population growth rate. In each case we present two models: one with a single coefficient on the proxy variable and a second that allows a separate effect for students in public and separate schools. Since our enrollment growth models suggest that both of these proxies have roughly twice as big an impact on public schools as separate schools, a key question is whether the effect on test score growth is roughly twice as big for students at public schools as at separate schools.

The models in Table 6 suggest that potential competition – as proxied by the local fraction of Catholics or its interaction with the rate of population growth – leads to faster test score growth. The coefficient estimates for reading and mathematics are comparable, while the

[36] Coefficients for these additional regressors for the reading test results are provided in Appendix Table 6.

estimated effects on writing are a little smaller in magnitude and marginally less significant. Importantly, for all three tests and either competition proxy, the estimated competition effects are roughly twice as big for students in public schools as for those in separate schools.[37]

To illustrate the size of the implied competition effects, consider a comparison between areas with a 20% Catholic share and a 60% Catholic share. The model in column 1 suggests that 6th grade reading scores are about 0.040 points higher in the higher-Catholic area, controlling for 3rd grade scores, student characteristics, and other characteristics of the local population. The standard deviation of 6th grade mathematics scores across students is approximately 0.8, so this is an effect size of approximately 5% of a standard deviation. The model in column 2 implies a somewhat bigger (0.048 point) gain for students at public schools, and a smaller (0.028 point) gain for students at separate schools. Similar effect sizes for test score gains in mathematics are implied by the models in columns 4 and 6, while the impacts on writing are about one-half as large.

The magnitude of the competition effects from the specifications using the interaction of Catholic share and population growth vary with the local population growth rate. As a point of reference, consider an area with a 4% growth rate. The model in column 3 implies that a 40 point increase in the local share of Catholics leads to a 0.024 (=0.4*0.04*1.48) gain in 6th grade reading scores. The model in column 4 gives a similar prediction for students at separate schools but implies a larger gain (0.044) for students at public schools. Again, the results for mathematics are similar, while those for writing are smaller.

Given the pattern of competition effects at public and separate schools in the interacted models in Table 6, we decided to fit a set of more restrictive models that use the enrollment growth coefficients from Table 4 to define two alternative indexes of competition: one based on

[37] Formal tests never reject this restriction, although the power of the tests is limited.

the local share of Catholics (from column 4 of Table 4) and the other based on the interaction of the Catholic share and local population growth (from column 6 of Table 4). The results are presented in the odd-numbered columns of Table 7.[38] The models in columns 1, 5, and 9 use the index based on the fraction of Catholics, while the models in columns 3, 7, and 11 use the index based on Catholic Share×Population Growth. The estimated competition effects from the two alternative indexes are generally of similar size (which makes sense, since both indexes are scaled to represent the proportional enrollment losses at a school when the competing system opens a nearby school). As in Table 6, the estimated effects for reading and mathematics are comparable in magnitude, while the effects for writing are smaller. And, as in Table 6, the coefficients associated with the interaction of the Catholic share and local population growth are more precisely estimated than the coefficients from the simpler Catholic share specification.

Although these models, like those in Table 6, suggest that competition between the dual systems raises student performance, one may still be concerned that the local fraction of Catholics is correlated with other factors that contribute to achievement growth between 3rd and 6th grades. One specific concern, suggested by recent work in the U.S., is that the local fraction of Catholics is (mechanically) negatively correlated with the fraction of families that report no religious affiliation. To the extent that the children of non-religious families have slower achievement growth, the models we have presented so far may overstate the effects of competition.[39]

To address this concern, the specifications in the even-numbered columns of Table 7 include two additional local controls (both interacted with the grade 6 dummy): the fraction of

[38] Specifically, the index based on the Catholic share = C_a×(0.094×Public + 0.052×Separate). The index based on the interaction = C_a×Pop.Growth×(2.118×Public + 1.056×Separate). The standard errors on the indexes are adjusted for the sampling errors of the enrollment growth coefficients using the procedure of Murphy and Topel (1985).
[39] See Lehrer (2005) for a review of evidence from the U.S. which generally concludes that religious affiliation has a positive effect on schooling outcomes.

people in the FSA who express no religious affiliation, and the fraction affiliated with non-Christian religions (i.e., Judaism, Islam, Hinduism, etc.). In these models, the effect of local competition is identified by variation in the fraction of Catholics, holding constant the fraction of Catholics and Protestants. Provided that children of Catholic and Protestant families have similar achievement growth, estimates from these models will provide consistent estimates of any competition effect.

The coefficients associated with these additional controls are reported in the third and fourth rows of Table 7. The estimates suggest that achievement growth is somewhat slower in areas with more non-religious families. In the case of reading the effects are relatively small and statistically insignificant, but in the case of mathematics the effects are relatively large. (The effect of the share of families with non-Christian religions is uniformly small and never significant). Controlling for the share of non-affiliated families, and those who identify with other non-Christian religions, the effects of the competition indexes are attenuated. Moreover, the sampling errors for the effect of the index based on the local fraction of Catholics increase substantially, reflecting the limited variation in this variable once we control for the fractions of families with no religion and non-Christian religions. Focusing on the more informative index based on the product of the local fraction of Catholics and population growth, the implied competitive effects on reading and mathematics are about 15% smaller than from parallel specifications without the extra controls, and only marginally significant. The implied effects on writing (which are always relatively weak) are reduced by about 30%.

We also re-estimated the specifications from columns 4, 8 and 12 of Table 6, including controls for the local fractions with no religion and non-Christian religions. In the reading test score model the estimated effect of Catholic Share×Population Growth is 2.33 (standard error=1.01) for public school students and 1.20 (0.75) for separate school students. For mathematics the corresponding coefficient estimates are 2.50 (1.55) and 1.63 (1.11), while for writing the estimates are 1.03 (0.73) and 0.62 (0.60). On average these estimates are about 20% smaller than the estimates for the parallel specifications in Table 6, confirming that the effects of local competition are slightly overstated in models that fail to control for the local fraction of "non-religious" people.

Overall, we interpret the results in Tables 6 and 7 as providing supportive, though clearly not decisive, evidence that competition for Catholic students in Ontario's dual system of publicly-financed schools leads to improved test outcomes. The average effects are relatively modest – on the order of 2-5% of a standard deviation increase in sixth grade reading or mathematics scores for a shift from an area where 20% of students can choose between systems to one where 60% can choose – and are only marginally significant in our most general specifications. On the other hand, we find a pattern of effects between public and separate schools that is remarkably consistent with the pattern of enrollment losses experienced when the competing system opens a nearby school, providing some additional evidence that competitive pressure accounts for the bigger test score gains in rapidly growing areas with a higher fraction of Catholics.

It is worth emphasizing that our test score measures have (at least) two major limitations. First, we are only measuring gains over 3 years, or one-quarter of the time that most students will spend in school. If similar effects were present at all stages of elementary and secondary schooling the benefits of competition would be commensurately greater. Second, it is possible that in more competitive markets teachers and principals spend more time and effort preparing for standardized tests, and less on other aspects of learning. If "test skills" have limited intellectual value, the effort devoted to competing over test outcomes is socially wasteful, and the higher test score gains observed in more competitive markets may be counter-productive. Arguably this concern is less important for tests of achievement at 3rd and 6th grades than for "IQ-like" tests, but it underscores the importance of using other longer-term outcomes (like high school graduation) in future work.

VI. Summary and Conclusions

Can a reduction in the monopoly power of local public schools improve the efficiency of elementary and secondary schools? In this paper we try to answer this question by studying the effects of school competition in Ontario, Canada, where two publicly funded school systems have co-existed for over a century. One of the systems is open to all students, while the other is limited to children of Catholic backgrounds. The fraction of families who can exercise choice between the competing systems varies widely across different areas of the province, providing the basis for our research design.

We analyze the dual system using a simple model of school choice and effort competition between school managers. This model predicts that schools operated by *both systems* will be more efficient in areas where there are more Catholics families willing to switch systems to access higher school quality. It also implies that we can infer the relative responsiveness of families to school quality by measuring the fraction who "switch brands" (Bucklin, Russell, and Srinivasan, 1998) when a nearby school is opened by the rival system.

We use a comprehensive panel of elementary schools to measure the characteristics of schools and areas that lead to greater sensitivity of enrollment to changes in the nearby schools operated by the competing school system. We find that enrollment losses following a nearby school opening by the other system are proportional to the share of Catholic families in the area. We also find that families are “less attached” to a system in more rapidly growing areas, suggesting that the effects of cross-system competition are most important in these areas.

We then analyze data for five cohorts of students who took province-wide standardized tests in reading, mathematics, and writing in grades 3 and 6. We model test outcomes using a value-added framework that relates the gains in scores for a cohort of student in a given school to characteristics of the students, the school, and the local area. In particular, we focus on the impact of cross-system competitive pressure, measured by the predicted enrollment losses at a school in response to a nearby school opening by the competing system.

Our basic specifications point to a significant but relatively small positive effect of enhanced competition on the test score gains of local students. Comparing markets where only 20 percent of children have choice to markets where 60 percent can choose between systems, we estimate that reading and mathematics test scores in 6^{th} grade are 0.02 to 0.05 of a standard deviation higher, relative to 3^{rd} grade scores. The impacts on writing are somewhat smaller, and mostly insignificant. Consistent with the patterns in our enrollment growth models, we find that competitive pressure is roughly twice as powerful at public schools as at separate schools.

Our most general specifications add controls for the local fractions of people who profess no religion, and non-Christian religions. In these specifications the estimated impacts of competition on test score gains are somewhat smaller, and only marginally significant. Taken as a whole, however, we interpret our findings as suggesting a positive impact of competition on test outcomes.

Our findings have at least two implications for education policy outside Ontario. First, it is clear that some fraction of students is willing to move between publicly-funded schools to access a combination of better quality or more convenient schools. Thus, competition can at least in principle lead to improved efficiency of publicly-funded schools. Extrapolating our estimates to a setting where 100% of students could choose between two competing systems, the implied effects are relatively large. Second, our results underscore the critical importance of further research on the links between parental choice decisions and the incentives faced by competing school systems.

References

Ahlin, Åsa, 2003. "Does School Competition Matter? Effects of a Large-Scale School Choice Reform on Student Performance," Working Paper Series 2003:2, Uppsala University, Department of Economics

Altonji, Joseph G., Todd E. Elder and Christopher R. Taber (2005a). "Selection on Observed and Unobserved Variables: Assessing the Effectiveness of Catholic Schools." *Journal of Political Economy* 113 (February), pp. 151-184.

Altonji, Joseph G., Todd E. Elder and Christopher R. Taber (2005b). "An Evaluation of Instrumental Variable Strategies for Estimating the Effects of Catholic Schools." *Journal of Human Resources* 40 (Fall), pp. 791-821.

Arum, R. (1996). "Do Private Schools Forces Public Schools to Compete?" *American Sociological Review* 61 (1), pp. 29-46.

Belfield, Clive R. and Henry M. Levin (2002). "The Effects of Competition on Educational Outcomes: A Review of U.S. Evidence." *Review of Educational Research* 72(2), pp.279-341

Bifulco, Robert and Helen F. Ladd (2004). "The Impacts of Charter Schools on Student Achievement: Evidence from North Carolina." *Education Finance and Policy* 1(1), pp.50-90.

Booker, Kevin, Scott Gilpatric, Timothy Gronberg, and Dennis Jansen (2005). "The Effect of Charter Schools on Traditional Public School Students in Texas: Are Children Who Stay Behind Left Behind?" Unpublished manuscript. Santa Monica: Rand Corportation.

Borland, M. V. and R. M. Howsen (1992). "Student Academic Achievement and the Degree of Market Concentration in Education." *Economics of Education Review* 11(1), pp. 31-39.

Bucklin, Randolph E., Gary J. Russell, and V. Srinivasan (1998). "A Relationship Between Market Share Elasticities and Brand Switching." *Journal of Marketing Research*, 35 (1), pp. 99-113.

Carnoy, Martin, Rebecca Jacobsen, Lawrence Mishel, and Richard Rothstein (2005). *The Charter School Dust-Up: Examining the Evidence on Enrollment and Achievement*. Washinton DC: Economic Policy Institute.

Chubb, John E. and Terry M. Moe (1990). *Politics, Markets, and America's Schools.* Washington DC: Brookings Institution.

Clark, Damon (2005). "Politics, Markets, and Schools: Quasi-Experimental Evidence on the Impact of Autonomy and Competition from Truly Revolutionary UK Reform." Unpublished manuscript. Gainesville FL: University of Florida Department of Economics.

Coleman, James S., Thomas Hoffer and Sally Kilgore (1982). *High School Achievement: Public, Catholic and Private Schools Compared*. New York: Basic Books.

Couch, J.F., William F. Shughart II. And A. L. Williams (1993). "Private School Enrollment and Public School Performance." *Public Choice* 76(4), pp. 301-312.

Dee, Thomas S. (1998). "Competition and the Quality of Public Schools." *Economics of Education Review* 17(4), pp. 419-427.

Epple, Dennis and Richard E. Romero (1999). "Competition Between Private and Public Schools, Vouchers, and Peer-Group Effects." *American Economic Review* 88 (March), pp. 33-62.

Evans, William N. and Robert M. Schwab (1995). "Finishing High School and Starting College: Do Catholic Schools Make a Difference?" *Quarterly Journal of Economics* 110 (November), pp. 941-974.

Figlio, David and Jens Ludwig (2000). "Sex, Drugs, and Catholic School: Private Schooling and Adolescent Non-Market Behavior." National Bureau of Economic Research Working Paper #7990. Cambridge MA: NBER.

Friedman, Milton. (1955). "The Role of Government in Education." In Robert A. Solo, editor, *Economics and the Public Interest*. New Brunswick New Jersey: Rutgers University Press.

Geller, Christopher R., David L. Sjoquist, and Mary Beth Walker (2006). "The Effect of Private School Competition on Public School Performance in Georgia." *Public Finance Review* 34 (January) , pp. 4-32.

Gibbons, Stephen, Stephen Machin, and Olmo Silva. (2006). "Choice, Competition and Pupil Achievement," IZA Discussion Papers 2214, Institute for the Study of Labor (IZA).

Goldberger, Arthur S. and Glen C. Cain (1982). "The Causal Analysis of Cognitive Outcomes in the Coleman, Hoffer and Kilgore Report." *Sociology of Education* 55 (April-July), pp. 103-122.

Grogger, Jeffrey and Derek Neal (2000). "Further Evidence on the Benefits of Catholic Secondary Schooling." *Brookings-Wharton Papers Urban Affairs*, pp. 151-193.

Hastings, Justine, Thomas Kane, and Douglas Staiger. (2006). "Parental Preferences and School Competition: Evidence from a Public School Choice Program." National Bureau of Economic Research Working Paper No. 11805. Cambridge, MA: NBER.

Howell, William G. and Paul E. Petersen (2002). *The Education Gap: Vouchers and Urban Schools.* Washington DC: Brookings Institution.

Hoxby, Caroline M. (1994). "Do Private Schools Provide Competition for Public Schools?" National Bureau of Economic Research Working Paper No. 4978. Cambridge, MA: NBER.

Hoxby, Caroline M. (2004). "Achievement in Charter Schools and Regular Schools in the United States: Understanding the Differences" Unpublished manuscript. Cambridge MA: Harvard University Department of Economics.

Hsieh, Chang-Tai and Miguel Urquiola (2006). "The Effects of Generalized School Choice on Achievement and Stratification: Evidence from Chile's Voucher Program." *Journal of Public Economics* 90, pp. 1477-1503.

Jepsen, Christopher (2002). "The Role of Aggregation in Estimating the Effects of Private School Competition on Student Achievement." *Journal of Urban Economics* 52, pp. 477-500.

Jepsen, Christopher (2003). "The Effectiveness of Catholic Primary Schooling." *Journal of Human Resources* 38 (Fall), pp. 928-941.

Krueger, Alan B. and Pei Zhu (2004). "Another Look at the New York City School Voucher Experiment." *American Behavioral Scientist* 47, pp. 658-98

Ladd, Helen F. (2002). "School Vouchers: A Critical View." *Journal of Economic Perspectives* 16 (Fall), pp. 3-24.

Lehrer, Evelyn L. (2005). "Young Women's Religious Affiliation and Participation as Determinants of High School Completion." IZA Working Paper No. 1818, October.

Nechyba, Thomas. (2000). "Mobility, Targeting and Private School Vouchers." *American Economic Review* 90 (March), pp. 130-146.

Neal, Derek (1997). "The Effects of Catholic Secondary Schooling on Educational Attainment." *Journal of Labor Economics* 15 (January), pp. 98-123.

Nevo, Aviv. "A Practitioner's Guide to Estimation of Random Coefficients Logit Models of Demand," *Journal of Economics & Management Strategy,* 9(4), 513-548, 2000.

Newmark, Craig M. (1995). "Another Look at Whether Private Schools Influence Public School Quality." *Public Choice* 82(3/4), pp. 365-373.

Millimet, Daniel L. and Vasudha Rangaprasad (2006). "Strategic Competition Amongst Public Schools." *Regional Science & Urban Economics,* forthcoming

Rivkin, Steven G., Eric Hanushek, and John F. Kain (2005). "Teachers, Schools, and Academic Achievement." *Econometrica* 73, pp. 417-458.

Rothstein, Jesse (2006a). "Good Principals or Good Peers: Parental Valuation of School Characteristics, Tiebout Equilibrium, and the Incentive Effects of Competition Among Jurisdictions." *American Economic Review* 96(4), pp. 1333-1350.

Rothstein, Jesse (2006b).”Does Competition Among Public Schools Benefit Students and Taxpayers? A Comment on Hoxby (2000).” *American Economic Review* (forthcoming).

Sander, William (1999). “Private Schools and Public School Achievement.” *Journal of Human Resources* 34 (Autumn), pp. 697-709.

Appendix 1:

Construction of a Data Set of Schools Affected by Openings and Closings

All data on Ontario schools were obtained from the Ministry of Education under several Freedom of Information Requests. The following basic school information was provided: school identification number, school name, school type, board affiliation, and last known address.[1] This information was requested for all schools that were in existence at any point from 1990 to the present. From this information, we identified a set of publicly funded, English speaking public and separate schools. This set of schools includes French Immersion programs in English speaking schools. From this set of schools, we excluded any school that we could identify as being a school operated for the mentally ill, prisons, and other types of special populations.[2]

For each school year, the Ministry provided enrollments for each grade based on the fall enrollment reports the schools were required to complete. From these enrollment figures we identified the set of schools for which a school had positive enrollment for one or more grades between 1st and 6th grades during the sample period.

Identification of an Opening or Closing

We tracked openings and closings of schools that offer grades 2, 3, and/or 4 in the opening or closing year.[3] To be classified as an opening school, enrollment in these grades must be positive in a given year (the "opening year") and *total enrollment* must be zero in previous years. Similarly, to be classified as a closing school, enrollment in grades 2, 3, and/or 4 must be

[1] If a school moved locations during the period under study, we do not observe the move.
[2] In the data cleaning process we excluded the following types of schools: schools whose address is located outside of the province; schools whose primary population are prisoners or infirmed individuals; schools that only offer kindergarten; schools on First Nation reserves; schools that never report a positive enrollment.
[3] This results in our excluding from an analysis "middle" schools that open or close during the sample period. In Ontario, most schools offer all grades between 1st and 8th grade.

positive in a given year and *total enrollment* must be zero in the next year (the "closing year") and all subsequent years. We ignore schools that open and close in the same year (i.e., only have positive enrollment in a single calendar year). Note that schools that expand or contract their grade offerings **are not** treated as opening or closing. Similarly, in a few situations, schools are paired together for administrative purposes. When this occurs provincial records show that both schools remain in operation but enrollment for the two is reported at only one of the schools. We identified these "pairing events" and validated their status with information from the Ministry of Education. We ignore enrollment changes arising from pairing events in the identification of an opening or closing.

Special considerations:

- Schools that change grades. There are a few schools that add or drop grades over time. Because these schools were in existence and continue to be in existence we do not treat them as openings or closings.

- There are some schools that close, remain closed for several years and then reopen. After confirming that the school has not been an annexed school in the intervening years (effectively remaining open during the period it appears to have been closed), we treat these events as separate events. We identified the following three events:
  - School closed in 1991 and then reopened in 1995.
  - School closed in 1993 and reopened in 1999.
  - School closed in 1995 and reopened in 1997.

- There are a few schools that appear to close in one year and within the next two years another school opens in the same location. Depending on changes in enrollments we either classify the schools as separate events or assume the events represent more of a "name" change than a true closing and opening. We identified seven sets of events that we concluded should not be treated as either closing or opening events.

- If a school slowly opens or slowly closes (e.g. increases/decreases the grades offered), we will modify the enrollment figures used in our analysis to reflect the change in enrollment for the appropriate cohorts of students (e.g. if a school opens and initially offers grades 1-3 but then expands to include grades 4-6, we will measure the change in enrollment to reflect enrollments for grades 1-3 in year t-1 and grades 2-4 in year t) if that school is used in the analysis (it is affected by another school that opens or closes). The year used to identify the opening or closing, however, is the first/last year the school is observed with positive enrollment, respectively.

Linking of school data to test scores

Beginning in school year 1998, all publicly funded schools were required to participate in the testing of students in grades 3 and 6 using a test instrument developed by the Educational Quality and Accountability Office ("EQAO"). The EQAO tests were designed to help schools and school boards obtain a better understanding of the effectiveness of the curriculum on obtaining student achievement. To date, performance on the EQAO test does not formally affect a school's budget. The test is given in the spring of each academic year. For each of three components (mathematics, reading, and writing), a student is scored on a scale of 1-4. Over time the duration and other aspects of the test have changed. The scale, however, has remained constant with 1 representing a well below expectations and 4 representing an exceeds expectation score.

For schools with more than **15** students, we obtained through a series of Freedom of Information requests student level data that contain information on student characteristics and performance on the three components of the test (mathematics, reading, and writing). We were provided with records for all students that should have sat the EQAO test. Thus, we were provided with records of students who only sat for part of the test and who did not sit for any of the test. To help control for issues of selection bias from students that might not have randomly not sat the exam, we were able to identify for each grade and school the share of test takers with no test score and whether these test takers were identified as receiving special education status.[4]

[4] Over time, the method used to classify students as receiving special education has changed slightly. For each test year we attempted to use a consistent method for identifying these students given these constraints. For more information on how we addressed and various other issues on student characteristics, please contact the authors.

We compared the number of potential test takers by grade with the fall enrollment figures we had for the schools. Given the enrollment figures were obtained in the fall and the test was administered in the spring, we expected there to be some slippage in the enrollment and test taker counts. In instances where there was a substantial discrepancy in these counts, we investigated the data further. In some instances the school's unique identifier was miscoded. Because we were given the name of the school, we were able to use hand checking to identify the appropriate school number to use in order to match the test level data with the school level data.

As explained in more detail in the paper, we observed that some schools had dramatically low numbers of students for whom we observe a test score. To refine our estimation, we excluded schools with a high number of non-test takers.

Linking of school data to Census and location measures

For each school we were given the last known address. We used the first three characters of the postal code to identify the "Forward Sortation Area" (FSA) of the school. Using the FSA we then matched census data from 1991, 1996, and 2001 to schools. If the current FSA did not exist for earlier years, we identified the FSA that most likely was covered historically and used census measures across all three periods that corresponded to the area covered by the school for all three census years. In some instances the FSA census data were suppressed and/or it was clear that the area covered by the FSA did not represent the area that was likely to be the school's catchment area. This usually occurred in rural areas where there was a small town that had an distinct FSA from the rural parts. We used the census measures for the broader area when it was clear that a school's enrollment included families residing in both the rural area and the small town.

For each school address, we used data provided by researchers at Carleton University to identify the longitude and latitude of each school location. If instances where the school address was given as a post office box, we used the longitude and latitude for the centroid of the postal code. For more information on the data from this source, please see www.geocoder.ca.

Appendix 2:

Construction of Circle Data Set

For each opening and closing school we constructed a "pre-defined" circle based on the average distance traveled by students to schools in the area.[1] We then refined the circle by excluding schools that were identified to be within the circle for which there is a physical obstacle preventing it from being a reasonable competitor. These obstacles include expressways, ravines, and industrial/commercial areas. We also included schools that were outside of the pre-defined circle if it appeared that the school was close enough to the opening/closing school to be a potential competitor. Our judgments were based on an examination of detailed satellite images that mapped the school addresses. In instances where the satellite image was unclear and/or the few school addresses that could not be found by the mapping software, we used print maps of Ontario streets that contain markers for existing and many previously existing schools.[2]

Across the 735 identified changes, we identified at least one school in 559 circles. There are 58 public openings, 35 separate openings, 74 public closings, and 10 separate closures for which there were no existing schools within a reasonable distance. We then eliminated circles that contained only rural schools that were affected by the change. This leaves a total of 442 changes that affected at least one non-rural school. Table Appendix 2 presents summary statistics on the refined circles we have selected by type of change.

[1] For more recent years of the school enrollment data, we were able to obtain counts of students attending the school based on their postal codes. This type of data is somewhat noisy as when compared with the location of the school there can be unrealistic distances between the students home postal code and the school. Moreover, we have this information for only those schools that were operating in the latter years of the sample. We, therefore, used this information to identify a baseline circle size of the catchment area of schools located in a given region.

[2] To define the circles, we used the latitude and longitude of the school based on its most recent street address. While information on latitude and longitude is publicly available from several sources, we found the most reliable source of this information from www.geocoder.ca. The individuals that provide this service have taken publicly available data and corrected them. Through our examination of printed maps and satellite images, we randomly confirmed that the information we received from Geocoder was better than the information from government sources.

In Panel B of Appendix Table 2 we report statistics on the circles for which we identified at least one non-rural affected school. The share of circles with existing public schools ranges from 86 to 100 percent. The share of circles with existing separate schools ranges between 73 and 95 percent. For approximately 20-25 percent of the opening circles and 60-65 percent of the closing circles we excluded schools that were identified in the pre-defined circles. For approximately 55-65 percent of the opening schools and 43-50 percent of the closing schools we added schools that are located outside of the pre-defined circle. A small proportion of the openings and closings only use schools located outside of the pre-defined circle.

Example of Circle Modification

Elkhorn Public School opened in 1996 in North York, a community that is a part of the Toronto District School Board.[3] In 1996 it had a total enrollment of 297 students. Students were enrolled in grades from kindergarten to grade 4. In 1997, enrollment grew to 371 and the school had students enrolled from kindergarten to grade 5. For the rest of the sample period, this school has had students enrolled in all of these grades. Approximately 65 percent of the students have a primary language other than English.

For this area, we estimated an average distance to school of 2.2 kilometers. We identified and mapped all schools that were in operation at the time of the opening up to 3.2 kilometers. For these schools we mapped the location (based on their addresses) using a satellite image and using printed maps that contain the specific location of schools. Below is a depiction of those schools that were within a radius of just less than 2.2 kilometers. We do not depict the school that are beyond 2.2. kilometers from the school as the decision of whether to keep it was based on the decision regarding Lescon Public School (a school within the 2.2 kilometer radius).

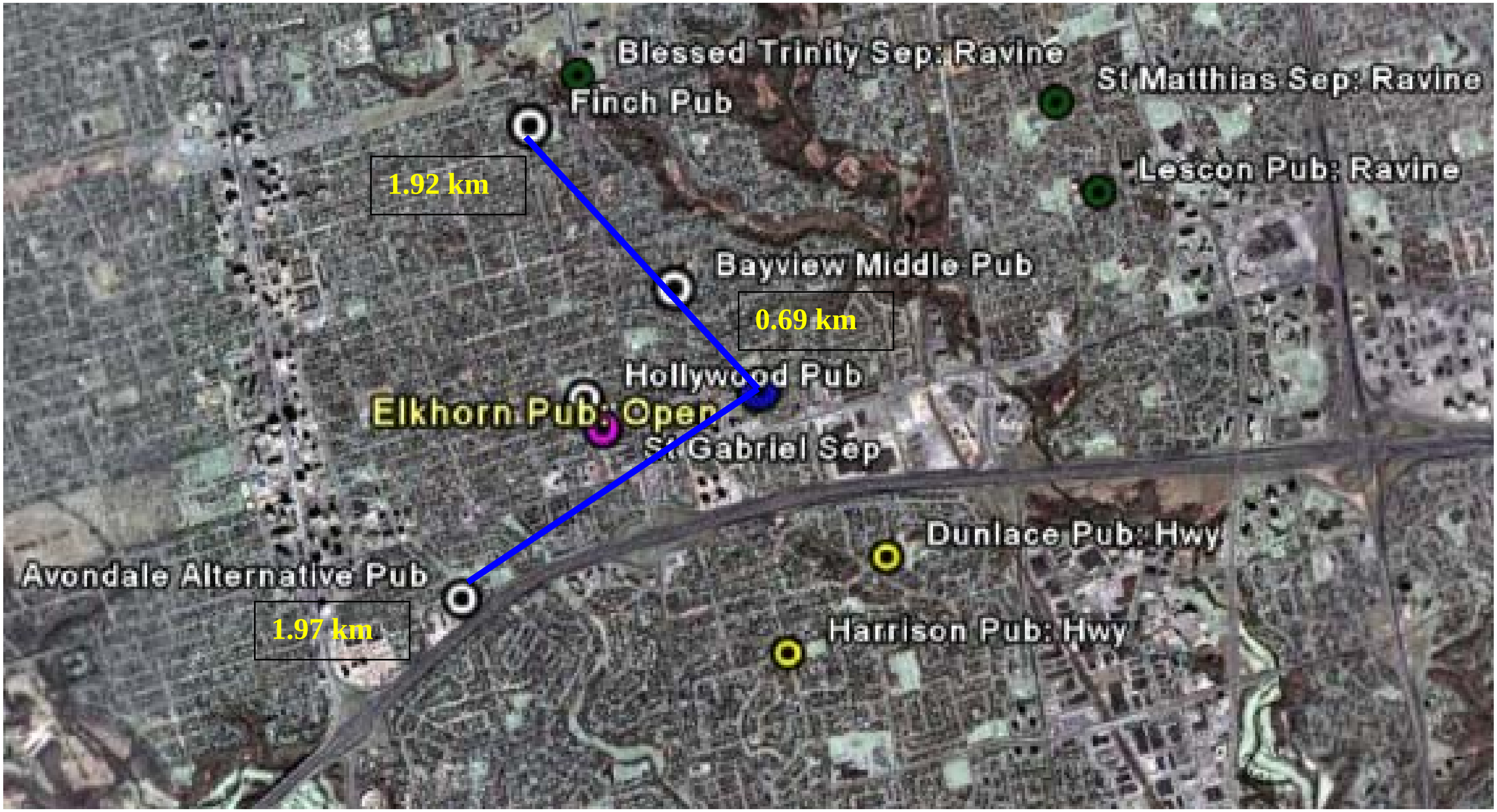
[3] On the location of this school, there was a public school that closed in 1985.

Depicted are 10 schools, 7 are public and 3 are separate. Among the public schools is Bayview Middle School. Until 1995 it offered grades kindergarten to grade 8. From 1996 onwards, the school has only offered grades 6 to 8. Thus, it appears that, in part, Elkhorn was established to take over the enrollment for Bayview. Another public school in the area is Avondale Elementary Alternative School. The school is alternative in that it allows for self-directed learning. It covers all elementary grades. Since opening (in 1992), the enrollment has been just slightly under 100 students. The remaining 5 public schools have average enrollments in grades 1 to 6 during the sample period that range between 126 and 281 students. Of the three separate schools depicted, average enrollment in grades 1 to 6 ranged between 163 and 296 students over the sample period.

There are two issues that caused us to restrict the sample of schools treated as being within a close distance of the opened school. First, there is a major freeway (Highway 401) that is located south of Elkhorn. This resulted the in the exclusion of Dunlace and Harrison Public Schools. Second, there is a ravine. This excluded two of the three separate schools (Blessed Trinity and St. Mathias) and one of the public schools (Lescon). The remaining schools are located within 2 kilometers of Elkhorn. Given students could reside in areas between Elkhorn and these schools, it seems reasonable to include these schools as ones that are potentially affected by the opening.

This leaves, however, only one potentially competing separate school. Blessed Trinity is just beyond the ravine and is close to Finch Public School, a school that is treated as within the circle of the opening. Figure 2 provides a more detailed image of the area around Blessed Trinity. Figure 2 shows that Blessed Trinity and Finch schools are separated by two major roads. Moreover, there are few houses that lie in between these schools. It appears that Blessed Trinity draws its students from the houses that located north east of the school, an area that is farther away from Elkhorn. Therefore, we decided that this school should not be treated as being potentially affected by the opening.

Figure A2-1



Blessed Trinity Sep: Ravine
St Matthias Sep: Ravine
Finch Pub
Lescon Pub: Ravine
1.92 km
Bayview Middle Pub
0.69 km
Hollywood Pub
Elkhorn Pub: Open
St Gabriel Sep
Dunlace Pub: Hwy
Avondale Alternative Pub
1.97 km
Harrison Pub: Hwy

Figure A2-2

Appendix Table 2: Statistics on Circles For Opening and Closing Schools

Panel A	Total changes	# w/ NO nearby school	# w/at least one non-rural school
Public School Opening	252	58	159
Separate School Opening	169	34	107
Public School Closure	212	74	97
Separate School Closure	102	10	79

Panel B: Statistics for Circles w/ Non-Rural Schools	%w/ Public Schools	% w/ Separate Schools	% Exclude Schools in Pre-Defined Circles	% Include Schools Outside of Pre-Defined Circles	% Include Only Schools Outside of Pre-Defined Circles
Public School Opening	86.2%	92.5%	23.9%	54.7%	13.8%
Separate School Opening	87.9%	72.9%	20.6%	64.5%	16.8%
Public School Closure	96.9%	94.8%	64.9%	43.3%	5.2%
Separate School Closure	100.0%	81.0%	62.0%	49.4%	1.3%

Appendix Table 3: Distribution of Affected Schools by Numbers of Opening and Closing Events that Affect the School

	Number of Closings:			
	None	One Closing	Two Closings	Three-Four Closings
Number of Openings:				
None	0	337	101	24
One Opening	272	48	12	9
Two Openings	90	7	1	0
Three Openings	34	0	0	0
Four-Six Openings	18	0	0	0

Note: sample of affected schools includes only non-rural schools.

Appendix Table 4: Census-Based Characteristics of non-Rural FSA's w/ School Changes

	Mean for FSA's with:			
	No Changes	School Openings	School Closings	Openings &Closings
Number of FSA's	183	77	92	45
Basic FSA Characteristics:				
Total population	24,429	26,123	25,217	30,312
Population Growth (annual)	1.99%	2.96%	0.29%	0.72%
Average Income (2001 dollars)	67,150	77,457	58,667	62,663
(standard deviation)	(26,402)	(17,284)	(16,044)	(15,395)
Share of Houses Built After 1990	7.42%	19.00%	3.79%	7.34%
Presence of Children:				
Share of population age 5-9	6.6%	8.1%	6.0%	6.8%
Share of population age 10-14	6.5%	7.6%	5.9%	6.7%
Family Characteristics:				
Share Single Parent Families	21.82%	16.52%	27.35%	23.34%
Share with 1 Child	41.94%	36.44%	44.73%	41.30%
Share with 3+ Children	18.25%	19.53%	17.12%	17.98%
Education (Adult Population):				
Share with University Degree	21.68%	22.75%	21.07%	18.97%
Share without High School Diploma	30.05%	25.53%	32.95%	30.12%
Ethnicity and Language:				
Share that Speak English at Home	90.31%	92.99%	87.36%	93.76%
Share Immigrations	23.19%	31.13%	28.79%	21.05%
Share European Ancestry	44.60%	41.10%	46.70%	41.78%
Share East Asian Ancestry	4.82%	8.70%	7.55%	4.18%
Share Southwest Asian Ancestry	3.41%	6.88%	3.64%	2.21%
Religious Affiliation:				
Share Catholic	34.53%	38.37%	40.32%	33.22%
Share Protestant	41.59%	35.44%	33.46%	44.64%
Share No Religion	15.01%	14.01%	15.46%	15.42%

Note: based on FSA-tabulations of 1991-1996-2001 Censuses.

Appendix Table 5: Summary Statistics for ALL EQAO Test Takers

	Public Schools		Separate Schools	
	Grade 3	Grade 6	Grade 3	Grade 6
	(1)	(2)	(3)	(4)
Reading Tests				
Number of observations	293,146	327,443	154,565	167,482
Average Score (1-4 Scale)	2.52	2.68	2.52	2.70
(standard deviation)	(0.76)	(0.75)	(0.75)	(0.73)
Share of Students with Missing Score	0.12	0.08	0.11	0.07
Share of Missing Students Identified as Excep	0.23	0.12	0.26	0.14
Share in School Cohorts Under Study	0.73	0.70	0.96	0.91
Mathematics Tests				
Number of observations	314,614	330,125	160,318	168,228
Average Score (1-4 Scale)	2.73	2.69	2.67	2.68
(standard deviation)	(0.75)	(0.81)	(0.73)	(0.79)
Share of Students with Missing Score	0.09	0.08	0.08	0.06
Share of Missing Students Identified as Excep	0.23	0.12	0.28	0.14
Share in School Cohorts Under Study	0.73	0.72	0.96	0.92
Writing Tests				
Number of observations	302,282	333,240	158,770	169,743
Average Score (1-4 Scale)	2.66	2.67	2.68	2.71
(standard deviation)	(0.66)	(0.71)	(0.65)	(0.75)
Share of Students with Missing Score	0.10	0.07	0.08	0.06
Share of Missing Students Identified as Excep	0.25	0.13	0.29	0.15
Share in School Cohorts Under Study	0.73	0.70	0.95	0.91

Notes: based on standardized tests administered in 1998-2006 to students in Grades 3 and 6.

Appendix Table 6: Coefficients on All Measures for Test Growth Competition Models

Dependent Variable: Performance on Test	Reading			
	(1)	(2)	(3)	(4)
Value Added Measures-- See Table 6				
Student Characteristics				
Dummy = 1 if Student is Female	0.158	0.158	0.158	0.158
	(0.003)	(0.003)	(0.003)	(0.003)
Female * Grade 6 Test Taker	0.047	0.047	0.047	0.047
	(0.003)	(0.003)	(0.003)	(0.003)
Dummy = 1 if Gender is Missing from Student Record	0.079	0.079	0.079	0.079
	(0.012)	(0.012)	(0.012)	(0.012)
Dummy = 1 if Student is Identified as ESL	-0.422	-0.422	-0.422	-0.422
	(0.010)	(0.010)	(0.010)	(0.010)
ESL * Grade 6 Test Taker	0.039	0.039	0.039	0.039
	(0.014)	(0.014)	(0.014)	(0.014)
Dummy = 1 if Student is Identified as Exceptional (Special Education)	-0.530	-0.530	-0.530	-0.530
	(0.010)	(0.010)	(0.010)	(0.010)
Exceptional * Grade 6 Test Taker	-0.028	-0.028	-0.027	-0.028
	(0.014)	(0.014)	(0.014)	(0.014)
Dummy = 1 if Student Attended Kindergarten (optional in Ontario)	0.052	0.052	0.052	0.053
	(0.006)	(0.006)	(0.006)	(0.006)
Kindergarten * Grade 6 Test Taker	0.074	0.074	0.074	0.074
	(0.009)	(0.009)	(0.009)	(0.009)
Dummy =1 if Kindergarten Status is Missing in Student Record	-0.013	-0.013	-0.013	-0.013
	(0.008)	(0.008)	(0.008)	(0.008)
Dummy = 1 if Student is Enrolled in French Immersion	0.095	0.096	0.093	0.093
	(0.018)	(0.018)	(0.019)	(0.019)
French Immersion * Grade 6 Test Taker	0.203	0.203	0.206	0.205
	(0.021)	(0.021)	(0.021)	(0.021)
Dummy = 1 if Student is Identified as Gifted	1.095	1.095	1.096	1.096
	(0.023)	(0.023)	(0.023)	(0.023)
Gifted * Grade 6 Test Taker	-0.198	-0.198	-0.198	-0.198
	(0.026)	(0.026)	(0.026)	(0.026)
School Level Measures				
Mean ESL in Grade (Test & Non-Test Takers) for School * Grade 6 Test Taker	0.321	0.320	0.320	0.314
	(0.060)	(0.060)	(0.060)	(0.061)
Mean Exceptional in Grade (Test & Non-Test Takers) * Grade 6	0.310	0.310	0.317	0.310
	(0.053)	(0.053)	(0.053)	(0.053)
Mean Gifted in Grade (Test & Non-Test Takers) * Grade 6	-0.445	-0.446	-0.455	-0.458
	(0.076)	(0.076)	(0.076)	(0.075)
Mean Female in Grade (Test & Non-Test Takers) * Grade 6	0.095	0.096	0.094	0.093
	(0.034)	(0.034)	(0.034)	(0.034)
Mean Kindergarten Status in Grade (Test & Non-Test Takers) * Grade 6	-0.130	-0.130	-0.130	-0.130
	(0.011)	(0.011)	(0.011)	(0.011)
Mean French Immersion in Grade (Test & Non-Test Takers) * Grade 6	-0.101	-0.101	-0.097	-0.098
	(0.027)	(0.027)	(0.027)	(0.027)
Share of Missing Test Takers for School	-0.242	-0.241	-0.242	-0.242
	(0.030)	(0.030)	(0.030)	(0.030)
Share of Missing Test Takers Identified as Exceptional for School	0.059	0.060	0.058	0.059
	(0.009)	(0.009)	(0.009)	(0.009)
Census Measures				
Fraction Immigrant * Grade 6 Test Taker	-0.209	-0.204	-0.202	-0.209
	(0.062)	(0.062)	(0.062)	(0.062)
Fraction Ethnicity Southwest Asian * Grade 6 Test Taker	0.357	0.350	0.373	0.379
	(0.106)	(0.106)	(0.106)	(0.106)
Fraction Ethnicity East Asian * Grade 6 Test Taker	0.341	0.341	0.335	0.346
	(0.072)	(0.071)	(0.071)	(0.071)
Fraction Ethnicity European * Grade 6 Test Taker	0.048	0.049	0.074	0.072
	(0.038)	(0.038)	(0.037)	(0.037)
CONSTANT	2.432	2.431	2.432	2.431
	(0.008)	(0.008)	(0.008)	(0.008)
SchoolxCohort Effect	yes	yes	yes	yes

Table 1: Summary Statistics on Opening and Closing Schools and Affected Schools

Panel A: Statistics on Schools that Open or Close

	Total Number of Events	Share of Events 1998 or Later	Share with 1+ Nearby Non-Rural Schools	Mean Enrollment: At Schools with 1 or More Nearby Non-Rural Schools	Mean Enrollment: At Schools without a Nearby Non-Rural School
	(1)	(2)	(3)	(4)	(5)
Public Opening	252	0.599	0.631	303.9	282.8
Separate Opening	169	0.604	0.633	315.5	285.8
Public Closing	212	0.717	0.458	228.9	208.5
Separate Closing	102	0.765	0.775	247.4	185.9

Note: see text for definitions. Enrollment measure used in columns 4-5 is maximum combined enrollment in grades 1-6 observed at opened or closed school during sample period.

Panel B: Mean Distance to Non-Rural Affected Schools (kilometers)

	Mean Distance to: All Affected Schools	Mean Distance to: Affected Public Schools	Mean Distance to: Affected Separate Schools
	(1)	(2)	(3)
Distance to Newly Opened Public School	1.12	1.21	1.02
# of schools	473	244	229
Distance to Newly Opened Separate School	1.21	1.13	1.06
# of schools	261	168	93
Distance to Newly Closed Public School	1.07	1.12	0.98
# of schools	414	244	170
Distance to Newly Closed Separate School	0.957	0.908	1.055
# of schools	330	220	110

Note: mean distance calculated to schools within affected circle only. Diameter of affected circle around opening or closing school based on local travel distances: see text. Schools affected by multiple openings/closings are included for each change.

Panel C: Distribution of Affected Schools by Numbers of Opening/Closing Events

	Type of Event: Public Opening	Separate Opening	Public Close	Separate Close
Total Number of Schools	159	107	97	79
Number of Non-rural Schools Affected:				
One School	24	24	6	4
Two Schools	49	38	15	9
Three Schools	31	25	27	22
Four Schools	28	15	16	15
Five Schools	21	4	3	11
Six Schools	2	1	13	7
Seven+ Schools	4	0	17	11

Note: Counts of opening/closing schools include only those with 1 or more nearby non-rural schools.

Table 2: Summary Statistics on Enrollment Growth Measures

	Public Schools	Separate Schools
Grade 1 Enrollment	50.4	44.3
Standard Deviation	(23.3)	(21.0)
Number of Observations	7554	5290
Proportional Change in Grade 1 Enrollment from Last Year to Current Year	1.87	2.38
Standard Deviation	(26.41)	(30.54)
Number of Observations	6994	4893
Proportional Change in Enrollment from Grades 1-5 Last Year to Grades 2-6 This Year	0.13	0.42
Standard Deviation	(17.35)	(12.49)
Number of Observations	7067	4940

Note: samples include school-year observations for non-rural schools affected by at least one opening or closing over the sample.

Table 3: Enrollment Growth Models for Schools Affected by Nearby Openings and Closings

	Percentage Change in Enrollment:	
	Grade 1 (t-1) to Grade 1 (t)	Grades 1-5 (t-1) to Grades 2-6 (t)
	(1)	(2)
Effects of Nearby Openings:		
Own Effects:		
1. Effect on Public School of Public Opening	-6.3	-4.0
	(1.5)	(0.9)
2. Effect on Separate School of Separate Opening	-7.9	-7.0
	(2.1)	(1.2)
Cross Effects:		
3. Effect on Separate School of Public Opening	-4.5	-2.2
	(1.4)	(0.7)
4. Effect on Public School of Separate Opening	-4.1	-3.2
	(1.7)	(0.9)
Effects of Nearby Closings:		
Own Effects:		
5. Effect on Public School of Public Closing	1.7	3.1
	(1.4)	(1.5)
6. Effect on Separate School of Separate Closing	1.2	2.7
	(2.2)	(0.9)
Cross Effects:		
7. Effect on Separate School of Public Closing	-2.0	-0.1
	(2.4)	(0.7)
8. Effect on Public School of Separate Closing	0.2	-1.6
	(1.4)	(1.0)
School fixed effects	Yes	Yes
Time-varying school characteristics	Yes	Yes
Time-varying local characteristics	Yes	Yes
Number of Observations	11,887	12,007
Number of Schools	939	945

Note: standard errors in parentheses. School characteristics are a dummy for being paired with another school for administrative purposes, the share of new teachers, and the years experience of the principal as a principal. Local characteristics are total population in the FSA, shares of population age 5-9 and 10-14, the share of recently constructed houses in the FSA, fraction of FSA residents who are Catholic, immigrants, and of East Asian, South Asian, or European ethnicity, average houshold income, fraction of population w/ a univeristy degree, no high school degree, fraction of 1 parent families, fraction of families with 2 or 3 kids, home language not English.

Table 4: Additional Enrollment Growth Models

Dependent variable: percentage change in enrollment from grades 1-5 (year t-1) to grades 2-6 (year t)

	(1)	(2)	(3)	(4)	(5)	(6)
Own Effects:						
1. Effect on Public School of Public Opening	-4.0	-0.3	-3.9	-3.8	-0.3	-0.2
	(0.9)	(1.1)	(0.8)	(0.9)	(1.1)	(1.1)
2. ...interacted with population growth for FSA		-126.2			-123.0	-123.5
		(29.4)			(29.1)	(29.2)
3. Effect on Separate School of Separate Opening	-7.0	-5.8	-7.0	-6.9	-5.8	-5.9
	(1.2)	(1.5)	(1.2)	(1.2)	(1.5)	(1.5)
4. ...interacted with population growth for FSA		-30.7			-25.6	-24.8
		(34.5)			(33.8)	(33.8)
Cross Effects:						
5. Effect on Separate School of Public Opening	-2.2	-0.8	-2.1			
	(0.7)	(0.8)	(1.8)			
6. ...interacted with population growth for FSA		-43.5				
		(13.7)				
7. ...interacted with share of Catholics in local area			-0.5	-5.2	-2.1	
			(4.6)	(1.8)	(2.1)	
8. ...interacted with share of Catholics in local area × population growth for FSA					-85.7	-105.6
					(36.1)	(30.4)
9. Effect on Public School of Separate Opening	-3.2	-0.5	4.4			
	(0.9)	(0.9)	(3.9)			
10. ...interacted with population growth for FSA		-78.4				
		(35.3)				
11. ...interacted with share of Catholics in local area			-20.9	-9.4	-1.7	
			(10.5)	(2.5)	(2.7)	
12. ...interacted with share of Catholics in local area × population growth for FSA					-195.2	-211.8
					(93.4)	(78.1)
Own-system and cross-system closing effects	Yes	Yes	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time-varying school characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Time-varying local characteristics	Yes	Yes	Yes	Yes	Yes	Yes

Notes: standard errors in parentheses. See Table 3 for list of additional covariates.

Table 5: Summary Statistics for EQAO Test Takers

	Public Schools		Separate Schools	
	Grade 3	Grade 6	Grade 3	Grade 6
	(1)	(2)	(3)	(4)
Test-Taker Characteristics for Students with At Least One Test Score:				
Number of observations	323,508	340,259	164,502	172,409
Share Female	0.49	0.49	0.49	0.49
… Share missing Gender	0.01	0.01	0.01	0.005
Share ESL Students	0.06	0.05	0.02	0.02
Share Exceptional Students	0.04	0.04	0.03	0.03
Share Attended Kindergarden	0.86	0.73	0.89	0.75
… Share Missing Kindergarden Information	0.06	0.24	0.04	0.23
Share French Immersion Students	0.09	0.06	0.04	0.04
Share Gifted Students	0.01	0.02	0.001	0.01
Share with Test Scores for All Three Tests	0.64	0.65	0.87	0.86
Reading Tests				
Number of observations	212,761	229,650	147,721	152,638
Average Score (1-4 Scale)	2.52	2.68	2.52	2.70
(standard deviation)	(0.76)	(0.74)	(0.75)	(0.73)
Share of Students with Missing Score	0.13	0.09	0.10	0.07
Share of Missing Students Identified as Exce	0.23	0.12	0.26	0.14
Mathematics Tests				
Number of observations	230,562	238,153	153,117	154,042
Average Score (1-4 Scale)	2.73	2.71	2.68	2.68
(standard deviation)	(0.75)	(0.80)	(0.73)	(0.79)
Share of Students with Missing Score	0.09	0.08	0.08	0.06
Share of Missing Students Identified as Exce	0.23	0.12	0.28	0.14
Writing Tests				
Number of observations	219,835	233,759	151,622	154,773
Average Score (1-4 Scale)	2.66	2.67	2.69	2.71
(standard deviation)	(0.66)	(0.71)	(0.65)	(0.69)
Share of Students with Missing Score	0.10	0.07	0.08	0.06
Share of Missing Students Identified as Exce	0.25	0.14	0.29	0.15

Notes: based on standardized tests administered in 1998-2006 to students in Grades 3 and 6.

Table 6: Test Growth Competition Models

Dependent Variable: Performance on Test	Reading				Mathematics				Writing			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Value Added Measures:												
Share Catholic * Grade 6	0.09				0.09				0.05			
	(0.04)				(0.06)				(0.03)			
Share Catholic * Grade 6 * Public School		0.12				0.14				0.07		
		(0.06)				(0.08)				(0.05)		
Share Catholic * Grade 6 * Sep. School		0.06				0.03				0.04		
		(0.06)				(0.07)				(0.04)		
Share Catholic * Pop. Growth * Grade 6			1.48				2.13				0.97	
			(0.68)				(1.03)				(0.56)	
Share Catholic * Pop. Growth * Grade 6 * Public School				2.73				3.17				1.49
				(0.97)				(1.52)				(0.71)
Share Catholic * Pop. Growth * Grade 6 * Separate School				1.52				2.17				0.99
				(0.70)				(1.06)				(0.57)
Dummy = 1 if Test Taker in Grade 6	0.06	0.05	0.07	0.07	-0.20	-0.22	-0.18	-0.18	-0.09	-0.10	-0.08	-0.08
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)	(0.02)
Separate School * Grade 6 Test Taker	0.02	0.04	0.03	0.03	0.02	0.06	0.03	0.03	0.02	0.03	0.02	0.02
	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)	(0.04)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Population Growth * Grade 6 Test Taker	0.03	0.04	-0.57	-0.85	0.24	0.25	-0.64	-0.88	0.08	0.09	-0.32	-0.43
	(0.13)	(0.14)	(0.34)	(0.38)	(0.20)	(0.20)	(0.50)	(0.57)	(0.11)	(0.11)	(0.27)	(0.28)
School x Cohort Fixed Effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R-Square	0.16	0.16	0.16	0.16	0.18	0.18	0.18	0.18	0.16	0.16	0.16	0.16
Number of Observations	742,770				775,874				759,989			

Notes: standard errors (clustered by school) are reported in parentheses. All models include student-level characteristics (with grade-specific coefficients), school-cohort means of student-level characteristics (interacted with Grade 6 dummy), FSA-level population characteristics (interacted with Grade 6 dummy). Student level controls are dummies for gender, attended kindergarten, exceptiona and gifted status, ESL, French immersion, and dummies for missing data on gender or kindergarten attandence. FSA-level variables are share of immigrants in FSA and shares of 3 main ethnic groups (South Asians, East Asians, and Europeans).

Table 7: Additional Test Growth Competition Models

Dependent Variable: Performance on Test	Reading				Mathematics				Writing			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Value Added Measures:												
Competition Index Based on Share of Catholics	1.27	0.89			1.32	0.04			0.72	-0.27		
	(0.64)	(0.87)			(0.84)	(1.14)			(0.48)	(0.65)		
Competition Index Based on Share of Catholics * Population Growth			1.25	1.09			1.34	1.07			0.64	0.46
			(0.75)	(0.70)			(0.96)	(0.89)			(0.45)	(0.40)
Fraction with No Religion * Grade 6		-0.09		-0.15		-0.42		-0.39		-0.21		-0.17
		(0.13)		(0.10)		(0.18)		(0.15)		(0.10)		(0.08)
Fraction with Non-Christian Religion * Grade 6		-0.03		-0.06		-0.04		-0.02		-0.10		-0.08
		(0.08)		(0.07)		(0.12)		(0.09)		(0.06)		(0.05)
Dummy = 1 if Test Taker in Grade 6	0.05	0.07	0.07	0.11	-0.21	-0.09	-0.19	-0.08	-0.10	-0.04	-0.08	-0.04
	(0.03)	(0.05)	(0.03)	(0.04)	(0.04)	(0.07)	(0.04)	(0.05)	(0.02)	(0.04)	(0.02)	(0.03)
Separate School * Grade 6 Test Taker	0.04	0.04	0.03	0.03	0.04	0.02	0.04	0.03	0.03	0.01	0.03	0.02
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Population Growth * Grade 6 Test Taker	0.04	0.03	-0.78	-0.71	0.24	0.21	-0.64	-0.51	0.09	0.07	-0.33	-0.24
	(0.13)	(0.13)	(0.42)	(0.40)	(0.20)	(0.19)	(0.58)	(0.56)	(0.11)	(0.11)	(0.28)	(0.26)
School x Cohort Fixed Effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R-Square	0.16	0.16	0.16	0.16	0.18	0.18	0.18	0.18	0.16	0.16	0.16	0.16
Number of Observations	742,770				775,874				759,989			

Notes: standard errors (clustered by school) are reported in parentheses. See note to Table 6 for other included covariates. Competition indexes are constructed regressors based on estimated effect of nearby school opening by competing system on enrollment growth. See text for further discussion. Standard errors of competition indexes are adjusted for sampling errors of "first stage" coefficients used to construct these variables.